NUTRITION ENHANCEMENT IN EARLY PSYCHOSIS (NEEP): A FEASIBILITY TRIAL OF ENHANCED NUTRITION WITH TEXT MESSAGING AND A DIETARY TRACKING MOBILE APPLICATION

by

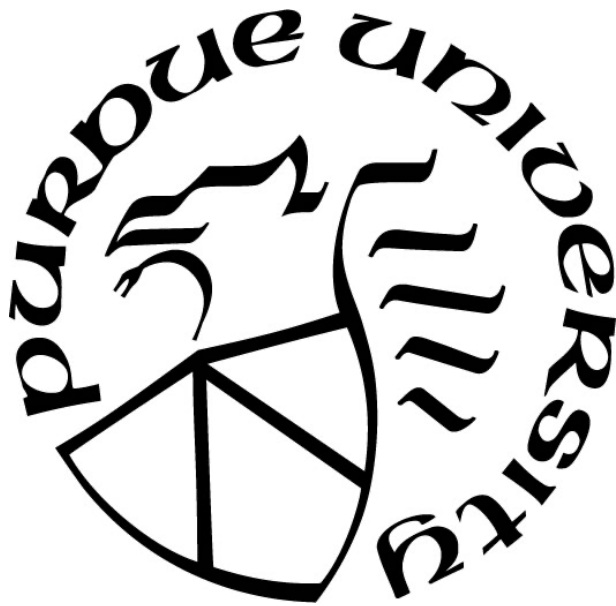**Melanie W. Fischer**

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This dissertation is dedicated to my little family: Ian, Zoey, and Ziggy.
You make my life so full of joy. I love you all so much.

I would also like to dedicate my dissertation to my mentor, Dr. Michelle Salyers. Throughout everything, you have always had my back. I am grateful for all the ways you have advocated for and protected me, but also pushed me throughout graduate school.
You are a great mentor and friend.

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ABSTRACT

Background. People with psychotic disorders tend to die earlier than the general population, primarily due to preventable cardiovascular disease. Behavioral risk factors, such as poor diet, have been identified as major contributors. Given the importance of prevention, the early stages of psychosis have been described as a "critical" time to intervene on health behaviors. As such, a mobile-based intervention, Nutrition Enhancement in Early Psychosis (NEEP) was created to improve diet quality in persons with early psychosis. This study has three aims: (1) assess the feasibility of the intervention, (2) examine preliminary outcomes, and (3) investigate mechanisms associated with dietary change.

Methods. NEEP incorporates a combination of nutrition education, goal setting, and mobile technology (i.e., a mobile application for dietary tracking, as well both automated and personalized text-messages). Given the pilot nature of the study, all participants *(N=15)* received the intervention. Feasibility was assessed through different metrics related to recruitment and adherence to the dietary tracking application, as well as self-report responses regarding acceptability. Preliminary outcomes (i.e., two measures of diet quality) and potential mechanisms of change (i.e., self-efficacy and motivation) were also evaluated using paired sample t-tests. Qualitative interviews were conducted following study participation. Given the emphasis on feasibility with a small sample, all significance tests were set at p <.10, and Hedges *g* was used to examine effects over time.

Results. 15 participants were enrolled in the study and 12 participants completed follow-up assessments. Evaluative measures of feasibility suggest that the majority of those who were screened enrolled in this intervention and regularly engaged with the mobile tracking device to record their dietary consumption. In addition, participants enjoyed the intervention and found it to be useful in improving their diet. Preliminary evidence also suggests this intervention may improve diet quality. As such, one indicator of improvement in diet quality was considered significant (Rapid Eating Assessment for Participants- Shortened; p=.084), and both measures of diet quality suggested improvement in diet at the end of the 28-day intervention with small to medium effect sizes (REAP-S *g*=.44; Heathy Eating Index-2015 *g*=.69). Contrary to hypotheses,

self-efficacy significantly decreased after the intervention (p=.028) and motivation remained relatively stable.

Conclusion. Results suggest that NEEP is feasible as a low-cost, low-resource mobile intervention that is well-tolerated and may improve diet quality in people with early psychosis; however, mechanisms of change require further exploration.

Keywords: Psychosis; First Episode; Diet; Nutrition; Mobile; Digital technology; MHealth

INTRODUCTION

People with severe mental illness (SMI), particularly those with psychotic disorders, die earlier than the general population, primarily due to preventable cardiovascular disease (CVD; Correll et al., 2017). Increasingly, diet has been recognized as a major contributor to CVD (Sievenpiper & Lavie, 2018; Sotos-Prieto et al., 2017); as such, dietary improvement may be warranted for people with severe mental disorders to prolong lifespan (Firth et al., 2018). One method which has shown promise for behavior modification in people with SMI, and may be a useful means of improving diet in this population, is through the use of mobile phones (Berry, Lobban, Emsley, & Bucci, 2016). Because prevention efforts are more effective for minimizing long term cardiovascular complications than remediation efforts (i.e., treatment of cardiovascular disease), the early stages of psychosis have been described as a "critical period" for targeting lifestyle behaviors, such as diet (Teasdale, Ward, Rosenbaum, Samaras, & Stubbs, 2017). The aim of the current project is to examine the feasibility and preliminary effectiveness of a novel mobile intervention to improve diet in those with early psychosis.

SMI and Early Mortality

People with SMI die as many as 15 to 25 years earlier than the general population (De Hert et al., 2011; Reininghaus et al., 2014). It is accepted that this early death rate is largely driven by elevated instances of cardiovascular disease (CVD) and cardiovascular-related deaths (Correll et al., 2017; Lawrence, Kisely, & Pais, 2010). Indeed, metabolic risk factors for CVD (e.g., high blood pressure, elevated C-reactive protein) arise 10-15 years earlier in this population (Bener, Al-Hamaq, & Dafeeah, 2014), and those with psychotic disorders are more likely to have cardiovascular incidents controlling for other risk factors (e.g., socioeconomic status, medical cormorbities; Guillen-Aguinaga et al., 2022). As a result, those with SMI are approximately four-times more likely than the general population to die as a result of these problems (Osborn et al., 2007). These high levels of disease are problematic on an individual level (e.g., early mortality and reduced quality of life due to physical illness), but also on a broader societal level, with substantial health care costs among this group. Even though estimates have not been conducted for treating CVD in SMI populations, the overall management of CVD in the United

States is approximately 500 billion dollars annually (Bloom et al., 2012). In the case of schizophrenia, the large financial burden falls primarily on the government in the United States, with 87% of these individuals relying on Medicare or Medicaid, compared to 26% of the general population (Khaykin, Eaton, Ford, Anthony, & Daumit, 2010). Therefore, preventing cardiovascular disease in this population should be a top priority not only to improve quality of life on an individual level, but also to decrease governmental spending on healthcare.

Higher instances of CVD in people with SMI are thought to occur through multiple pathways. For instance, people with SMI are more likely to engage in behaviors that contribute to CVD such as cigarette smoking and poor eating habits, and are less likely to engage in physical activity (Dickerson et al., 2018; Druss, 2007; Parks, Svendsen, Singer, Foti, & Mauer, 2006). Those with SMI are also thought to be at higher risk of CVD due to the medications used to treat mental illness. In fact, while antipsychotic medications are often effective for controlling the positive symptoms associated with psychosis, these medications have been implicated in metabolic abnormalities (e.g., altered glucose metabolism) as well as the worsening of poor health behaviors (e.g., more sedentary behavior and increased consumption of sugary foods) due to increased lethargy and hunger (Cascade, Kalali, Mehra, & Meyer, 2010). As such, efforts to improve health behaviors early in treatment may be especially important in people with psychosis (Esposito & Giugliano, 2005). Given that antipsychotic medication is often associated with rapid weight gain, as well as a preference for high-fat, high-sugar food (Cascade et al., 2010), improving diet quality may be valuable for the long-term physical health of those with psychosis, and targeting these behaviors during the early stages of psychotic illness may be most effective.

Poor Diet and Cardiovascular Disease

Poor diet may contribute to CVD and early mortality in multiple ways. First, poor diet quality has been identified as an independent predictor of shortened lifespan due to its influence on cardiovascular disease. In a large-scale study with over 73,000 people spanning 12 years, improvements in diet quality predicted a decreased risk of death, even after controlling for other important CVD risk factors (e.g., race, family history of CVD, BMI, physical activity levels, smoking status, etc.; Sotos-Prieto et al., 2017). This is likely because nutrient-poor foods can adversely affect cardiovascular functioning (Caporaso et al., 2020; Jawzali, Saber, & Khalil,

2017; Ostchega, Zhang, Hughes, & Nwankwo, 2018). Specifically, diets high in saturated fats and low in unsaturated fats are associated with increased insulin resistance, dyslipidemia, and higher levels of cholesterol (Riccardi, Giacco, & Rivellese, 2004); in addition, higher intake of certain carbohydrates, especially in the form of refined sugars, is associated with elevated glycemic load (Hu & Willett, 2002). Moreover, low fiber and low fruit consumption is associated with uncontrolled glucose levels (Alissa & Ferns, 2017) and higher levels of inflammatory markers (e.g., C-Reactive protein), which both promote the development and worsening of cardiovascular disease related factors. While weight loss has been associated with reductions in inflammation, evidence suggests that improvement in diet quality, even in the absence of Body Mass Index (BMI) change, can also result in significant reductions in inflammation (Richard, Couture, Desroches, & Lamarche, 2013; Shivappa et al., 2017; Shivappa, Steck, Hurley, Hussey, Ma, et al., 2014). Changing dietary habits to incorporate more nutrient-rich foods and decrease nutrient-poor foods may be a more attainable goal than weight reduction, which is often difficult to do and difficult to sustain.

While improvements in diet have health benefits independent of BMI, the health consequences of obesity cannot be ignored. Obesity (i.e., Body Mass Index (BMI) > 30kg/m^2) has been identified in large, high-quality longitudinal and prospective studies as a major contributor to premature death through its effects on cardiovascular function (e.g., Burke et al., 2008; Fox et al., 2008; Kim, Cho, & Park, 2015); Those with SMI are between two to eight times more likely to be obese than the general population, in part due to rapid weight gain often witnessed at the beginning of antipsychotic treatment (Annamalai, Kosir, & Tek, 2017). Additionally, those with SMI who are obese also tend to have high levels of visceral fat (i.e., fat that surrounds organs concentrated in the abdomen), which has been identified as particularly damaging to cardiovascular health (Elffers et al., 2017; Farnam, Zipple, Tyrrell, & Chittinanda, 1999), placing them at even higher risk of cardiovascular incidents.

Effects of Antipsychotic Medication

As mentioned above, one reason for this weight gain and poor diet quality may be partially due to the medications used to treat severe mental illness. Antipsychotics are widely used for the treatment of psychosis and have revolutionized the treatment of SMI. While these medications can be helpful for reducing symptoms of psychosis such as delusions and

hallucinations, they have also been linked to several health-related concerns that cannot be dismissed. Indeed, the safety of antipsychotic medications has been questioned due to the association with altered glucose and lipid metabolism that often follow their initiation, as well as excessive and rapid weight gain (Allison & Casey, 2001; Henderson et al., 2005; Koro et al., 2002). In fact, metabolic dysfunction begins within weeks of starting antipsychotic medication (Phutane et al., 2011; Pramyothin & Khaodhiar, 2010), and it has been suggested that there is a fivefold increase in CVD-related risk factors within even the first few years of treatment (Saddichha, Manjunatha, Ameen, & Akhtar, 2008). Research has shown antipsychotic medications impact diet quality in people with SMI, and that patients treated with antipsychotics report increased appetite after initiating treatment, as well as an increased caloric intake six months later, particularly in the form of increased consumption of saturated fat, sugar, and foods with a high glycemic index (Treuer et al., 2009). Although mechanisms are not entirely understood, dopamine, serotonin, muscarinic, and histamine receptors have all been implicated in antipsychotic medication-induced hunger changes (Lett et al., 2012). Moreover, the initiation of antipsychotic medications is associated with decreased confidence and self-esteem, often as a direct result of rapid weight gain (McCloughen, Foster, Huws-Thomas, & Delgado, 2012). Unfortunately, but understandably, this uncontrolled weight gain has also been shown to decrease medication compliance (Perkins, 1999). Thus, identifying ways to help people with psychosis manage their diet could not only prolong lifespan, but might also help reduce some of the short-term frustrations associated with taking antipsychotic medication and improve treatment compliance, particularly in young people who may be more sensitive to the negative social consequences of rapid weight gain.

SMI and Poor Diet

It is well-established that those with SMI engage in poor dietary habits, such as the overconsumption of nutrient-poor foods (e.g., fast food, sugary drinks) and the underconsumption of nutrient-rich foods (e.g., whole grains, fruits, vegetables). For example, this population is 30% more likely than those in the general population to consume only one meal per day (Kilbourne, Brar, Drayer, Xu, & Post, 2007), eat fast food regularly, eat sweet and salty snacks every day, and add salt to their food (Kilian, Becker, Krüger, Schmid, & Frasch, 2006). These individuals are also less likely than the general population to report eating fruits or

vegetables regularly (Dipasquale et al., 2013; Kilian et al., 2006) or meet dietary recommendations (DeSalvo, Olson, & Casavale, 2016). People with SMI are more likely to eat in excess, including eating larger portion sizes and more calories (Dipasquale et al., 2013), drinking beverages with high amounts of sugar (Elmslie, Mann, Silverstone, Williams, & Romans, 2001), eating high amounts of fat (specifically high saturated fat) and lower amounts of fiber (S. Brown, Birtwistle, Roe, & Thompson, 1999; Ryan, Collins, & Thakore, 2003). Because those with SMI are more likely to be obese, efforts have primarily focused on weight loss in this population (e.g., Brown, Goetz, Hamera, & Gajewski, 2014; Holt et al., 2018; Naslund et al., 2017). While these studies have demonstrated weight loss and improvements in health, these benefits often do not extend beyond the length of the intervention, suggesting that individuals are not changing their habits long-term. Because evidence suggests that the consumption of calorically dense, nutrient-poor foods is the primary cause of this obesity (Dipasquale et al., 2013), targeted efforts to improve diet *quality* in those with SMI may be more effective and sustainable than effort to promote weight loss, especially if targeted early in the course of psychosis.

Considering this poor diet quality, it is no surprise that those with SMI also have nutrient deficiencies, such as low levels of folate and vitamin B (Aucoin, LaChance, Clouthier, & Cooley, 2020; Firth et al., 2018). These deficiencies are associated with elevated levels of inflammation (Lallès, 2019), which may be more harmful to those with SMI than the general population as psychosis itself is associated with high levels of pro-inflammatory cytokines (Mondelli & Howes, 2014; Ryan et al., 2003). Excessive consumption of high-fat and high-sugar foods can also increase systemic inflammation, and high levels of inflammation have been linked to increased symptomology and worse prognosis of psychotic disorders (Shivappa, Steck, Hurley, Hussey, & Hébert, 2014). Therefore, there is reason to believe that intervening on diet quality may improve both physical and mental health.

Nutritional Interventions

Poor diet is often referenced as a major contributor to early mortality in people with psychotic disorders; however, there has been relatively minimal effort to improve the *quality* of diets in this population. While the few nutritional interventions that have been implemented have been found effective in curbing weight gain and improving diet quality for people with psychotic

disorders (Aucoin et al., 2020; Teasdale et al., 2017), a major limitation of those studies is that they are all multimodal, meaning they incorporated multiple wellness aspects into the interventions (e.g., mindfulness, physical activity, adherence to medication). As such, it is difficult to identify the active ingredient in these interventions and whether changes can be seen when implementing lower-cost, more targeted interventions. In fact, according to a review which synthesized 29 studies of interventions that contained a nutritional element, there has been no efforts to improve diet on its own in psychotic disorders, and even so, most interventions that have a nutritional component have focused on people with long standing psychosis (Teasdale et al., 2017). Only a handful of interventions that contain a nutritional element have even been conducted with those who are in early psychosis (i.e., Alvarez-Jimenez et al., 2006; Curtis et al., 2016; Gaughran et al., 2020; Teasdale et al., 2015; Teasdale et al., 2016) Unfortunately, interventions that only target older adults may be initiated too late for meaningful improvements in physical health factors, considering that risk factors arise between 10-15 years earlier in this population. Modifying health behaviors earlier in life has a longer lasting impact than targeting these behaviors later in life, and these prevention efforts are generally more effective and cost-effective than remediation efforts (Fawzy & Lip, 2021). Therefore, it is essential to conduct research examining ways to improve health in younger individuals with psychosis, a population that is well-known to have poorer health later in life and substantially earlier mortality.

Beyond the age of the target population, there are several limitations to current interventions that need to be addressed. While there is evidence to suggest that nutritional interventions can improve diet and reduce weight gain (Teasdale et al., 2016), these nevertheless may be overly burdensome and not address important mechanisms of behavior change. Many existing nutritional interventions are resource intensive and require numerous in-person visits with mental health providers or dieticians, which has been shown to limit participation ((Scott B Teasdale, Curtis, et al., 2019). For example, existing nutritional interventions may necessitate weekly consultations with a registered dietician (Teasdale et al., 2015)) or mental health professional (Gauphran et al., 2020), weekly shopping tours and cooking groups (Teasdale et al., 2015; Teasdale et al., 2016), multiple in-person education modules (Alverez-Jimenez, 2006), or long-term cognitive behavioral therapy (Gauphran et al., 2020). As such, nutritional interventions for those with early psychosis have focused primarily on psychoeducation, skills building, and problem solving during individual counseling sessions. And, while these are

effective behavior change strategies (Bonfioli, Berti, Goss, Muraro, & Burti, 2012), additional strategies (e.g., motivational enhancement; self-monitoring) have been identified as important for changing diet, both in the general population (Burke, Wang, & Sevick, 2011) and for those with SMI (Teasdale, Ward, et al., 2019). Given the motivational deficits and low levels of self-efficacy in those with SMI (Chang et al., 2017; Fervaha et al., 2014), strategies to increase these mechanisms may stimulate behavior change and improve diet, ultimately reducing the risk of cardiovascular problems.

One way to improve existing nutritional interventions for people with SMI is to target these behaviors with the use of digital technology. Indeed, while paper diaries are the most common method to monitor dietary intake, this method is tedious and has poor adherence, especially for those with SMI (Teasdale et al., 2019). Moreover, there is evidence that technology-based monitoring tools have been more successful, with greater levels of adherence and attainment of dietary goals for the general population (Burke et al., 2012). The use of technology may be especially fruitful for interventions geared towards younger populations with psychosis, where technology may be more integral to their lives.

Digital Technology

Indeed, mobile phone ownership, including "smart phones," has been increasing among those with SMI, particularly in younger populations (Ben-Zeev, Davis, Kaiser, Krzsos, & Drake, 2013; Sanghara, Kravariti, Jakobsen, & Okocha, 2010; Luther et al., 2020; Torous et al., 2014). Accordingly, digital technology interventions have been increasing in this group (Batra et al., 2017), and research suggests they are feasible and acceptable in SMI populations (Berry et al., 2016). For example, interventions utilizing mobile phones have been successfully used to increase motivation (Luther et al., 2020), medication adherence (Niendam et al., 2018), and self-monitoring of symptoms (Depp, Moore, Perivoliotis, & Granholm, 2016). Moreover, given the general integration of technology into the lives of young people, those with early psychosis have expressed a desire for more services to be delivered through digital platforms (Lal et al., 2015). This has only been exacerbated by the COVID-19 pandemic, and it is likely that digital interventions will continue to be an integral part of mental health care in the future (Ben-Zeev, 2020). Despite this, to my knowledge, only one study to date has used mobile technology to intervene on diet in those with SMI. Aschbrenner and colleagues (2016) developed a mobile

application which, among other things, provided education on nutritional choices and allowed participants to track food if they desired. However, their study focused primarily on increasing physical activity with the overarching goal of weight loss, rather than targeted efforts to improve diet. Despite the increasing use of mobile phones to encourage effective behavior modification in those with psychotic disorders, as well as the successful use of technology to improve dietary behavior in the general population (Afshin et al., 2016), mobile technology has not been used to target diet quality for any age group of people with psychosis. Accordingly, research is needed to determine the feasibility of a mobile intervention, which may overcome obstacles of traditional nutritional interventions in this population. The current study seeks to examine the feasibility of a new digital nutrition intervention for people with early psychosis. Given the importance of prevention in reducing CVD (Teasdale et al., 2019), as well as the desire and ability for young people to engage in digital services (Lal et al., 2015), the current intervention was developed to be a significant and innovative contribution to people with early psychotic disorders.

THE PRESENT STUDY

The current intervention, *Nutrition Enhancement in Early Psychosis (NEEP)*, is grounded in Social Cognitive Theory (SCT; Bandura, 1991), which suggests that self-efficacy and motivation are integral to goal persistence and success. *Self-efficacy* refers to individuals' perceived confidence in their abilities to perform a behavior. According to Bandura, self-efficacy should be a key target in therapeutic interventions and is important for sustained motivation. As such, the current intervention combines a nutrition education session especially adapted for those with psychosis, with efforts to increase self-efficacy and motivation for a healthy diet by goal setting, monitoring (i.e., dietary tracking), reinforcement (i.e., automated text messages in the form of reminders and motivational messages), and feedback (i.e., personalized text-messages.) The current study was conducted in those with early psychosis and had three aims: (1) assess the feasibility and acceptability of NEEP, (2) assess the preliminary outcomes of NEEP, and (3) examine possible mechanisms associated with behavior change (i.e., motivation, self-efficacy). I hypothesized that NEEP would be feasible and acceptable and would result in improvements in diet quality. I also hypothesized that NEEP would impact mechanisms of behavior change, specifically that it would improve self-efficacy and motivation.

Methods

Study Overview

This was an open-trial, single arm pilot study to determine the feasibility and preliminary impact of using *Nutrition Enhancement for Early Psychosis* (NEEP) to enhance diet quality in people with early psychosis. During the baseline visit, participants received a nutrition education session and then set dietary goals for the four weeks of the intervention (28 days). During the intervention, participants were asked to track their diet every day using a free, commercially available dietary tracking mobile application. Twice daily, participants received automated text messages designed to be motivational and remind them of the goals they had set for themselves. Once per week (every 7 days), participants were sent a personalized text message about their use

of the dietary tracking app, as well as feedback on their goals. Follow up assessments were conducted after participants completed the 4-week intervention.

Participants

Following Institutional Review Board and hospital approval, participants were recruited from a First Episode Psychosis Clinic at a local hospital from March 2021 to October 2021. Recruitment occurred in several ways. First, flyers were posted in the waiting room of the First Episode Psychosis Clinic, which included details and instructions to contact study personnel for more information. Second, study personnel were given access to a list of clinic patients who had expressed interest in participating in research and provided their phone numbers. The current study also shared recruitment databases with another IRB approved study that had enrolled participants with early psychosis. Study personnel called these participants to inquire about their interest in the current study. Finally, study personnel set up a table in the clinic waiting room with information about NEEP where individuals were able to approach study personnel and ask questions about the current intervention.

Participants were eligible for the current study if they: 1) were currently receiving treatment at a First Episode Psychosis Clinic; 2) were able to consent for themselves (i.e., did not have a legal guardian); 3) had an internet-enabled cell phone that was capable of downloading mobile applications and receiving text-messages; 4) ≥ 18 years old; and 5) were willing to participate in a brief nutrition education presentation during baseline. Participants were excluded if they self-reported 1) history of an eating disorder, or 2) had been hospitalized for any reason over the past 30 days.

Baseline occurred in two ways: either in-person at the First Episode Psychosis Clinic or virtually over Zoom. Participants were able to complete assessments virtually if they reported that they 1) used their cell phone every day or almost every day, 2) knew how to download mobile applications to their cell phone, and 3) felt confident in their ability to learn how to use a mobile application with study personnel completely over Zoom.

Compensation for the baseline and follow-up visits were each $30 in cash or via an electronic gift card. In line with previous studies (Ben-Zeev, Kaiser, & Krzos, 2014; Luther et al., 2020), participants were also reimbursed for data and text-messaging costs at the follow-up visit ($15). Participants who were not eligible to complete the study visit over Zoom *and* did not

have transportation to the clinic received an additional $20 to compensate for transportation costs. At baseline, consent was obtained either through a written signature (in-person) or through a waiver of informed consent (over Zoom) prior to all study procedures. All procedures were approved by the local Institutional Review Board.

Nutritional Enhancement for Early Psychosis (NEEP)

Nutrition Education. After completing baseline self-report assessments and the 24-hour dietary recall (see Measures section for details), participants took part in a nutrition education presentation (See Table 1 for list of all procedures and the order of these procedures). This brief, 20-to-30-minute presentation was created by the lead author for this study and was done in collaboration with an Assistant Professor of Medicine who has a doctorate in nutrition science and a registered dietician who regularly conducts dietary counseling with people with psychotic disorders.

This session consisted of education regarding the heightened risks of physical illness for people with mental illness and ways to prevent these metabolic disorders, specifically through healthy eating. Recommendations of dietary guidelines according to the US department of Agriculture[1] were then discussed and concrete ways to modify consumption to meet these recommendations were provided. To enhance clarity and demonstrate visual representations of various food portions, measuring cups were used during this presentation and subsequently given to participants for their own use. Education on specific dietary information for people with SMI was also provided, including known deficiencies (e.g., folate) and areas of over consumption (e.g., fatty foods; Aucoin, LaChance, & Cooley, 2020). The final part of the nutrition education session included reviewing with the participant their nutrition profile derived from the 24-hour dietary recall and comparing it with the recommended dietary guidelines (See Appendix 1 for complete nutrition education presentation guide and measures section for an overview of the 24-hour dietary recall).

Goal Setting. After the nutrition education session administered by study personnel, participants were asked to identify a minimum of one (maximum of two) nutrition goals to complete over the four weeks that were specific, measurable, achievable, realistic, and timed (SMART;

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[1] US Department of Health and Human Services and US Department of Agriculture Dietary guidelines for Americans 2015–2020, eight edition; http://health.gov/dietaryguidelines/2015/guidelines/ (2015)

Bovend'Eerdt et al., 2009). This goal setting session incorporated evidence-based, recovery-oriented goal setting techniques that focused on identifying the value, importance, and meaning of the goals (Collaborative Goal Technology; Clarke et al., 2009). Examples of nutrition goals include "eat red meat only twice per week," "eat a piece of fruit, 3 times per week," and "only eat fast-food once per week." Of note, goals needed to be centered on improving diet quality, not about weight loss, though that may have been important for some participants.

Dietary Tracking. Participants were asked to track their diet during the four weeks of the study using the widely used, and commercially available mobile food tracking application, MyFitnessPal (MFP; Evans, 2017). To ensure that participants knew how to use this mobile application, study personnel conducted a technology training session within the baseline visit to show participants how to download and use the dietary tracking app. Participants were provided non-identifying usernames and passwords to connect to MFP and use over the duration of the study. Participants were made aware that study personnel had access to all foods tracked within the mobile application and would be logging into their account and using this data to provide personalized feedback each week. After downloading and logging into the application on their personal mobile device, participants completed a practice session with the assistance of study personnel, entering all foods in MFP that has been reported during the 24-hour dietary recall. Participants were also provided with a handout detailing the steps to using the dietary tracking application.

Text messaging. Participants were sent text messages as part of the study. Two text messages were automated: the first was sent between 8am-11am, and then the second was sent between 5-8pm, with minor adjustments made based on participant preference. These text messages were intended to remind participants of their goal (e.g., eating one cup of vegetables, 3 days per week), reinforce working towards their goals (e.g., awesome job!), as well as motivate them to achieve their goals (e.g., you can do it!). If participants were unfamiliar with text messaging, each received a training and a handout on how to open and read text messages with simple directions describing the text message study procedures (Ben-Zeev et al., 2014; Granholm et al., 2011; Luther et al., 2020), including how to modify personal text message settings (e.g., notification volume). However, all participants were familiar with text messaging using their mobile devices.

In addition to the automated text messages, participants were also sent one personalized text message every seven days throughout the duration of the study (for a total of three personalized text messages). Using data obtained from their MFP account, one personalized text message was sent to participants by the lead study personnel each week to provide feedback on goal progress and use of the dietary tracking mobile application, as well as attempt to increase motivation to reach goals (See Table 2 for an example of an automated and personalized text messages). Because text messaging is not considered a secure form of communication, if a participant had a study-related question that was asked through text messaging, study personnel asked the participant to set up a phone call to discuss this question over the phone. Of note, no participant asked a question through text messaging that required a follow up call.

Measures

Feasibility and Acceptability

NEEP Feasibility was assessed by multiple indicators. First, *uptake of the intervention* was defined by the number of people who enrolled in the study out of those who were eligible after screening. Second, *application engagement* was defined as the number of people who entered food into MyFitnessPal (MFP) at least once per day. And finally, *application completion* was defined as the number of people who indicated a completed dietary log each day. Predetermined benchmarks were set a priori to indicate feasibility (See below in Data Analysis.)

NEEP Acceptability was assessed with the Usability, Satisfaction, and Ease of Use questionnaire (USE; Lund 2001). This 30-item self-report questionnaire examines four dimensions of acceptability: usefulness, satisfaction, ease of use, and ease of learning. For usefulness and satisfaction, participants were asked to think about the intervention overall. For ease of use and ease of learning, participants were instructed to think only of the dietary tracking application. The measure is considered valid based on comparisons with similar measurements of usability and satisfaction (r between .60 and .82, p< .001; Gao, Kortum, & Osward, 2018). In the current sample, internal consistency was .97. Predetermined benchmarks were set a priori to indicate acceptability (See below in Data Analysis).

Primary Outcomes - Indicators of Diet Quality

Subjective Dietary Assessment was assessed using the 13-item Rapid Eating Assessment for Participants-Shortened version (REAP-S; Segal-Isaacson, Wylie-Rosett, & Gans, 2004). This is a validated measure of diet quality with possible responses being "usually/often," "sometimes," and "rarely/never" (e.g., *"How often do you skip breakfast?" or "How often do you eat foods such as fried chicken, fried fish, or French fries?"*). Possible scores range from 13 to 39, with a higher score indicating better diet quality. This measure has been shown to be reliable and valid for assessing dietary quality in the general population (Johnston et al., 2018). However, in the current sample, internal consistency was low at only .59. Given the low internal consistency, analyses were run to see if reliability could be improved by removing poorly correlated items (Raubenheimer, 2004). However, removal of no item substantially improved the reliability; therefore, no item was removed.

Diet Quality was assessed through the administration of 24-hour recalls utilizing the Automated Self-Administered 24-Hour Dietary Recall (ASA-24HR) 2020 version developed by the National Cancer Institute[2]. The ASA-24 is a validated, web-based, 24-hour dietary assessment tool and was administered with the help of study personnel. Diet quality was quantified through the application of the Healthy Eating Index – 2015 (HEI-2015; Guenther et al., 2013; Guenther, Reedy, & Krebs-Smith, 2008).   The HEI-2015 total score is a density-based score that ranges from 0-100, with higher scores indicating better adherence to Dietary Guidelines for Americans and better diet quality.

Secondary Outcomes – Potential Mechanisms of Change

Dietary Motivation was assessed using the Intrinsic Motivation Inventory for Schizophrenia Research (IMI-SR) (Choi et al., 2009). This 21-item questionnaire is comprised of an overall score and three domains related to intrinsic motivation for any activity: interest/enjoyment (e.g., *I enjoy doing this activity*), perceived choice (e.g., I *did this activity because I wanted to*), and value/usefulness (e.g., *I think this activity is important to do*). Items are answered on a 7-point Likert scale, with responses ranging from (1) "not at all true" to (7) "very true." For the current study, participants were given a broad definition of healthy eating

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and, because the IMI-SR can be adapted for a variety of interventions, "this activity" was changed to "healthy eating." The IMI-SR has been validated in a psychiatric sample and has good internal consistency (alpha between .70-.77; Choi et al., 2010). The internal consistency for the current sample for the total IMI-SR was .72.

Dietary Self-Efficacy was measured using the 20-item Eating Habits Confidence Survey (EHC; Sallis, 2014). This survey consists of a five-point Likert scale ranging from (1) "I know I cannot" to (5)"I know I can" with higher scores reflecting higher levels of self-efficacy. Items include "Eat smaller portions at dinner" and "Stick to low-fat, low-salt foods when you're bored, tense, or depressed." Internal consistency was .59 for the current sample. To improve the internal consistency, analyses were run to examine whether removal of any items would increase the internal consistency of the scale to an acceptable level. With the removal of the question "stick to low-fat, low-salt foods when the only snack close by is from a vending machine," the internal consistency was increased to .85. Accordingly, analyses examining dietary self-efficacy were run twice, once using all items and once with this item excluded (Gliem & Gliem, 2003). No significant differences emerged and results are presented without this item included.

General Self-Efficacy was measured with the 10-item General Self-Efficacy Scale (GSE; Schwarzer & Jerusalem, 1995). The measure uses a four-point Likert scale from (1) "not at all true" to (4) "exactly true." Example items include, "*It's easy for me to stick to my aims and accomplish my goals*" and "*I can solve most problems if I invest the necessary effort*." This scale has been used in individuals with severe psychiatric difficulties and has demonstrated to have excellent internal consistency (.92-.93) and very good to excellent test re-test reliability (.75-.94). (Vauth et al., 2006; Chiu & Tsang, 2004). Internal consistency was .92 for the current sample.

Qualitative Feedback

At follow up, participants were also asked a series of open-ended questions regarding their experience in NEEP. These questions included: (*1) How helpful did you think NEEP was? (2) How was your experience of using the MyFitnessPal dietary tracking application? (3) How helpful were the daily text-messages? 4) How helpful was the personalized text messages? (5) Do you think the intervention changed how you ate?If so, how? (6) Were there things outside of the intervention that impacted your ability to be successful? and (7) What changes would you make to the intervention?* Responses were recorded in writing by research staff.

DATA ANALYSES

Statistical Assumptions

Data was cleaned, and assumptions were checked. All data was approximately normally distributed, and skew (+/- 3) and kurtosis (+/-10) were within acceptable parameters (Kline, 2015; See Table 3). Quantitative data was primarily analyzed using SPSS statistical software (version 27). The statistical analysis software SAS (Version 9.4) was used to calculate the HEI-2015 based on an algorithm and code provided from the ASA website.[3]

Feasibility

To assess NEEP feasibility, predetermined benchmarks were set. Based on similar metrics used by a previous mobile intervention for those with early psychosis (Lim et al., 2020), feasibility was based on three markers of success: *uptake of the intervention, application engagement, and application completion.* Given the novelty of the current intervention, successful *uptake of the intervention* was defined as the majority of eligible participants (>50%) participated in at least the baseline assessment. Successful *application engagement* was defined as the majority (>50%) of participants who completed the baseline assessment recorded at least one food into MFP 70% or more days (i.e., 20 days or more) during the 28-day intervention. Finally, successful *application completion* was defined as the majority (>50%) of participants who completed the baseline assessment completed an entire food record in MFP for at least 50% (i.e., more than 14) of the days. Completing an entire food record was defined as the participant pressing a button at the bottom of their dietary record that stated that they entered all food for the day.

Acceptability

Predetermined benchmarks were also used to assess NEEP acceptability. Similar to feasibility, acceptability of the intervention was defined as the majority of participants (>50%)

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[3] https://epi.grants.cancer.gov/asa24/resources/hei.html

indicated that they agreed or strongly agreed that the intervention was useful (On the USE questionnaire). Acceptability of MFP was defined as most participants (>50%) agreeing or strongly agreeing that the dietary tracking application was easy to use and easy to learn.

Primary and Secondary Outcomes

Primary outcomes were assessed with paired sample t-tests and estimates for Hedge's *g* effect sizes on subjective dietary assessment and diet quality (i.e., small=.2, medium=.5, large=.8; Cohen, 1988). Given the small sample size, Hedge's *g* was preferred to Cohen's *d* for estimates of effect size (Delacre, Lakens, Ley, Liu, & Leys, 2021). Paired sample t-tests were also conducted for all participants to examine whether there were increases in mechanisms of behavior change following NEEP: self-efficacy and motivation. Because self-report measures were checked by study staff after completion for any missing value, missing data were extremely rare. Only two items were left blank by all participants at both time-points. Mean substitution was used for these two items. Given the small sample size, all significance levels were determined a priori at p<0.10.

Qualitative Interviews

Interview responses were analyzed using an inductive, consensus-based approach that borrowed concepts from emergent content analysis (Hsieh & Shannon, 2005). Analysis began with research staff individually reviewing a small subset of responses and identifying those which may relate to feasibility and acceptability of the intervention. The team met to discuss their findings and to agree upon emerging themes in which to categorize responses. A preliminary code book was developed. Two research staff met a second time after implementing this preliminary code book. Discrepancies were discussed and consensus was reached. Using the final codebook, research staff divided the interviews in half and individually coded their assignments. Once independent coding assignments were complete, research staff reviewed the coding of the other coder to check for consistency and accuracy. Any discrepancies were flagged and discussed until mutual agreements on coding were met.

RESULTS

Participant and Recruitment Characteristics

Thirty-two participants were assessed for eligibility between March and October 2021. Of those who were assessed, 24 participants were eligible (75.0%). The most common reason for ineligibility was that an individual's phone was not consistently connected to the internet ($N=3$). Other reasons included the participant being unwilling to track their diet ($N=1$), believing the baseline assessment was too long ($N=1$), having a legal guardian ($N=1$), or having been hospitalized in the past 30 days ($N=1$). In one instance, an individual expressed interest in the study but was a family member of an individual seeking services at the clinic and was not receiving services themselves, making them ineligible ($N=1$). Out of the 24 people who were eligible, nine people decided against participating in the study ($N=9$; 37.5%). Participants stated a variety of reasons for not participating including being "too busy" ($N=4$), feeling that they did not need the intervention ($N=2$), or failing to show up to the baseline appointment and not responding to attempts to reschedule ($N=3$).

In total, 15 participants were consented and enrolled, and twelve participants completed both baseline and follow up (80.0%). Participants primarily completed the baseline in-person ($N=12$; 80.0%); however, three participants completed the entire intervention virtually ($N=3$; 20%). Of the 15 that completed baseline, one participant withdrew within 24 hours of baseline by texting study personnel that he no longer wanted to participate. Unfortunately, he was unable to be reached for further investigation regarding the reasons for withdrawal. Additionally, two people were lost to follow up. Neither participant that was lost to follow up entered any food into the dietary tracking application, and neither was able to be reached for further questioning about reasons for leaving the study. Although too small for statistical comparisons, study non-completers ($N = 3$) and completers ($N = 12$) did not appear to differ on demographics or any variables of interest.

Participants who enrolled were primarily male ($N=11$; 73.3%) and Black ($N=10$; 66.7%), with an average age of 25.3 (5.4) years, ranging from 18-33 years. All participants were taking antipsychotic medications, with the most common being the Invega Sustenna shot ($N=7$, 46.7%). Participants used mobile technology regularly, with all participants ($N=15$, 100%) reporting they

used their smartphone multiple times per day. Most participants had Android phones (*N=10*, 66.7%) versus iPhones. The majority had unlimited talk and text plans (*N=13*, 86.7%) and two participants were unsure whether they had unlimited talk and text plans because their parents paid for their cell phone bills. Similarly, most participants had unlimited data plans *(N=10, 66.7%)*. Two participants reported having either two *(N=1)* or three *(N=1)* gigabytes of data per month, and three participants were unsure how much data they had per month *(N=3)*. Most participants lived with family members (*N=11;* 73.3%) (See Table 4).

<div align="center">

NEEP Feasibility

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Uptake of the Intervention. NEEP met predetermined benchmarks for feasibility in terms of *uptake of the intervention.* Specifically, in the current study, 62.5% (> 50%) of those eligible attended baseline (*N=15* out of 24).

Application Engagement. NEEP met the predetermined benchmarks for feasibility in terms of *application engagement.* Greater than 50% of enrolled participants (*N=8* out of 15; 53.3%) entered at least one food into MyFitnessPal 70% of the days (i.e., 20 or more days). On average, participants entered at least one food into MyFitnessPal on average 17.1 (11.0) days of the 28 days (61.1% of total days). Of the participants who attended follow up (*N=12),* there was notably higher engagement. Of these twelve participants, 66.7% *(N=8)* entered food into the dietary tracking application at least 70% of the days (i.e., more than 19 days), and on average, these participants entered food into the application 21.4 (7.4) of the 28 days (76.4%) (See Table 5 for details on *application engagement* and *completion*).

Application Completion. NEEP did not meet the predetermined benchmarks of feasibility in terms of *application completion* by enrolled participants. Seven participants (*N=7* out of 15; 46.7%) completed their food diary more than 50% of the days. On average, participants indicated a completed food record 13.1 (10.6) days out of the 28-day intervention. However, as expected, out of those who completed follow up, a higher percentage of participants (*N=7* out of 12, 58.3%) completed their food diary more than 50% of days. These 12 participants indicated a completed food record on average 57.1% (*M=16.4, SD=9.2*) days out of the total 28.

NEEP Acceptability

Overall Acceptability. NEEP met the predetermined benchmarks for acceptability (See Table 6). The majority (>50%; i.e., more than 6) of participants at follow up *(N=12)* either agreed or strongly agreed with most items on the USE questionnaire. For example, most participants said they agreed or strongly agreed that the intervention was useful (*N=10;*83.3%), that it helped them be more effective (*N=9; 75%*), and believed it met their needs (*N=9*; 75%). In terms of usability, fewer participants said they agreed or strongly agreed that the intervention saved them time (*N=6; 50%*) or made the things they wanted to get done easier (*N=5; 41.7%*).

Most participants agreed or strongly agreed with most items assessing overall satisfaction with the intervention. For example, participants agreed or strongly agreed that they were satisfied with the intervention (*N=10*; 83.3%), would recommend it to a friend (*N=9*; 75.0%), and that it was fun (*N=8; 66.7%*). Participants even agreed or strongly agreed that the intervention was "wonderful" (*N=8*, 66.7%). Fewer participants agreed or strongly agreed that the intervention was "pleasant to use" (*N=6: 50%*), or that they "needed to have it" (*N=5; 41.7%*) (See Table 6).

Acceptability of Mobile Application. The mobile tracking application was received well, with most participants finding it both easy to use and easy to learn. For example, most participants agreed or strongly agreed that MFP was easy to use (*N=10*; 83.3%), simple (*N=10*; 83.3%), user friendly (*N=11; 91.7%*), and both occasional and regular users would both like it (*N=10; 83.3%*). Participants also stated that MFP was easy to learn (*N=11*, 91.7%), that they learned the application quickly (*N=10*; 83.3%), it was easy to remember how to use it (*N=10*; 83.3%), and they quickly became skillful at the mobile application once they learned it (*N=9*; 75.0%) (See Table 7).

Primary Outcomes

Subjective Dietary Assessment. As hypothesized, significant small size effects were found for improvements in subjective diet quality utilizing the REAP-S (*p*=.084; *g*=.44). Participants assessed their diets as lower quality at baseline (*M*=22.4, *SD*=4.0) than after the intervention (*M*=24.8, *SD*=3.2) (See Table 8 for all primary and secondary outcomes).

Diet Quality. Although not statistically significant, data derived from the 24-hour recall suggests there may have been an improvement in dietary quality, as calculated by the HEI-2015,

at a medium effect size (p=.130 g=.69). Participants recalled eating a lower-quality diet the day prior to baseline (M=40.7, SD=9.4) than the day prior to follow up (M=48.7, SD=13.4). Given the large difference in standard deviations, scatter plots were created to examine outliers. One participant (103) significantly decreased in diet quality after the intervention (T1=60, T2=33). As a sensitivity analysis, the analysis was re-run without the outlier and a significant and large effect (p=.018, g= 1.07) was found for increases in diet quality from baseline (M=38.9, SD= 13.1) to follow up (M=50.1, SD=7.2) (See Table 9 for scatterplot). While this should be interpreted with caution because this is a single case study, during qualitative feedback, this participant said that the intervention had originally improved his diet, but he had just returned to work; in turn, his diet had recently worsened because the only food available to him on his drive home was from fast food restaurants. Of note, analyses were re-run on all outcome variables excluding participant 103. No other differences in interpretation emerged.

Secondary Outcomes

Dietary Motivation. Contrary to hypotheses, NEEP did not have a significant impact on motivation for changing dietary behavior overall (p=.398), perceived value of changing diet (p=.938), or interest in improving diet (p=.398). However, participants reported feeling as if they had significantly less choice around improving dietary behavior (p=.069), with reporting that they believed they had more choice regarding their diet (M=4.9, SD=1.0) at baseline than at follow up (M=4.5, SD= 0.7).

Dietary Self-efficacy. Contrary to hypotheses, changes in dietary self-efficacy (Eating Habits Confidence Questionnaire) were not significant. However, a medium effect size was detected in the opposite direction than anticipated (g=.57). That is, participants reported higher levels of confidence in the ability to change their dietary habits at baseline (M=3.4, SD=0.8) than at follow up (M=3.0, SD=0.6).

General Self-Efficacy. Similarly, hypotheses were not supported regarding general self-efficacy. While there was a significant change in self-efficacy (p=.028); however, this was not in the expected direction (g=.63). Participants reported higher self-efficacy overall at baseline (M=3.2, SD=0.4), than at follow up (M=2.8, SD=0.8).

Qualitative Responses

All participants described that the intervention was helpful in some way (*N=12*). People mentioned a variety of reasons as to how NEEP helped them (See Table 10). For example, people mentioned that NEEP heightened their awareness of their current dietary habits *(N=7),* specifically, that they were eating more calories than they previously had thought, as well as less nutrient-rich foods and more nutrient-poor foods. Many mentioned that the intervention helped improve dietary choices that aligned with goals set during the goal-setting part of the baseline interview (*N=7;* e.g., increasing vegetables, eating more fruit, or decreasing fast food). In a similar vein, participants said that the intervention (specifically real-time feedback from the dietary tracking application) helped them to stop overeating and decrease the total amount of calories they were eating overall (*N=2*; 15.7%). One individual even said that these dietary improvements helped him to lose seven pounds during the 28-day intervention.

Participants also commented that the intervention increased motivation for improving the quality of their diets (*N=7*; 58.3%) and that being in the intervention will continue to change the quality of their diets in the future *(N=6; 50.0%)*. Participants also stated that the intervention made them care more about their physical health *(N=4; 33.3%)*. Specifically, participants said that they did not want to die early due to cardiovascular disease (*N=1*), leave their child (and future children) without a parent due to this early death *(N=1),* or get diabetes *(N=1)*. Two people said that it was not helpful in changing their dietary habits *(N=2);* however, both participants also said that the intervention was helpful in other ways, such as highlighting current poor diet (*N=2*), improving motivation for eating healthy (*N=1*), and it will help them make changes to their diet in the future *(N=1)*.

Overall, participants enjoyed the intervention and said they would make no changes to it *(N=9; 75.0%)*. However, three people offered one or more suggestions on how to improve the intervention. Two people suggested increasing personalized text messages to be sent more than once per week (*N=2*; 16.7%). When examining all feedback regarding personalized text messages, participants said the personalized messages increased feelings of accountability knowing someone was looking at their dietary logs, stating that the personalized text messages felt like they had a "personal trainer," and they liked having "someone to cheer [them] on." One person mentioned that the personalized text-messages felt like she had "someone on [her] team" and another person said that personalized messages made it feel like someone cared about his

health, which was important to him "because you don't have a lot of people like that in your life." Two of these three people (16.7%) suggested decreasing the frequency of the automated text-messages, and that the twice-per day messages became "annoying" after the first few days. (Of note, when including feedback from all participants, most people *(N=9;* 66.7%) said that these automated messages served primarily as reminders, and they no longer looked at the messages as the intervention progressed.) Finally, even though this was beyond the scope of the study's control, two people expressed frustration with the dietary tracking application and suggested improving the application to include more foods. These participants explicitly said that the barcode scanning option did not work for certain foods, or it was difficult to enter food when eating at a restaurant that was not a fast-food chain. Of note, the people who offered suggestions were the same three people; however, all three people offered multiple suggestions.

   Participants mentioned certain things made it easier to be successful in meeting their goals, as well as things that made it more difficult. Family support was the only variable mentioned that aided in goal success (*N=8;* 66.7%), stating family support and involvement made it easier to improve their diet quality and meet their goals. For example, these participants mentioned that they told their families about the intervention, and their families bought food that was conducive with their nutrition goals (*N=5*; 33.3%). Two participants (16.7%) mentioned that they also began to have input on their families' menus for dinner to try to make meals healthier. Another participant said that her mother did not know how to cook, but learned to make a vegetable dish (i.e., cooked asparagus) to aid in her daughter's goal to eat more vegetables. On the other hand, participants stated several barriers that got in the way of their success. A lack of support from family made it harder for some to be successful (*N=2;* 16.7%); these participants stated that their families verbally expressed support but made no dietary changes themselves or what they cooked to help the participant with their goals. Three people (25.0%) said that unhealthy options were often easier to access than healthier options. For example, fast-food restaurants were close to their house and these restaurants do not have any healthier options. Participants also mentioned that they rarely eat at home in general (*N=2;* 16.7%), or their living situation (i.e., group home) did not serve food that was conducive to meeting their goals (i.e., eat one apple per day). Of note, two individuals lived in group homes during the study, but only one commented that this made it harder to be successful. The other participant stated that her group home also did not carry foods conducive with her goals for the intervention; however, she used

her own money to purchase fruits for herself to keep in her room (e.g., apples and bananas). In a similar vein, participants noted the lack of ability and/or motivation to cook healthy meals at home made it more difficult to eat healthy (*N=3;* 25.0%). While one participant stated that he did not have the motivation to cook in general (*N=1*; 8.3%), two participants stated that other obligations (i.e., school or work) decreased the motivation and energy to plan and cook healthy meals (*N=2;* 16.7%). Finally, two participants mentioned that antipsychotic medications side effects made them crave nutrient-poor foods, especially following the injection (*N=2*; 16.7%).

Although not captured in the qualitative interviews, many participants appeared surprised during the nutrition education presentation and were unaware that people with psychotic disorders die early compared to the general population, primarily from cardiovascular disease. Many were not aware that antipsychotic medication can result in hunger-induced changes and weight gain, and instead thought their weight gain was a result of feeling depressed after experiencing psychosis and receiving a diagnosis of a psychotic disorder. While one participant said he did not want to hear anything that may make him want to stop the medication, multiple other people mentioned that this was helpful information, and two people told the interviewer at follow up that this information prompted them to speak with their psychiatrist about medication-induced weight gain and whether there were different medications that may lessen some of these side effects.

DISCUSSION

Efforts to improve cardiovascular health and prevent early mortality in those with psychotic disorders is a major treatment need in this population. The main aim of this study was to test the feasibility and acceptability of an intervention that leverages mobile technology with brief nutrition education and goal setting to improve diet quality in those with early psychosis. To my knowledge, this is the first study to use a commercially available, free mobile application to help those with psychotic disorders monitor their own diet. The results suggest that NEEP may be a feasible, low-cost, low-resource intensive intervention that improves diet quality in people with early psychosis.

Feasibility

Several indicators suggest that NEEP may be a feasible intervention in this population. First, during recruitment, most people who were screened and eligible for the study wanted to participate in the intervention(62.5%). Out of those who enrolled, 80% completed the 4-week intervention study. This suggests general health and wellness may be important to some individuals with early psychosis. Yet, recruitment was slower than anticipated. This may be due to several factors. First, individuals were only screened after learning the aim of the study (i.e., to improve diet). Because we do not have information on the number of people who learned about the study aim and decided not to participate, these results may only apply to those who are interested in improving their diets or losing weight and may not be applicable to those with early psychosis more generally. While slow recruitment may be partially be due to a lack of interest, it was also likely due to problems related to the Covid-19 pandemic. At the time of recruitment, therapeutic services were primarily being conducted virtually, and fewer people were coming in-person to clinics and hospitals. Even though there were several methods of recruitment (including calling potential participants, posting flyers, and engaging in in-person recruitment), almost all participants (12/15; 80%) were recruited in-person. This was largely because participants infrequently answered phone calls made during recruitment, likely due to various reasons. For one, younger people may prefer text-messaging to talking on the phone (Jefferies & Ungar, 2020). In addition, due to the high frequency of SPAM calls to personal cell-phones (Tu,

Doupé, Zhao, & Ahn, 2016), people may be less likely in general to answer calls from an unknown number. While most participants were recruited in-person, the individuals who opted to come into the clinic despite the availability and clinician preference for teleservices at the time may have been doing so because they were less technologically savvy, and therefore would be less comfortable completing an intervention that required the use of a SMART phone every day. Therefore, recruitment may be faster when study personnel are able to interact in-person with most clients in the clinic.

Once enrolled, participants engaged with the mobile application. Engagement in mobile applications has posed a challenge to digital technology interventions in the past, especially for people with psychosis (Arnold et al., 2019; Aschbrenner et al., 2015; Macias et al., 2015); however, in the current study eleven out of twelve participants who completed follow-up (and who used that mobile application at all) entered at least one food into MyFitnessPal for two weeks out of the four-week intervention. That is, most participants remained engaged in the intervention and used the application most of the total days. This suggests that our sample of young adults with early psychotic disorders were motivated to track their diet, found it helpful to do so, and their health-related goals were important to them.

While NEEP met two markers of feasibility, NEEP did not meet predetermined criteria for *application completion* (indicating a "completed dietary log" at the end of the day). Completion rates were lower than hypothesized for all participants but were substantially higher for those who attended follow up. Notably, the three participants who did not attend follow up also did not enter a single food into the dietary tracking application. This may signify that these people never intended to engage in the study beyond completion of the baseline visit. In addition, while *application completion* was intended to capture the difference between people who used the application to enter *all* food (as opposed to those who only entered one or a few foods per day), *application completion* may be too conservative to indicate feasibility. For example, participants may be entering in all foods eaten, but forgetting to press "complete diary" at the end of the day. The difficulty of accurately capturing whether someone has tracked all food is not unique to the current study. For example, one study indicated a completed diary when recording more than ≥800 calories per day (Patel, Hopkins, Brooks, & Bennett, 2019). However, this strategy may not effectively capture total dietary intake, especially for people with psychosis because these individuals may eat 800 calories or more in a single meal and continue to eat more

throughout the day. More research is needed to better capture the dietary habits of people with psychotic disorders and what may be the best way to indicate whether and individual has entered all food eaten that day. In addition, it may be that entering in all food (completing the diary) is not as important as being more cognizant of the quality and caloric density of foods that one is eating. One individual during the qualitative interview said that he used MFP during the first week and recognized that he was eating more calories than he realized, and that his diet consisted of too many nutrient-poor foods and not enough nutrient-rich foods. He said he stopped using the mobile application to track his calories after becoming frustrated with the mobile tracking application but was generally more of aware of his caloric intake and his diet quality. Of note, automated text-messages did occur twice daily, which included reminders to "complete diary log,"; however, during qualitative interviews, multiple participants stated that they stopped looking at these messages and they served primarily as reminders to work towards their goals and enter food into MyFitnessPal. Therefore, people may not have been reading these reminders asking them to complete their dietary log at the end of each day. Thus, completion rate of dietary logs may not be a useful marker of feasibility in future studies.

Acceptability

In addition to being feasible for the participants who were screened and enrolled in this study, this intervention was also acceptable to those who completed it. Participants were satisfied with the intervention and stated that it helped them to be more effective in meeting their dietary goals. While recommendations suggest text messages should not be sent more than once a day during interventions that target behavior change (Abroms, Whittaker, Free, Van Alstyne, & Schindler-Ruwisch, 2015), the current study suggests multiple texts per day were not burdensome for the majority of the sample , with only two people stating that they wished there were fewer automated text-messages. In addition, people were provided weekly personalized feedback that pointed out when they did or did not reach their goals, which may have felt invasive to some. However, most participants found the intervention helpful, useful, and would even recommend the intervention to a friend. Furthermore, despite increased cognitive deficits in individuals with psychotic disorders (Bora & Murray, 2014; MFP; Sheffield, Karcher, & Barch, 2018), people reported that the mobile application was easy to use and easy to learn. In fact, those who completed the technology training via Zoom were able to learn the mobile application

and were no less engaged in the intervention than other participants. Given the age and familiarity with technology, future mobile interventions in this population may want to include an option to complete mobile interventions entirely remotely.

Primary Outcomes

The current study found preliminary evidence to suggest that NEEP may contribute to meaningful changes in dietary behavior. Indeed, both indicators of diet quality suggested improvement in diet quality from baseline to follow-up. The subjective dietary assessment utilizing self-report diet over the past week significantly improved for the whole sample. In addition, while the diet quality from the recall was not significant, it had a medium size effect on improved diet quality. Of note, after removing one person whose diet significantly worsened, the effect became stronger[4]. This may signify that this intervention results in meaningful improvements in dietary quality. However, when the removal of one person can make such a meaningful difference, this highlights the need for a large sample. Further, to draw any interpretations about effectiveness, a large randomized controlled trial would be needed to determine whether the intervention is effective, and if so, what aspects of the intervention (e.g., nutrition education, tracking diet, text messages) may be the most important in dietary change.

Mechanisms of Change

Two mechanisms of change that reflect Social Learning theory were proposed and assessed for how this intervention would enhance dietary quality. However, neither self-efficacy nor motivation increased following the intervention. In fact, self-efficacy significantly decreased at the end of the 4-week intervention. While there is some evidence that those with psychotic disorders experience low levels of self-efficacy (Chang et al., 2017), there is also evidence that people with severe mental disorders may be overconfident in their functional abilities, wrongfully believing they will do something well (Durand et al., 2015). While increased self-efficacy appears to be important in goal pursuits in the general population, overconfidence may be a stronger predictor of poor performance in those with psychotic disorders (Perez, Tercero, Penn, Pinkham, & Harvey, 2020). One hypothesis as to why self-efficacy decreased in

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[4] Effect size change of 0.69 to 1.07

participants over time is because after trying to change their diet for four weeks, they may have formed more realistic ideas about how difficult it is to make dramatic changes to their diet. Changing dietary habits is hard for everyone (Clonan & Holdsworth, 2012), and is likely more difficult for individuals on antipsychotic medications; however, participants reported high levels of confidence in their ability to eat healthier at baseline. This intervention may have provided more realistic feedback about how difficult dietary habits can be to change.

Of note, while people reported lower levels of self-efficacy after the intervention, levels of motivation for eating a healthy diet remained relatively stable throughout the intervention. This was true for all aspects of motivation, except for feelings of choice regarding eating a healthy diet which decreased (i.e., "*I believe it is my choice to have a healthy diet*"). While this was originally intended to measure motivation because people are more motivated to do an activity when they believe they are in control of that activity, this may also reflect a decrease in confidence associated with eating heathier. At the beginning of the study, they may have been overconfident in their ability to change dietary habits easily, and this study may have provided realistic feedback about the difficulty of implementing these changes. While motivation did not increase as hypothesized, levels of motivation stayed relatively stable from baseline to follow up. While people did not become more motivated to eat a healthy diet, participants also did not lose interest in the idea of improving their diet, even after the realistic feedback that suggested the task was more difficult than they originally believed. This suggests that individuals with early psychosis may improve their own diet and make better food choices, even after realizing it will require significant effort.

Feedback

During qualitative interviews at follow up, participants expressed that they found the intervention to be helpful in many areas. Particularly, participants did not realize how poor their diet was prior to the intervention and how many calories they were consuming. High caloric diet is directly related to weight gain and obesity (Blundell & King, 2007), so this awareness is important for curbing weight gain, especially in a population who is prone to obesity and obesity-related health problems (e.g., cardiovascular disease and diabetes). The intended purpose of the intervention was to improve diet quality without an intention of weight loss; however, one individual reported that he lost seven pounds from improving his dietary choices and expressed

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excitement about this. Many participants reported the intervention helped them to decrease their overall caloric intake suggesting that these changes may result in weight loss overtime, or at least curb weight gain.

Importantly, multiple people mentioned that the intervention made them care more about their health than they did prior to the intervention. Specifically, participants mentioned that the nutrition education provided during baseline was important for highlighting how poor eating habits can result in long-term consequences for their health. Many individuals stated that they were unaware of early mortality in people with psychosis, and specifically the impact of antipsychotics on weight gain. While communication from providers surrounding health related consequences is important for promoting health behavior change (Bernhardt, 2004), feedback from participants in the current study suggests that psychiatrists may not be educating those with early psychosis on how antipsychotics can lead to weight gain, the importance of healthy eating and exercise to curb this weight gain, and the increased risk of cardiovascular disease in people with SMI. There could be several reasons for this, including limited time (Robinson et al., 2020) and the concern that these young people may become distressed or less likely to take their medication after hearing this news (Perkins, 2002). Notably, the current study suggests that psychoeducation on healthy eating paired with tools to help improve diet may make individuals with early psychosis more involved in their healthcare and more interested in improving health behaviors.

Most people had no changes they would suggest to improve the intervention. However, those who offered suggestions said they would like an increase in personalized text-messages, and a decrease in automated text messages. Multiple participants commented on how the personalized text-messages motivated them, stating that they enjoyed having someone who was supportive and invested in their goal success. Social support is an important predictor of success in recovery-oriented goals (El-Monshed & Amr, 2020)); however, people with early psychosis are less likely to have this support and are more likely to experience social isolation and feel lonely (Sündermann, Onwumere, Kane, Morgan, & Kuipers, 2014). As such, the engagement and acceptability of the intervention may have been driven by the relationship with the interventionist who expressed concern about their health and was both supportive and invested in their success. While people described that automated text messages were helpful as reminders towards their goal, participants emphasized the importance of the personalized text messages for

enhancing motivation. This highlights a challenge when developing text-message interventions. While the personalized and relational components of an intervention may play a pivotal role in goal success, higher levels of interactive text messages may not have ecological validity due to high levels of resources which are required for this level of personalized engagement (Abroms et al., 2015; Luther et al., 2020). One solution may be to identify the personal needs and preferences of each participant in future interventions and adapt the text-message frequency of both the personalized and automated text-messages to meet these preferences. This may especially useful if done after the first week of the intervention when people may have a better understanding of what the intervention entails and may be able to make a more informed choice around their preferred frequency of text-messages from the intervention.

Several participants noted the importance of family support for sustained healthier eating. Family support is important for almost every aspect of recovery for people with early psychosis such as medication adherence, relapse prevention, and over-all psychological well-being (e.g., Addington, Collins, McCleery, & Addington, 2005; Rabinovitch, Cassidy, Schmitz, Joober, & Malla, 2013; Selick et al., 2017). This intervention demonstrates the importance of this support extends to heath behaviors, specifically healthy eating. Most study participants lived with family members and said that their family was supportive of this desire to eat healthier. People mentioned that their family members did the grocery shopping and cooking, bought foods such a fruits and vegetables, and allowed participants to provide input in meal suggestions, making it much easier to meet their goals. In contrast, people also mentioned that when family was not supportive, or did not change their own dietary habits, it was much more difficult to stick to their goals. Given the role of families in helping provide a supportive atmosphere towards recovery, the current study suggests that families should be educated on the consequences of a low-quality diet for people with early psychosis and the importance of promoting health behaviors, especially when an individual has a personal goal of improving their own diet quality.

Participants also discussed other barriers towards healthy eating, such as unhealthy options close to their home. It is well-established that fast-food options are more prevalent in low socioeconomic neighborhoods (Hurvitz, Moudon, Rehm, Streichert, & Drewnowski, 2009; Smoyer-Tomic et al., 2008; Woolf, Fair, King, Dunn, & Kaczynski, 2020) where many people with early psychosis live. These food deserts (i.e., areas with limited access to grocery stores), or more specifically food swamps (i.e., areas with a high density of fast-food chain restaurants) are

a major contributor to obesity (Alviola IV, Nayga Jr, & Thomsen, 2013; Cooksey-Stowers, Schwartz, & Brownell, 2017). The lack of motivation and/or ability to cook healthy options, as well as low-quality food options near to the homes of these individuals may highlight the importance of planning for people with early psychosis. Planning may be especially difficult for people with psychosis (Wood, Cupitt, & Lavender, 2015); therefore, future interventions may want to include an emphasis on easy meal planning during the nutrition education or within personalized feedback, as well as options that may be healthier at fast-food restaurants.

Limitations

There are limitations that should be kept in mind when interpreting the results of this study. First, the sample size was small with only 12 participants completing the intervention. As mentioned, this is in part related to the problems of recruiting during a pandemic. Nevertheless, given the small sample size, we were likely underpowered to detect the markers of effectiveness. As mentioned, an important limitation is that participants self-selected into an intervention aiming to improve diet quality. People who immediately expressed disinterest after learning about the aim of the intervention were not screened, and therefore these individuals were not captured in markers of feasibility. In turn, this study may not generalize to those with early psychosis more generally. In addition, there were limitations around the way diet quality was measured, self-reported diet quality using the REAP-S has not been validated in a psychiatric sample, and there was evidence of low internal consistency within the current sample. This may signify that this measure of diet quality is not a reliable measure in those with early psychosis and was not measuring a single construct of diet quality on a continuum where higher scores indicated a better diet. In addition, the current study only had two 24-hour recalls (baseline and follow-up) when assessing dietary quality. Recommendations suggest that studies should assess 24-hour dietary intake at least two separate times to establish baseline dietary consumption, and at least two separate times to establish a follow-up consumption. However, given the confines of the pilot study, this was not possible. In addition, there is concern as to whether the 24-hour recall adequately captures dietary habits in people with psychotic disorders (Scott B Teasdale, Firth, Stubbs, & Burrows, 2018). This highlights a broader limitation of measuring diet quality in this population. Given there has been limited research in this area, there is currently no validated measure to assess diet quality in people with psychotic disorders. Future studies should

aim to validate a measure to capture diet quality adequately and reliably in people in this population, especially given the importance of the topic.

Strengths

While there are limitations, it is important to note that this study has several strengths. This study is low-cost and uses participants' personal cell phones to download a free, commercially available dietary tracking application. This extends prior work demonstrating that using personal cellphones in interventions is possible and clinically useful for people with severe mental illness, especially those with early psychosis. Out of the thirty-two people who were screened for the current study, no participant stated they did not have a smart phone. This aligns with estimates that between 72-81.4% of people with a psychotic disorder own a cell-phone (Ben-Zeev et al., 2013; Firth et al., 2015), and this is certainly higher for people with early psychosis given their younger age. This number was increasing prior to the pandemic (Firth et al., 2015) and access to mobile technology is likely much higher now. Of note, the current intervention had an 80% completion rate (12 completed out of 15 enrolled), which is similar, but also slightly higher than other mobile interventions in this population (Alvarez-Jimenez et al., 2014). Moreover, despite the majority completing some of the intervention in-person, all participants who completed the study entirely virtually voiced no problems with the intervention, suggesting NEEP could be administered entirely virtually if need be. This is added evidence to the fact that mobile technology interventions are easily implemented in this population and should be increasingly used to target health behaviors in people with severe mental disorders, especially in those with early psychosis.

What may be even more important is that this study was not only feasible, acceptable, and low cost, it requires few personnel resources. This intervention can be delivered by a single individual (who does not possess a background or degree in nutrition science) with a widely available, free mobile application. The intervention consists of a short nutrition education presentation (See Appendix 1), goal setting, dietary application training, automated text-messages and then reviewing use of the dietary application to provide brief feedback on progress towards their goals once per week. As such, this study has a high level of ecological validity and could be implemented as a part of therapy or recovery coaching by any mental health professional when an individual has a goal around improving health and eating a healthier diet.

Conclusion

This study supports the feasibility and acceptability of a novel mobile intervention aimed at improving diet quality in people with early psychosis. While any results suggesting effectiveness are preliminary and speculative, there is evidence to suspect that NEEP may be a low-cost, low resource means of improving diet quality in this population . Given that people with psychotic disorders die around 20 years earlier than the general population due to a variety of factors including poor diet quality (De Hert et al., 2011; Reininghaus et al., 2014), a large randomized controlled trial is needed to determine whether this intervention may be an effective way to change dietary habits, and in turn, help to reduce this early mortality.

TABLES

Table 1. Order of Study Procedures

Baseline (T1)	Follow-Up (T2)
• Informed Consent	• Self-Report Measures
• Self-Report Measures	• Qualitative Interview
• 24-hour Dietary Recall	• Payment
• Nutrition Education Presentation	
• Review of Personalized Nutrition Profile with Participant (generated from 24-hour recall)	
• Goal Setting	
• Text-Message Training (if needed)	
• Download MyFitnessPal on Participant SMART phone and Provide Study ID and Password for Login	
• MyFitnessPal Training Utilizing Food Recalled during 24-hour Recall	
• Payment	

Note. Procedures are listed in the order they occurred. Between baseline and follow-up, participants were instructed to track diet daily using MyFitnessPal. Participants were sent two automated text-messages daily. Participants were sent personalized text-messages every seven days (e.g., if they had baseline on Monday, personalized text-messages would occur on Mondays). Three personalized text-messages were sent during the four-week intervention period.

Table 2. Automated and Personalized Text messages

Text message Type	*Example Text*
Automated	**Morning:** *Hey (name)! Good morning! Did you enter all the food you ate yesterday into MyFitnessPal? Remember to press "complete diary" after you fill it out.* *You had two goals to improve your diet. First you wanted to (goal #1). Second, you wanted to (goal #2). Remember, you wanted to do this because (reason). You said these goals are important because (reason). You can do it!! Good luck today.* **Evening:** *Hey (name!) Did you complete your goals for today? You had two goals to improve your diet. First, you want to (goal #1). You also wanted to (goal #2), It can be hard, but you can do it! If you have not met your goals, that's ok! There is still time. I believe you can absolutely achieve this goal!*
Personalized	**Every 7 Days:** *PERSONALIZED TEXT MESSAGE: Hi (name!) It is (study personnel). I have reviewed your MyFitnessPal. You did an AMAZING job at tracking your diet! You filled out MyFitnessPal 5 out of the past 7 days and indicated a completed dietary log 3 out of the past 7 days. Awesome work!* *You had the goal of (e.g., eating a salad three times per week). Reviewing your MyFitnessPal, you ate two salads! That's amazing. You are so close to your goals! Keep going this next week. Again, awesome job!*

Table 3. Assessment of Normality

Variable	T1 Mean	T1 SD	T1 Skew	T1 Kurtosis	T2 Mean	T2 SD	T2 Skew	T2 Kurtosis
Subjective Dietary Assessment	22.53	3.81	-0.03	-1.32	24.83	3.19	-.04	-1.18
Diet Quality	42.74	10.09	0.42	-0.27	48.71	13.42	-.43	-1.19
Motivation- Overall	5.07	0.76	-0.62	-1.25	4.70	0.75	-0.03	-1.20
Value	4.66	1.10	-0.60	-0.67	4.51	0.80	-0.06	0.29
Interest	4.43	0.89	0.28	-0.41	4.14	0.93	0.67	-0.26
Choice	4.92	0.93	-0.17	-1.88	4.48	0.71	0.96	0.08
Diet Self-efficacy	3.46	0.75	-0.58	-0.89	3.03	0.59	1.16	0.29
General Self-efficacy	3.23	0.40	-1.00	2.49	2.77	0.79	-0.91	0.81

Note. T1 includes all 15 participants. T2 includes the 12 participants that completed follow up measures. Subjective Dietary Assessment was measured by the Rapid Eating Assessment for Participants- Shortened Version (REAP-S). Diet Quality was measured by calculating the Healthy Eating Index (HEI-2015) from the 24- hour dietary recall. Motivation was assessed by the Intrinsic Motivation Inventory for Schizophrenia (IMI-SR) with an overall score, and three subscales such as value of activity, interest in the activity and feelings of choice about doing the activity. Dietary Self-Efficacy was measured using the Eating Habits Confidence Survey (EHC). General Self-Efficacy was measure by the General Self-Efficacy Scale (GSE).

Table 4 . Demographics of Participants

Baseline characteristics	*n*	%
Age, years, *M* (*SD*)	*25.3 (5.4)*	5.4
Sex		
Male	11	73.3
Female	4	26.6
Race		
Black	10	66.7
White	4	26.6
Hispanic	1	6.7
Marital status		
Single, Never Married	15	100.0
Housing Type		
Living with family	11	73.3
Group home	2	13.3
Living with roommate	1	6.7
Living alone	1	6.7
Antipsychotic medication		
Invega Sustenna	7	46.7
Clozapine	3	20.0
Abilify	2	13.3
Risperidone	2	13.3
Zyprexa	1	6.7
Cellphone paid by		
Parents	7	46.7
Self	8	53.3
Cellphone use frequency		
More than everyday	15	100.0

Note. Analyses included 15 participants who completed baseline.

Table 5 . Application Engagement

Participant Number	Intervention Completely Virtually?	Days Entered At least One Food into MyFitnessPal Out of 28	Application Engagement criteria met (>70%)	Days Indicated Completed Food Record Out of 28	Application Completion criteria met (>50%)
101		28 (100.0%)	Yes	26 (92.8%)	Yes
102		6 (21.4%)	No	1 (3.6%)	No
103		26 (92.8%)	Yes	3 (10.7%)	No
105		28 (100.0%)	Yes	28 (100.0%)	Yes
106		28 (100.0%)	Yes	28 (100.0%)	Yes
108	Yes	14 (50.0%)	No	8 (28.6%)	No
109		14 (50.0%)	No	14 (50.0%)	No
111	Yes	28 (100.0%)	Yes	24 (85.7%)	Yes
112		24 (85.7%)	Yes	20 (71.4%)	Yes
113		21 (75.0%)	Yes	16 (57.1%)	Yes
114		25 (89.3%)	Yes	15 (53.6%)	Yes
115	Yes	15 (53.6%)	No	14 (50.0%)	No

Note. Results are displayed for the 12 participants who completed baseline and follow-up (i.e., 104, 107, 110 are excluded.)

Table 6. Acceptability of NEEP

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Usability items					
It helps me be more effective	0	0	3 (25%)	7 (58%)	2 (17%)
It helps me be more productive	0	1 (8%)	2 (17%)	7 (58%)	2 (17%)
It is useful	0	1 (8%)	1 (8%)	9 (75%)	1 (8%)
It gives me more control over the activities in my life	0	2 (17%)	3 (25%)	5 (42%)	2 (17%)
It makes the things I want to accomplish easier to get done	0	3 (25%)	4 (33%)	3 (25%)	2 (17%)
It saves me time when I use it	0	3 (25%)	3 (25%)	4 (33%)	2 (17%)
It meets my needs	0	1 (8%)	2 (17%)	7 (58%)	2 (17%)
It does everything I would expect it to	1 (8%)	0	2 (17%)	5 (42%)	3 (25%)
Satisfaction items					
I am satisfied with it	0	0	2 (17%)	8 (66%)	2 (17%)
I would recommend it to a friend	0	0	3 (25%)	6 (50%)	3 (25%)
It was fun to use	0	1 (8%)	3 (25%)	7 (58%)	1 (8%)
It works the way I want it to work	0	1 (8%)	4 (33%)	5 (42%)	2 (17%)
It is wonderful	0	1 (8%)	3 (25%)	6 (50%)	2 (17%)
I feel I need to have it	0	3 (25%)	3 (25%)	3 (25%)	2 (17%)
It is pleasant to use	0	0	5 (42%)	4 (33%)	2 (17%)

Note. Analyses included the 12 participants who completed baseline and follow-up.

Table 7 . Acceptability of Diet Tracking Mobile Application, MyFitnessPal

|	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
Ease of Use					
It is easy to use	0	0	2 (17%)	9 (75%)	1 (8%)
It is simple to use	0	1 (8%)	0	10 (83%)	1 (8%)
It is user friendly	0	0	1 (8%)	10 (83%)	1 (8%)
It requires the fewest steps possible to accomplish what I want to do with it	0	1 (8%)	1 (8%)	9 (75%)	1 (8%)
It is flexible	0	1 (8%)	2 (17%)	7 (58%)	2 (17%)
Using it is effortless	0	1 (8%)	2 (17%)	7 (58%)	2 (17%)
I can use it without written instructions	0	1 (8%)	1 (8%)	7 (58%)	3 (25%)
I don't notice any inconsistencies when I use it	0	3 (25%)	2 (17%)	5 (42%)	2 (17%)
Both occasional and regular users would like it	0	0	2 (17%)	9 (75%)	1 (8%)
I can recover from mistakes quickly and easily	0	1 (8%)	3 (25%)	6 (50%)	2 (17%)
I can use it successfully every time	0	1 (8%)	3 (25%)	7 (58%)	1 (8%)
Ease of Learning					
I learned to use it quickly	0	0	2 (17%)	7 (58%)	3 (25%)
I easily remember how to use it	0	1 (8%)	1 (8%)	7 (58%)	3 (25%)
It is easy to learn to use it	0	0	1 (8%)	8 (66%)	3 (25%)
I quickly became skillful with it	0	0	3 (25%)	6 (50%)	3 (25%)

Note. Analyses included the 12 participants who completed baseline and follow-up.

Table 8. Paired Sample T-Tests

Variable	Baseline Mean (SD)	Follow-Up Mean (SD)	Paired *t*-test			
			t-value	*df*	Sig	Effect size (*Hedge's g*)
Subjective Dietary Assessment	22.4 (4.0)	24.8 (3.2)	-1.9	11	.084*	.44
Diet Quality	40.7(9.4)	48.7 (13.4)	-1.6	11	.130	.69
Motivation- Overall	5.0 (0.8)	4.7 (0.7)	0.88	11	.398	.33
Value	4.5 (1.2)	4.5 (0.8)	-0.08	11	.938	.00
Interest	4.3 (0.9)	4.1 (1.0)	0.45	11	.398	.21
Choice	4.9 (1.0)	4.5 (0.7)	2.0	11	.069*	.46
Dietary Self-Efficacy	3.4 (0.8)	3.0 (0.6)	1.5	11	.167	.57
General Self-Efficacy	3.2 (0.4)	2.8 (0.8)	2.5	11	.028**	.63

Note. *p<.10, **p<.05; Analyses included the 12 participants who completed baseline and follow-up. Subjective Dietary Assessment was measured by the Rapid Eating Assessment for Participants- Shortened Version (REAP-S). Diet Quality was measured by calculating the Healthy Eating Index (HEI-2015) from the 24- hour dietary recall. Motivation was assessed by the Intrinsic Motivation Inventory for Schizophrenia (IMI-SR) with an overall score, and three subscales such as value of activity, interest in the activity and feelings of choice about doing the activity. Dietary Self-Efficacy was measured using the Eating Habits Confidence Survey (EHC). General Self-Efficacy was measure by the General Self-Efficacy Scale (GSE).

Table 9. Scatterplot of Diet Quality with All Participants
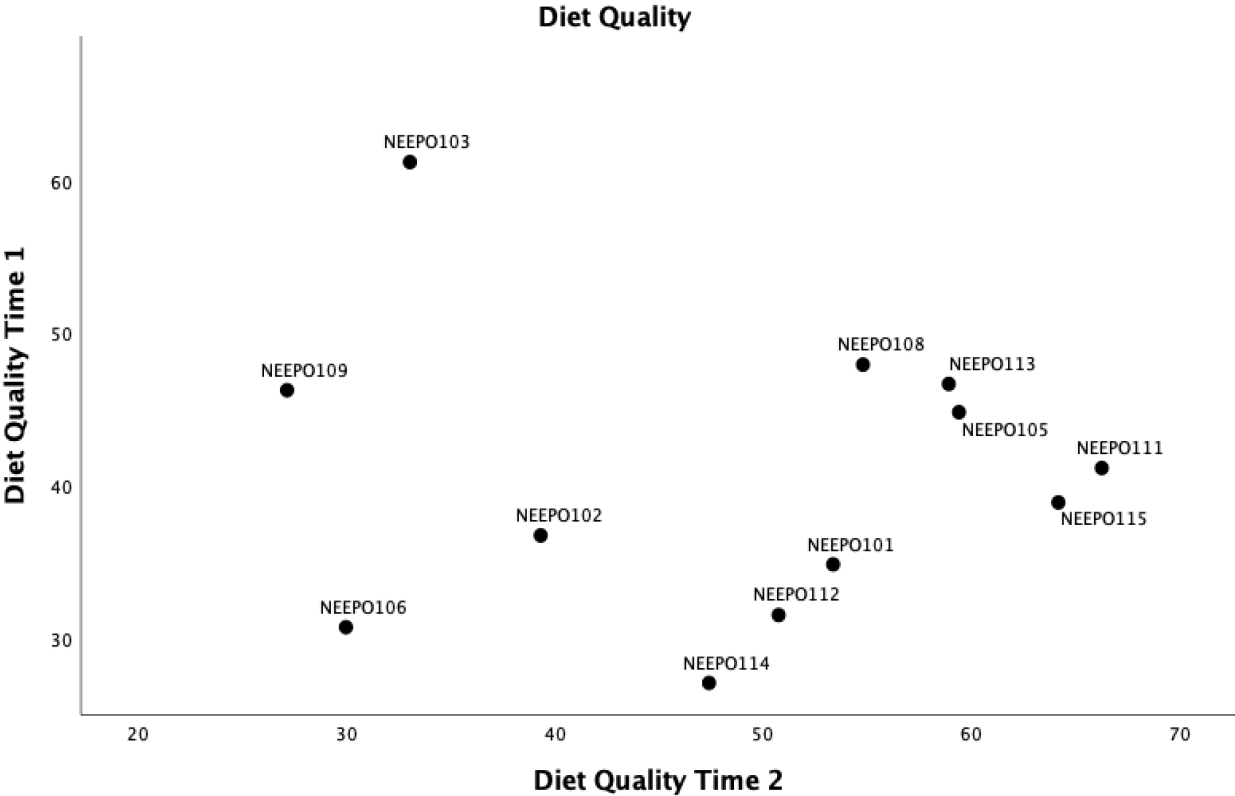
Note. Scatterplot includes the 12 participants who completed baseline and follow-up.

Table 10. Qualitative Responses

In what ways was the intervention helpful?

	n (%)	Sample Quotes
Highlighted poor current diet	7 (58.3%)	*"You realize what's going in your body and what's not going in your body. It helps a lot." "It was adding up my calories and everything I was eating… and I was like, 'woah, that's a lot.'"*
Increased motivation	7 (58.3%)	*"It kept me motivated. You really helped keep me motivated and to keep going."*
Improved choices	7 (58.3%)	*"I was eating less carbs, less meat, and more nutritious meals over the days."*
Decreased caloric intake	2 (15.7%)	*"It helped to prevent me from eating more than I should."*
Cared more about health generally	4 (33.3%)	*"I have to think long and critically about what I eat because I do know that the leading cause of death in America is heart disease… that makes me nervous because I don't want my life to be short because I made terrible decisions [about what I'm eating.]"*
Will improve diet in the future	6 (50.0%)	*"I'm going to keep using the app… to figure out where and what kind of areas [in my diet] I can improve."*
Did not improve diet quality	2 (16.7.0%)	*"It didn't really change the way I ate. I was eating the same stuff."*

How would you improve the intervention?

Increase personalized text-messages	2 (16.7%)	*"I would prefer maybe twice per week (instead of once per week.) You don't have to reach out to me every single day… it would probably be enough in the beginning of the week, like Monday, and then the end of the week like Friday."*

Decrease automated text-messages	2 (16.7%)	*"It was a lot… I don't need a text-message before breakfast because I rarely eat breakfast." "It was a little bit annoying… not that annoying, but you know."*
Improve the dietary tracking application	2 (16.7%)	*"When you tried to scan the barcodes [on MyFitnessPal] it wouldn't work, so that was frustrating."*
No changes	9 (75.0%)	*"I don't really have any changes I could make."*
Outside of the intervention, what helped you be successful?		
Family support	*8 (66.7%)*	*"[After telling my mother about the intervention] my mother bought a lot of vegetables. She bought kale. She bought broccoli, cauliflower, cucumbers."*
Outside of the intervention, what made it harder to be successful?		
Low motivation to cook	*3 (25.0%)*	*"I cook somethings but not a lot of things. Sometimes you want to come home and not cook."*
Lack of support	*2 (16.7%)*	*"My family was indifferent. They was like "good for you" but they went back to their old habits of eating fried chicken and a whole bunch of pork… no vegetables, no fruit."*
Unhealthy options easier to access	*3 (25.0%)*	*"Restaurants that are readily available that don't serve healthy options. At least around where I live at, there are no healthier options."*
Antipsychotic medication side effects	*2 (16.7%)*	*"After I get my Invega shot, I get like these hunger cravings for some reason, and it's always like I want fried food."*

Note. N=12; Categories are not mutually exclusive or comprehensive. Percentages can be more or less than 100%.

APPENDIX

Nutrition Education Presentation

1

Nutritional Education Guide

Education presentation occurs IMMEDIATELY after the two 24-hour dietary recalls with ASA-24, and prior to goal setting

> *"So today we are going to talk a little bit about nutrition. What do you know about healthy eating?* (leave unstructured space for brief collaborative discussion of their thoughts of healthy eating before returning to why you are doing the nutritional education.)

> *The reason I am talking about this with you today is because people with mental illnesses are at an increased risk of physical health related illness, particularly as they get older. And when I say illnesses, I mean things that impact that functioning of your body, such as diabetes and heart disease. Are those familiar to you?*

> *This is likely due, in part, to some of the medications used to treat mental illness, such as antipsychotics. Although helpful with controlling voices and other symptoms of mental illness, they can cause weight gain, tiredness, and increased hunger, especially cravings for fatty and sweet foods. This makes people with mental illness drink things like sugary soda more frequently than other people, and eat things that are known to contribute to heart disease and diabetes like fried and fast food. The good news is, this can be prevented and made better, in part, by improving health behaviors such as healthy eating, physical activity, and not smoking. We are just going to focus on healthy eating.*

> *So first we are going to talk about what it means to eat healthy and how much of each food you should aim to eat. We are also going to talk about WHY each food is important for your health. Then we are going to take a look at YOUR diet based on the recall you did earlier and identify what might be some healthy eating areas you want to focus on to feel your best over the next month. How does that sound?*

****

** PROCEED TO NEXT PAGE TO REVIEW WITH PARTICIPANT.
REVIEW WITH PARTICIPANT (**HOW MUCH SHOULD I EAT? AND WHY?**) Pg. 2-4
REVIEW WITH PARTICIPANT (**WHAT DOES THE RESEARCH SAY ABOUT THE EATING HABITS OF THOSE WITH MENTAL ILLNESS?**) pg. 5
Provide copy of pages 2-5 to participant.
Guide resumes on page 6.

HOW MUCH SHOULD I EAT? AND WHY?

FRUIT

How much fruit should I aim to have?
>   Women (Ages 14-18 years old): 1.5 cups per day
>   (Ages 19-30 years old): 2 cups per day
>   Men   (Ages 14-50 years old): 2 cups per day

What counts as a cup of fruit?:
>   In general, 1 cup of fruit or ½ cup of dried fruit can be considered as 1 cup from the Fruit Group.

Why is it important to have fruits in my diet?
- Most fruits are naturally low in fat, sodium (salt), and calories
- Fruits have important nutrients that can help maintain healthy blood pressure
- Fruits have dietary fiber which may help reduce risk of heart disease and improve bowel function. It helps reduce constipation
- Fruits help keep teeth and gums healthy
- Fruit can help reduce birth defects for in babies if women eat them while pregnant

What are your favorite fruits?

VEGETABLES

How many vegetables should I have?
>   Women (Ages: 14-50 years old): 2 ½ cups per day
>   Men   (Ages: 14-50 years old): 3 cups per day

What counts as a cup of vegetables?
>   In general, 1 cup of raw or cooked vegetables or vegetable juice, or 2 cups of raw leafy greens can be considered as 1 cup from the Vegetable Group.

Why are vegetables important?
- Naturally low in fat and calories. Vegetables help you feel full while eating fewer calories.
- Vegetables are important sources of nutrients and fiber
- Helps to maintain a healthy blood pressure, may lower the risk of heart disease
- Vegetables help reduce constipation
- Vegetables can help reduce birth defects when a woman eats them during pregnancy
- Helps keep skin and eyes healthy and protects them against infections
- Helps heal cuts and keep teeth and gums healthy

What are your favorite vegetables?

GRAINS (Especially WHOLE grains!)

How much grains should I aim to have? (But don't worry too much about restricting!)
> Women (Ages 14-51 years old): 3 oz per day
> Men   (Ages 14-30 years old): 4 oz. per day
>   (Ages 31-50 years old) : 3 ½ oz per day

What counts as an ounce of grains?
> In general, 1 slice of bread, 1 cup of ready-to-eat cereal, or ½ cup of cooked rice, cooked pasta, or cooked cereal can be considered as 1 ounce from the Grains Group. However, this is where it gets confusing. There is a difference between **WHOLE grain** and **ENRICHED grain.** Enriched grain refers to white bread, pasta, and most cereals. While these are grains, these food are <u>not</u> very healthy. However, WHOLE grains are packed with nutrients and fiber. Make sure to look at the FIRST ingredient of the label. Does it say WHOLE grain? You want to aim to have at least half of your grains be WHOLE grains. Whole grain includes **whole wheat bread, brown rice, oatmeal,** and **quinoa.**

Why is it important to eat whole grains?
- Whole grains are an important source of fiber and vitamins
- May lower risk of heart disease, obesity, type II diabetes
- The fiber in grains may prevent constipation, and make you few fuller with fewer calories
- Whole grains help you maintain energy throughout the day
- Whole grains have minerals that are used to build a healthy immune system and build strong bones

What are your favorite whole grains?: _____

PROTEIN

How much protein should I aim to have?
> Women (Ages: 9-18 years old) : 5 oz per day
>   (Ages: 19-30 years old) : 5 ½ oz per day
> Men   (Ages 14-30 years old) : 6 ½ oz per day
>   (Ages 31-50 years old) : 6 oz per day

What counts as an ounce of protein?
> In general, 1 ounce of meat, poultry or fish, ¼ cup cooked beans, 1 egg, 1 tablespoon of peanut butter, or ½ ounce of nuts or seeds can be considered as 1 ounce-equivalent from the Protein Foods Group.

Why is it important to eat protein?
- Meat, chicken, fish, beans, peas, eggs, nuts, and seeds contain many nutrients
- Proteins help build muscle, bones, cartilage, skin, and blood
- Eating protein helps you feel fuller longer

What are your favorite forms of proteins? _____

DAIRY

How much dairy should I have?

Men & Women (All ages): 3 cups

What counts as a cup of dairy?

In general, 1 cup of milk, yogurt, or soy milk, or 1 ½ ounces of natural cheese can be considered as 1 cup from the Dairy Group.

Why is it important to eat dairy?

- Dairy is a source of calcium, which helps build and maintain strong bones and teeth
- Nutrients in dairy help maintain healthy blood pressure

What are your favorite forms of dairy?

All information retrieved from https://www.myplate.gov

WHAT DOES THE RESEARCH SAY ABOUT THE EATING HABITS OF PEOPLE WITH MENTAL ILLNESS?*

People with mental illness may eat a little too much...
(with tips to reduce!)

- **Refined carbohydrates**
(e.g. white bread, chips, or pasta)
    - Choose whole grain or wheat bread instead of white bread
    - Make meat or eggs for dinner rather than pasta
    - Snack on nuts or trail mix rather than chips
    - Eat an open-faced sandwich (only one piece of bread)
    - Cook brown rice instead of white rice

- **Total fat**
(e.g. sweets, ice cream, fast food)
    - Choose skim milk rather than whole or 2%
    - Cook at home rather than eating fast food
    - Eat baked meat (e.g. chicken or fish) rather than fried meat
    - Cook with vegetable oil rather than butter (make sure to measure!)

People with mental illness may not eat enough...
(with tips to increase!)

- **Fiber**
    - Use whole grain bread
    - Eat fruits for snacks or with your meals (especially Grapes, Watermelon, Apples, Oranges, Bananas, Strawberries)
    - Eat vegetables with each meal or for a snack (e.g. Carrots, Broccoli, Spinach)

- **Fruits & Vegetables**
    - Frozen and canned fruits and veggies are JUST as healthy and keep longer. Go to frozen section of grocery store. Frozen veggies can be easily baked with oil, salt, and pepper

... or get enough of these vitamins and minerals...
(with tips to increase!)

- **Omega-6 Fatty Acid**
    - Eat tofu or eggs—both are cheap and can be stored for a long time
    - Peanut butter

- **Vitamin B12**
    - Eat meat, fish, milk, cheese, eggs

- **Vitamin B6**
    - Eat fish, bananas, oatmeal, peanuts, chicken

- **Zinc**
    - Eat chicken, beans, nuts, peas

- **Folate**
    - Eat broccoli, brussels sprouts, salad, spinach, peas, chickpeas

- **Vitamin C**
    - Eat oranges, broccoli, berries, peppers

- **Selenium**
    - Eat cottage cheese, eggs, brown rice, bananas, oatmeal, ham, chicken, brazil nuts

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* Aucoin, M., LaChance, L., Cooley, K., & Kidd, S. (2020). Diet and psychosis: a scoping review. *Neuropsychobiology, 79*(1-2), 20-42. https://www.karger.com/Article/FullText/493399

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AFTER REVEWING RECOMMENDATIONS ON DIETARY CONSUMPTION OF FOOD GROUPS, REVIEW PERSONAL DATA WITH PARTICIPANT FROM THE ASA-24 OUTPUT.

For example,

"Do you remember when we discussed what you ate over the past two days? Let's review that together and identify some areas where you may not be eating enough or may be eating too much of certain types of foods."

Go through the output of the ASA-24 and give them feedback about amount of each food group.

See below for example screen shot from ASA-24 output:

Daily Food Group Recommendations — c = cups oz = ounces

GRAINS	FRUITS	DAIRY	VEGETABLES	PROTEIN FOODS
UNDER	UNDER	UNDER	UNDER	ACHIEVED
EATEN 5.5 oz / 6.0 oz TARGET	EATEN 0.1 c / 2.0 c TARGET	EATEN 1.0 c / 3.0 c TARGET	EATEN 1.5 c / 2.5 c TARGET	EATEN 11.4 oz / 5.5 oz TARGET

SUBGROUPS EATEN

- Whole grains (e.g. whole wheat bread) 2.4 oz
- Refined grains (e.g. white bread) 3.1 oz

- Fruits 0.1 c
- Juices 0.0 c

- Milk and Soy Milk 0.3 c
- Yogurt 0.8 c
- Cheese 0.0 c

- Dark Green vegetables 0.0 c
- Red and Orange vegetables 0.3 c
- Legumes (e.g. beans and peas) 0.6 c
- Starchy vegetables (e.g. potatoes, corn) 0.0 c
- Other vegetables (e.g. celery and onions) 0.6 c

- Meat, Poultry and Eggs 8.9 oz
- Seafood 0.0 oz
- Nuts, Seeds, Soy and Legumes 2.5 oz

After reviewing ASA-24 output with participant, now turn to goal setting manual when participant is ready to begin setting nutrition related goals.

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