"It's Definitely Been a Journey": A Qualitative Study on How Women with Eating Disorders Use Weight Loss Apps

Elizabeth V. Eikey
The Pennsylvania State University
University Park, PA USA
eveikey@psu.edu

Madhu C. Reddy
Northwestern University
Evanston, IL USA
mreddy@northwestern.edu

ABSTRACT

Technology is often viewed as either positive or negative. On one hand, in HCI, weight loss apps are usually seen as a positive influence on users. From the sociocultural perspective, on the other hand, media and technology negatively impact body satisfaction and contribute to eating disorders; however, these studies fail to include weight loss apps. While these apps can be beneficial to users, they can also have negative effects on users with eating disorder behaviors. Yet few research studies have looked at weight loss apps in relation to eating disorders. In order to fill this gap, we conducted interviews with 16 women with a history of eating disorders who use(d) weight loss apps. While our findings suggest these apps can contribute to and exacerbate eating disorder behaviors, they also reveal a more complex picture of app usage. Women's use and perceptions of weight loss apps shift as they experience life and move to and from stages of change. This research troubles the binary view of technology and emphasizes the importance of looking at technology use as a dynamic process. Our study contributes to our understanding of weight loss app design.

Author Keywords

Weight loss apps; mobile applications; eating disorders; anorexia nervosa; bulimia nervosa; qualitative; persuasive; food journal; self-tracking; quantified self

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

INTRODUCTION

Many young women use mobile health applications for weight loss (weight loss apps). As of January 2014, 51.7% of the 46 million people who used apps from the health and fitness category were women [52]. According to Neilson, the most popular health app during this time was MyFitnessPal, an app that allows users to track calories, exercise, and weight, with 8.7 million users [52].

Women's motivation for using these apps is often to lose weight even if they are technically at a healthy weight [51]. With the pressure to be thin and beautiful, some women have an unrealistic and distorted view of their bodies. In fact, in North America, there is such a pervasive body dissatisfaction and preoccupation with weight that psychologists have developed the term "normative discontent", which describes the "normalcy" of being unhappy with one's weight as a woman [39].

From the sociocultural perspective, much of this dissatisfaction is driven by the media and now technology [39]. The sociocultural model of eating disorders posits that "disordered eating is a result of internalizing the increasing pressures for women in Western society to achieve an ultra-slender figure/the thin ideal, which current cultural trends emphasize as an essential component of beauty" (p.1225) [18]. With this obsession with weight and size, women may engage in extreme and even dangerous behaviors to achieve an unattainable idea of beauty – even when losing weight is unnecessary. Some of these women develop eating disorders as a result. In fact, it is estimated that 35% of "typical dieters" develop eating disorder behaviors, and of those, 20-25% develop partial or full eating disorders [37].

Few research studies have looked at weight loss apps as a type of new media that may contribute to or exacerbate eating disorders. Yet weight loss apps often contain the same types of content as other technologies that have been shown to worsen body dissatisfaction and disordered eating. In Human-Computer Interaction (HCI), weight loss apps are often viewed as positive influence on users. In order to understand if weight loss apps contribute to eating disorders, we wanted to hear stories from women with a history of eating disorders who use or have used weight loss apps. We used semi-structured interviews with 16 participants in order to get in depth and detailed descriptions of their experiences. One primary research question guided our study: How do women with a history of eating disorders use weight loss apps?

What emerged from this data is a complex perspective of how weight loss apps are used. While there is evidence to suggest that weight loss apps, like other technologies, may contribute to and exacerbate eating disorder behaviors, how these apps are used and users' perceptions of these apps change over time. This finding "troubles" the typical binary view of technology. That is, instead of technology being seen as only positive or negative, the role of technology can shift

depending on where users are in their health "journey". This should be of growing interest to the HCI community because viewing technology as just good or bad neglects the larger picture of how technology use changes depending on user needs. Specifically, our study shows women with eating disorders reflect on and use apps differently as they go through their eating disorder journey. Our research has implications for the design of more health-focused apps.

BACKGROUND
Eating Disorders
While it is estimated that 20 million women in the United States have an eating disorder, many more have unhealthy eating behaviors or may be undiagnosed [33,48]. It is estimated that 8%-17% of college-aged students have an eating disorder, and 20% of college students believe they have had an eating disorder in their lifetime [14,21,34].

For the purposes of our study, we focused on behaviors associated with anorexia and bulimia nervosa and other specified eating disorder/eating disorder not otherwise specified because there is some overlap between these disorders [1]. Eating disorder behaviors related to these disorders include excessive calorie or food restriction, intense fear of gaining weight, obsession with weight and consistent behavior to prevent weight gain, self-esteem overly related to body image, bingeing, feeling of being out of control during bingeing, purging, dramatic weight loss, preoccupation with weight, food, calories, fat grams, and dieting, refusal to eat certain foods, comments about feeling "fat", hunger denial, excessive exercise regimen, and development of food rituals.

Some eating disorder behaviors may be viewed as typical to achieve weight loss or not severe enough to warrant medical attention. Research has shown that even women of a healthy weight may utilize "weight loss methods" indicative of eating disorders [33]. Additionally, research has shown that 25% of college women in the United States have engaged in bingeing and purging as a weight loss method [48].

Sociocultural Perspective of Eating Disorders
While biological and psychological factors play a role in an individual's predisposition and development of eating disorders [12], researchers in psychology have highlighted the sociocultural perspective - that social and cultural factors play a significant role in the development and prevalence of eating disorders [3]. This perspective is used to understand how social and cultural factors, such as traditional media, affect an individual's mental processes and behaviors [36]. For example, it has been used to understand the impact of media on body image and eating behaviors [3]. For quite some time, research has shown that media exposure contributes to body dissatisfaction and disordered eating [31]. However, much of this research has focused on conventional mass media, such as magazines and television.

In recent years, researchers have been calling for more work in understanding the impact of new media, such as online

content, on the thin ideal, body image, and eating disorder symptomology [31]. From this perspective, technology is viewed as a negative influence on users. Recent work has shown that online content, such as social media, is associated with poor body image and eating disorders, especially among women [2,16,24,26,42]. Many online weight loss and fitness communities either overtly or subtly promote eating disorders, and this negatively affects users who are trying to address their eating disorder issues [41,45]. Researchers in psychology have recognized the importance of understanding the effects of new media on eating disorder symptomology.

However, their focus has largely been on social media. For example, using Facebook is correlated with drive for thinness in women and men [23] and body dissatisfaction [16,17,42]. Mabe et al. [24] found that frequency of Facebook use was related to disordered eating. Similarly, Stronge et al. [42] found women and men of all ages are more likely to have poorer body satisfaction if they use Facebook. Kim and Chock [23] conducted an online survey to examine Facebook's impact on users' body image attitudes. While they did not find a correlation between time spent on social media and body image concerns, they found engaging in particular social media behaviors such as checking friends' profiles, leaving messages, and commenting on profiles is correlated with a drive for thinness in both females and males.

Even HCI researchers who study eating disorders have primarily focused on social media [7,13,30]. Some researchers have found that social media promotes eating disorder behaviors. For example, Chancellor et al. [7] found that despite Instagram's strategies to reduce pro-eating disorder content, pro-eating disorder communities still exist and are thriving. Similarly, Pater et al. [30] analyzed hashtags on Tumblr, Instagram, and Twitter and found pro-eating disorder-related hashtags, images, and text. While this work is important because many people (especially young females) use social media, research is lacking on the role of weight loss apps. Additionally, this perspective only considers media and technology as a negative influence; whereas our study looks at weight loss apps as both positive and negative.

Health Apps for Weight Loss, Diet, and Exercise
We add to the HCI literature on food journaling, self-tracking, weight loss and persuasive technology. In HCI, many researchers focus on how weight loss apps are positive influences on users. Specifically, weight loss technology is often seen as a way to help people combat obesity and obesity-related health conditions. Thus, the focus is on designing apps to motivate users to eat less or healthier, exercise more, and use the app long-term [4,6,9,10,20,22,27,35,40,46,47,49] and how this technology contributes to users' ability or their perception of their ability to achieve health goals, such as weight loss and exercising [8,28].

These apps can be useful weight loss tools [19,38], but they may also trigger unhealthy eating and exercise behaviors by creating a dependence on logging food, exercise, and weight. Tan et al. [44] found that users felt weight loss and fitness apps could be both helpful and harmful for eating disorder recovery but did not elaborate further. Prior to weight loss apps, some people (including those with eating disorders) tracked their diet and exercise on paper. While this can still negatively impact eating disorder behaviors, weight loss apps are more personalized, discreet, mobile, and quicker to use. They also provide users with precise values for food and exercise and visualizations of weight loss and calories consumed/burned with an added component of the app "rewarding" them for eating less, exercising more, and losing weight.

Recently, some HCI researchers have been challenging the narrative that quantifying behaviors and logging is always positive or appropriate. For example, Cordeiro et al. [11] considered the use and problematic aspects of food journaling for a general population, where the focus is to encourage logging. Similarly, Cordeiro et al. [10] discussed how in self-tracking, quantifying behaviors are pervasive but not always appropriate because of user goals. Purpura et al.'s [32] fictional Fit4Life is related to our work because they discussed problems of persuasive technology. They call for us to expand our criteria beyond BMI because it is not a good measure of health and explore unintended consequences.

Our study directly contributes to prior HCI work. Like other researchers, we also believe the quantification of behaviors is not always appropriate but investigate the use of *existing* self-tracking tools to understand how users' needs are not being met. Our study looks at the issues of weight loss technologies and unintended consequences but in the context of eating disorders.

METHODS
Participants and Recruitment
To be eligible for the study, participants (1) Had to use/have used weight loss apps, (2) Be an 18-25 year old woman, and (3) Have/had an eating disorder (symptoms related to anorexia and/or bulimia nervosa). Although eating disorders are increasing among men [43], we focused on women because they are more likely to develop eating disorders [15]. Because some people do not meet the full criteria for a specific diagnosis and because many people never seek treatment for their eating disorder, we recruited both participants who were formally diagnosed and those who were not. We posted flyers at the university and at public locations around the local town. Each participant was compensated $25.

Data Collection Sessions
The first author conducted all data collection sessions. Each session consisted of a survey, a think-aloud exercise, and a semi-structured interview. Through the survey, we obtained demographic information as well as history and status of their eating disorders. For the think-aloud exercise, we asked

participants to go through 3 tasks: (1) setting goals, (2) viewing progress visualizations, and (3) using social and community features. After the think-aloud exercise, we moved into the interview portion of the study, which focused more on their perceptions of the app and technology use in general. The think-alouds showed us how users used the app and provided us with concrete examples of goals set, calorie budgets, etc. During the interview, we asked users to reflect on how they have used the app over time, show what made them feel negative and positive emotions, explain how the app changed their behaviors, and discuss what aspects were helpful to recovery and exacerbated ED symptoms.

The think-aloud exercises were video recorded. The entire discussion was audio recorded; thus, transcriptions represent both think-alouds and interviews. Each session took anywhere between 40 minutes and 1 hour and 45 minutes. We conducted a total of 16 sessions because we saw repetitive themes in participants' responses (i.e., data saturation) [25].

Analysis
The audio files from the data collection sessions were transcribed into electronic format (approximately 278 pages). This was appropriate because the goal was "to analyze the content of communication" to understand the participant's experience (p. 2937) [50]. Then we used thematic analysis to identify themes across the data set [5]. As participants explained their use over time, we noticed a lot of discussions about "before" and "after", so we first grouped discussions according to users' descriptions of when they first started to use the app and then after they changed their use/stopped using the app. We then developed initial codes, searched for themes, and reviewed and grouped them together, which led to the final themes.

FINDINGS
We first present information about our participants. Then we discuss how their app use changed over time. Finally, we provide quotations from participants that exemplify their experiences. Specifically, we focus on:

1. Disordered use of weight loss apps (such as obsessive logging, need to be exact, acute awareness of numbers, restricting, manipulating the app to lose weight, compensatory behaviors, manipulating the app to avoid negative emotions),
2. Making a change (such as adding in calories and/or focusing on nutrition and taking a break from apps), and
3. Falling back into old habits.

These showcase the participants' journey of weight loss app use as many reflected on their eating disorder and app usage over time.

Participants
Participants were ages 18-23 with the mean being 20.88 years. The majority of participants identified as White (non-Hispanic) (*n*=12) with one from Israel. Two identified as Asian, Asian American, or Pacific Islander, 1 identified as

multi-racial, and 1 identified as Native American or American Indian. As shown in Table 1, most participants had not been professionally diagnosed with an eating disorder (*n*=12), and most reported being in recovery or recovered (*n*=13). Participants estimated they had an eating disorder anywhere from 2 months to 7 years, and their eating disorder behaviors included extreme restriction, obsession with "healthy" foods, bingeing, excessive and compensatory exercise, purging, and extreme anxiety and concern related to food and weight. Most (*n*=13) felt their eating disorder began before using weight loss apps. Participants reported using weight loss apps between 2 months and 8 years (mean of 35.63 months or 2.97 years with a standard deviation of 31.92 months or approximately 2 years). The most commonly used app was MyFitnessPal (*n*=15).

Founded in 2005, MyFitnessPal[1] has become one of the most popular weight loss apps [52]. It allows users to create a diet plan by entering their height, starting weight, goal weight, weekly weight loss/gain goal, and activity level. Users can enter their foods by searching the database of foods, manually entering calories, or scanning barcodes, and they can input exercise manually or by synchronizing other apps or wearables, such as Fitbit. The app also allows users to track nutrients, such as carbohydrates, and set nutrient goals. MyFitnessPal provides visualizations of calories consumed/burned, weight loss, and nutrients. Users can also choose to connect with other users through adding friends, messaging friends, participating in challenges, and posting on the MyFitnessPal forums.

Patterns of Use

Participants discussed not only their current use of weight loss apps, but also their past use and how it has changed over time. Because many participants have been using weight loss apps for over a year (and some many years), they shared how their eating disorder influenced their app use and how the app impacted their eating disorder. Most participants also felt they were in recovery from their eating disorder, which gave them the opportunity to reflect on how they arrived at this point in their health journey. In fact, some participants actually referred to their eating disorder and subsequent app experience as a journey.

In hearing their experiences, a pattern of use began to emerge as shown in Figure 1. The lines in the figure represent bidirectional arrows. In the beginning, participants' intentions were most commonly to lose weight (whether or not they were at a healthy weight). When they first began using weight loss apps, they found them helpful in losing weight and tracking their foods even though some of their behaviors were disordered. A number of participants

describe how their diet and tracking sort of "spiraled out of control". As time went on, participants began to think that they may have an eating disorder and that the app was exacerbating it. Upon this realization, participants would either decide to use the app as a tool to eat more or stop using the app altogether. However, participants often began using weight loss apps again and felt they were battling their eating disorder mindset even when recovery was the focus. We showcase their journey by providing quotations regarding their experiences of (1) using the app in a disordered way, (2) deciding to make a change, and (3) falling back into old habits.

Disordered Use of Weight Loss Apps

During the height of their eating disorders, participants talked a lot about the ways they used weight loss apps in an unhealthy manner (even though they did not often recognize their behaviors as disordered early on) and ways the app impacted them.

Obsessive logging

A number of participants explained that they became obsessed with logging their food and began using the app multiple times a day. One participant talked about how she felt the need to log everything she ate:

"I got more hung up on tracking everything. Before I could just eat something. I didn't have to worry about logging it into something. I didn't really keep track of it throughout the day…. Then the ability to track it only made it [eating disorder behaviors] worse… Definitely before [recovery], it was really bad. Like I would get on there [the app] a few times a day, like more than the 3, and just be very obsessive about it." [U02]

Similarly, another participant discussed how obsessive food logging and tracking turned into an eating disorder:

"I started to diet and that's kind of how my eating disorder manifested itself, after the diet became an obsession with tracking my food and how low I could get the number basically… When I was in the middle of my eating disorder, I would definitely use it [the app] everyday. And it was one of those things where I would pretty much try and track everything the day before." [U06]

These participants explained that they used the app many times a day everyday to the point that they felt compelled to log and track their foods and check the app.

Need to be exact

Participants also talked about how they felt the need to be exact with recording their calories and macronutrients.

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[1] https://www.myfitnesspal.com/

ID	Professionally Diagnosed	ED[2] / ED Behaviors	Do you think you currently have an ED?	ED Length	ED Before or After App	Apps Used	App Use Length
U01	Yes	Anorexic behaviors, binge eating	No	2 months	After	MyFitnessPal	2 months
U02	Yes	Anorexic behaviors, orthorexia[3]	Yes	1 year	Before	MyFitnessPal, Nike+Running	1 year
U03	No	Anorexia nervosa, exercise anorexia	No	6 years	Before	MyFitnessPal	8 years
U04	No	Anorexic behaviors, EDNOS/OSFED[4], excessive exercise, strict diet	No	1 year	Before	MyFitnessPal, MapMyRun	4 years
U05	No	Anorexic behaviors, back and forth between eating and not eating	No	2 years	Before	MyFitnessPal, Fitbit, Moodnotes	4 months
U06	No	Anorexia nervosa, orthorexia, binge eating disorder	No	3 years	After	MyFitnessPal, FitBit	4 years
U07	No	Anorexic behaviors, restriction, purging	No	1 year	Before	MyFitnessPal	5 months
U08	No	Anorexic behaviors, barely ate, some bingeing, EDNOS/OSFED	No	1 year	Before	MyFitnessPal, WeightWatchers, 21 Day Fix	7 years
U09	No	Anorexia nervosa	No	2 years	Before	MyFitnessPal, Calorie Counter	7 years
U10	No	Bulimia nervosa	No	6-7 years	Before	MyFitnessPal	4 years
U11	No	EDNOS/OSFED, binge eating-exercise/diet-binge eating, had great anxiety related to eating/dieting	No	>4 years	Before	MyFitnessPal	8 months
U12	Yes	Bulimia nervosa	No	6 months	Before	Cronometer	1.5 years
U13	Yes	Anorexia nervosa	Yes	3 years	After	MyFitnessPal	5 months
U14	No	EDNOS/OSFED, always thinking about food, need to track everything eaten, concern when not hitting macronutrients, restriction, bingeing	Yes	7 years	Before	MyFitnessPal	2 years
U15	No	Anorexia nervosa	No	1 year	Before	Lose It, Steps, MyFitnessPal	2 years
U16	No	EDNOS/OSFED, anxiety about food, afraid to eat "unhealthy" in pubic, bingeing in private, compensatory exercise, diet-bingeing cycles	No	4 years	Before	MyFitnessPal, FitBit, Nike Running App, Nike Training App, Healthy Out, Eating Well, Spartan Race	5 years

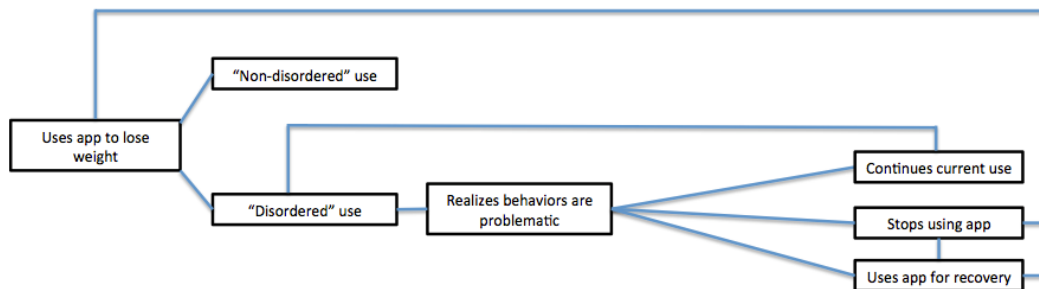**Table 1. Information about participants' eating disorder and app use**

Figure 1. Patterns of weight loss app use

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[2] ED = eating disorder

[3] Orthorexia is an obsession with eating healthy foods.

[4] EDNOS = eating disorder not otherwise specified; OSFED = other specified feeding or eating disorder

One participant explained how she would log every single piece of food even if it were only a portion of a calorie:

"So literally, it [the app] just knew everything… It had the one tiny little morsel of food logged in there… I remember I went to church one day and I got a communion [wafer], and I even found the calories of it, which it's a half of calorie, that doesn't matter. But I think it was still in there, so I logged it… Why would you even have that in there? So that just didn't help." [U13]

Another participant described her anxiety around needing to hit her calorie and macronutrients exactly and how that affected her ability to spend time with her family:

"I try to get exactly on [the number]… I like having it exactly on… It [the app] made me more OCD [obsessive compulsive disorder], 'cause I'm like, 'I have to hit this number,' basically… It's made me more, very stringent on what I'm eating and making sure I hit those numbers… There was one time my parents wanted to go out to dinner… So, I called the [restaurant] so I could already track it and have it as close as possible. And then my parents get here, and they're like, 'Oh, we're going go to [this other restaurant] instead.' And I was literally having anxiety about going. I didn't want to go to dinner. I was like, 'No. I already had everything perfectly planned for my day,' and that was probably a bad moment… I feel like eating disorders stem from people trying to be perfect, and with this, you're hitting numbers trying to be perfect, so I think that could be kind of bad." [U14]

Many participants discussed how they used the app to help them achieve exactness when tracking calories and macronutrients. Using the app fueled this desire to be exact and resulted in anxiety if they did not know the precise amount of calories and macronutrients in the foods they were eating in order to log them accurately.

Acute awareness of numbers
Weight loss apps also tend to put an emphasis on numbers associated with foods and exercise. As participants discussed, this focus on numbers worsened their eating disorder behaviors. One participant talked about how the app made her more aware of calories, which fed into her need for control:

"I guess it [the app] has made me more aware of numbers and just trying to meet some you know, calories burned for exercise and stuff like that because it will log it in there. So getting really hung up on numbers has worsened things… like you get so fixed on controlling everything because you know it's at your hands, literally. You can control everything and then act on it. If I want to, the night before, I'll tell myself what I will eat, like I get very big on planning the meal for the next day when it's still the day before. So it's a big control thing…" [U02]

Similarly, another participant talked about how weight loss apps can change users' relationship with food so that the food essentially boils down to its numbers. At the worst of her eating disorder, one participant talked about how every food was viewed as its calorie amount:

"I think it's [logging food and exercise everyday] definitely very triggering because you become obsessed with food, you look at food differently. Like now when I look at food, I see like that's protein, that's fat, that's carbs instead of like that's a chicken breast, that's peanut butter, that's a piece of bread, and so it's always thinking, how can I eat these things when I only have so many carbs or I have to eat this much protein. And so it's definitely very, very triggering to be tracking it all the time. And especially back then [during my eating disorder], it was like, 'Well, that's 100 calories right there, like I need to eat broccoli instead, that's like 35 calories.' It's a number game basically." [U06]

The heavy focus on the numbers in weight loss apps was problematic for a number of participants. By providing a way to monitor their diet so closely, the app fueled their need for control.

Restricting
One way participants maintained control was through restricting their calories. Participants described how they felt encouraged by the app to continue to restrict and accomplished when they ate under their daily calorie allotment. One participant described how she was almost in competition with herself and the app to eat fewer calories each day:

"I kind of set it [my goal], and then it [the app] gave me a calorie count of maybe 1200 calories. But I never wanted to go above 1000 calories. I remember like coming home from the gym, and if I was around like 500 calories, like I was happy with that… so I definitely didn't want to be anywhere near the maximum. I wanted to be underneath. So that's like a negative thing, thinking back… But at the time, it was kind of like a game to beat the calories, kind of. So one day I had a 0, maybe it was like a negative calorie. I was like, 'Oh, wow, like look at me, like that's cool!' But that's not what you should be thinking [laughs]. Or the days where I was eating like above 1000, I was like, 'Oh, I ate way too much today,' just because I wanted to be like way under the like 1200… Just because like you can visualize what you're eating, so the more you don't eat, it's like, 'Oh I beat the app!'… I definitely wanted to beat the calories they gave me. I feel like that kind of does start an eating behavior where you don't want to eat anything." [U07]

Similarly, another participant talked about how the app made it seem "good" to eat under the allotted calories and how she felt proud when she did:

"It [the app] had you put in your weight and stuff. I think that the calories they gave you was the lowest that it would give you [laughs]. And then it just became this weird competition thing with it… [I felt] amazing [when I ate under my calorie allotment]… I just felt like I achieved my goal for the day. I just felt a sense of achievement. And then each day I would get lower and lower and lower… Because it [the

app] taught you that if you went over, you didn't succeed that day. But if you went under, then congrats, you're going to lose weight! You did what you were supposed to do that day... At the end of the night I would look through what I ate, and if it was mostly vegetables or something, I'd be proud, and then if it was strayed from that a little, I would probably freak out." [U13]

Participants discussed how the apps could contribute to their restrictive behaviors by making it seem like a game to eat less than the given amount and less than the prior day. By seeing that they ate under their calorie budget, many participants would feel a sense of accomplishment, which fueled their desire to continue and even intensify their restrictive behaviors.

Manipulating the app to lose weight
Some participants talked about ways they manipulated the app so that they were actually netting less calories than the app stated. This was often achieved by not honestly reporting information about exercise and activity level. For instance, one participant talked about how she reported her activity level as "sedentary" even though she was really active so that she would lose more weight quickly:

It [the app] only takes you as low as 1200 calories because that's a regular diet would recommend, the lowest you can go. So I would adjust my diet... I put in I wasn't active even though I was really active, so my maintenance calories were already lower than they should have been. And then if I put in like lose 2lbs per week, it would be even lower. So I feel like that can be manipulative... I think it can easily spiral into like disordered eating." [U03]

Another participant explained how she would do a lot of calorie-burning activities and then go to the gym but never log calories burned from exercise:

"I was dancing 4 days a week for like 2-ish hours and then I was swimming 4-5 days a week for 1-2 hours as well as thinking I needed to start lifting. So I would in between all that, go to the gym 4 times a week and lift up the 10lb dumbbells, so my calorie expenditure was probably 3000-4000 calories a day, and I was eating 1000... I didn't [record my exercise]. I don't think I ever recorded it simply because I knew I was doing so much." [U06]

These participants manipulated their calorie budgets and expenditures by not accurately inputting their activity level and exercises. Without exercise, the app told them that they would lose weight, so being more active than reported acted as buffer or a means to more quickly achieve weight loss.

Compensatory behaviors
While participants felt rewarded by staying under their daily calorie allotment, sometimes they would exceed those budgets, and the app would reflect that. Participants often purged through exercise but sometimes vomited. Many talked about how they restricted their intake more the following days to compensate for being over budget. One

participant described how she would use exercise to "get calories back" and would restrict more if she exceeded her allotment:

"If I see the red, it's pretty much a bad day, and I feel like I have to start all over again. So then you'll probably see the next week [I'll] be super low in like everything... I used to work at [a doughnut shop], so I would snack on things there, so you can log having a [doughnut hole]... and I actually had eaten a lot of calories, and I felt like crap... And I logged it, and I think it went into the red. When I went to gym, I worked out for so long that day, and I was able to see it go back to green and still say it had remaining calories... Like to see it go back to green made me feel like, 'Ok, like I'm fine' even though in retrospect, even if I'm eating a bunch of crap and exercising, that's really not that much healthier... But I liked seeing it go from like red to green."

Another participant discussed how she used exercise to "cancel out" calories:

"So I kind of used this app to document like every single thing I did. So if I went for like an hour walk, I would put it in here. And like every little exercise I did to get calories out of the app, I would do that... the exercise part was kind of how I was able to get to my 500 calorie limit. Normally, I would only want to eat around 800 or 900 calories, and then after exercise, it would drop down to, I would normally burn like 300 calories, so it would get pretty low. I remember one day... after exercising, I was at 0 calories. And I was like, 'Look! Look at this! That's kind of cool.' Like thinking about it, it's like so bad, but the app's kind of designed that way, to kind of want you to cancel out your calories." [U07]

The apps are designed in a way that allows users to "remove" calories eaten by adding in exercise. Participants often talked about how they would utilize exercise as a way to compensate for going over their calories for the day. They also would eat less in the days following exceeding their calorie budget.

Manipulating the app to avoid negative emotions
Exceeding the calorie budget almost always resulted in negative feelings, such as guilt and shame. In order to avoid those feelings, some participants would not log their food if they knew they would exceed their allotment. One participant talked about how she felt devastated when she significantly exceeded her calorie budget, so she would rather not enter it on the app:

"Normally on my cheat days, I try not to even enter it in the app because I didn't want to see it on the app [laughs]. But I think we went to the [restaurant] with my dad, and I remember me and my sister, we split a cheesecake, and she went to enter it in the app and saw that it had 40 saturated fats! And she literally started to almost cry after seeing that 'cause like, that's just almost, it's weird to say, but it's kind of devastating just because like visually, once you start losing weight, I started to picture the food I ate on parts of my body. So I was like, 'That cheesecake's going to go right to my

thighs, like right to my stomach.' I didn't even enter it in the app 'cause I was like, 'I don't want to see it,' like I didn't want to know." [U07]

Another participant also did not want to see how many calories she consumed on the app:

"What actually happens is if it's way over, I just don't log it [because] I don't want to see the damage. So I literally won't log it… I avoid that negative emotion by just simply not logging it." [U10]

The act of logging those foods and visualizing the calories on the app made it seem "real", which resulted in too much guilt and shame. By selectively inputting their calories, some participants were able to minimize negative emotions associated with exceeding their calorie budget.

Making a change
Many participants explained that at some point they began to realize their behaviors and thoughts associated with food, exercise, and body image were unhealthy. When they actively decided to try to be healthier, participants would either change how they used the app or stop using the app.

Adding in calories and/or focusing on nutrition
One way participants changed their app usage and oriented their use towards recovery was by slowly adding more calories to their diet and focusing more on nutrition. Through the app, they logged additional calories as well as macronutrients. This essentially taught them that they could eat more, which reduced their fears around weight gain. One participant talked about how adding calories and tracking macronutrients helped her recover:

"I slowly added calories, and then that's when I started tracking my macros, like my protein, carbs, and fat, to reach a certain amount to slowly gain weight, and then I guess you could say the way I use the app in recovery, like it kind of taught me how to eat again because when I would eat, it was just so disordered. I would have like 5 crackers. It was just all over the place. So I would say tracking my macros on here [the app] helped me recover because it taught me how to eat again, like a breakfast, lunch, dinner, and then snacks." [U03]

Another participant explained how seeing that she could eat more without gaining too much weight helped her:

"It's [the app] helped… I can fit certain things into my macros and not feel bad about it. I was fitting an Oreo everyday kind of thing and realized that there's no bad foods… It helped me eat a lot more. This past off-season I was eating so much. Honestly, I don't want get back up to that point, but it really helped my metabolism get up and so I could track it and realize, 'Oh, I can eat this much food and still stay pretty lean.'" [U14]

While participants were still logging their foods, they began to change their perceptions around food, which helped them in their recovery.

Taking a break from weight loss apps
Sometimes participants felt the best course of action for their recovery was to stop using the app. For example, one participant talked about how ceasing use really helped her recover:

"[sigh] I took a break from tracking, like the past year, I stopped using the app and just kind of started eating like a normal person again, and that was really nice so. I think everyone should do that, and I think that's really what has helped me." [U06]

Another participant described how she stopped using the app when it consumed too much of her time and she was having anxiety attacks about food:

"I went to a psychologist on campus… because I was so anxious. And if I would binge-eat, then it would have been binge-eating of vegetables because I was so anxious about gaining weight. Just something at some point after a long miserable, I think semester at least, I just said no more and this is crazy. Nothing should drive me nuts, like food. So that's when I said, 'I'm going to erase it [the app], I'll be fine.' Then I would cheat a little bit, like I would remember everything. So I would write down on a paper. I had this and this and like add it up and do a calculation in my head. But that's when I erased it [the app], when it was just occupying me and energy-wise and time-wise just to insanity really." [U12]

At some point, many of the participants stopped using weight loss apps at least for some period of time because they thought it would help with recovery.

Falling Back into Old Habits
Although a number of participants took a break from using weight loss apps, many of them began using weight loss apps again. Even when participants had recovery goals in mind, they wanted to use weight loss apps to keep track of their foods or to lose weight. Some participants described pressures to lose weight and be fit as a result of being athletes or fitness competitors, and they felt the app in some ways was the only way to achieve that:

"[I started to use the app again because of] just the desire to lose the weight because I know that I can't do it on my own. I really enjoyed competing in the body building show, and I really enjoyed that experience of being on stage and it's like this very glamorous day, you've never felt prettier. You get your hair done, your makeup done, it's crazy, it's a great day. But it was the after effects that I struggled with, and so I want to do that again, but I know I'm not ready to do it if I can't lose the weight on my own and like get to a better starting point… I think that I am at a healthy weight, just not where I want to be." [U06]

In addition to wanting to track foods, one participant explained that deleting the app caused her anxiety, so she felt compelled to use it to manage her diet:

"Last summer, I had to delete it. I deleted it and had to get it back 'cause I was like, 'Oh, my gosh, I need to know what I'm eating.' And I'm a very scientific numbers-based person, so I like having everything on point... So, it's hard for someone to have an app like that whenever you're like that. It consumes you... I literally got anxiety, so I had to get it back... I just want to hit everything correctly." [U14]

While participants were interested in supporting their recovery, they often felt the need to continue to use weight loss apps either to help them reach athletic and fitness goals or to relieve anxiety around food and weight.

DISCUSSION

Our findings highlight two sides to weight loss apps, troubling the binary view of technology. On one hand, they can exacerbate and contribute to eating disorders. On the other hand, users use apps for eating disorder recovery. We further discuss how our findings trouble the binary view of technology and then provide insights from our study that are useful for designing more health-focused apps and technologies in the future.

Troubling the Binary View of Technology

Typically, studies talk about technology as either a negative influence or a positive one. For example, from the sociocultural perspective, technology negatively impacts body image and eating disorder behaviors while much HCI research views weight loss apps as beneficial to users. Our findings show that weight loss apps can be both negative and positive. In line with the sociocultural perspective, there are aspects of weight loss apps that contribute to and exacerbate eating disorder behaviors, such as the heavy focus on numbers, which fuels obsessive logging, makes users want to be exact, changes the relationship with food, and allows them to manipulate the app to lose more weight; and calorie visualizations, which make users feel rewarded for eating under and guilty for eating over their budget and contribute to their need to exercise to compensate for calorie consumption. Therefore, some users, especially those who are still struggling with eating disorder behaviors and poor body image, can easily be triggered by using weight loss apps. In the right mindset though, users who are trying to add more calories into their diet or focus on nutrition may find it helpful to track their foods and alleviate anxiety around weight gain.

As this study demonstrates, focusing on a binary view of technology is problematic because technology is neither inherently good nor bad. Thus, the context around technology use is crucial in understanding users' needs and the effects of using health technology, particularly when talking about eating disorders. While many users believe weight loss apps can be problematic for those with eating disorders, many stated the effects of the app depend a lot of how users use them and users' own mentalities, attitudes, and motivations during use.

Users go through stages of use and report both positive and negative effects of the app at these various stages. As users reflect back on their journey, they talk a great deal about the negative effects of the app during the early stages of use. However, when they first began using the app, they often did not realize their behaviors were indicative of an eating disorder and even found the app helpful. Users then often begin to realize their behaviors are unhealthy. Sometimes users continue using the app to restrict calories or "erase" calories. However, some decide to make a change to be healthier or focus on eating disorder recovery. Users are motivated to make a change due to personal reasons, such as realizing the health implications of their eating disorder (e.g., having a low heart rate, infertility). Sometimes parents discover their daughter has an eating disorder, and they intervene by making her see a professional, ceasing use of the app, or controlling her meals and exercise. Other times, users make a change because of the social dynamics in college, which often center on food (e.g., going out to eat, eating at the dining commons, going to parties, etc.). In order to participate in the "typical" college lifestyle and maintain friendships, users decide to stop using the app, use it less frequently, or use it differently (i.e., changing calorie budget). Unfortunately, because of the way in which weight loss apps are designed and the nature of eating disorders, users sometimes revert to old habits of unhealthy eating and exercising or begin using the app when they feel it is not healthy for them. This reflects users' journey of not only how they used weight loss apps, but also how they perceived them in relation to their eating disorder.

Weight Loss App Design

Although weight loss apps can be used in both positive and negative ways, there are certain aspects of weight loss app design that need to be reconsidered in order to focus more on promoting health. This study highlights ways weight loss apps may unintentionally promote unhealthy habits or lead to negative emotions. For instance, we found users manipulate the app to avoid negative emotions, such as guilt, when they exceed their calorie budget, which is in line with Cordeiro et al.'s [11] findings about food journaling and negative nudges.

When users exceed their calorie allotment, that number turns red. This happens regardless if the user exceeds their allotment by 1 or 1000 calories. Many participants talked about how seeing this number displayed and how "seeing the red" made them feel anxious and guilty. In order to alleviate these feelings, participants would either exercise to "get back in the green" or not log when they knew they would exceed their budget. As Cordeiro et al. [11] suggested, it is not necessary to make users feel so guilty for going over their budget, especially by little amounts, as this may actually cause users to feel badly, resort to extreme measures, or not use the app at all.

When users net fewer calories than they are budgeted, many weight loss apps show their calories remaining as a green

number. We found users felt the remaining number in combination with the green color encouraged them to try to eat under their allotted calories or purge (most often through exercise) to "remove" calories from the app. Consuming fewer calories gave participants a sense of pride and achievement, which they felt was intensified because of how the app showed their food and calories. Interestingly, this is in contrast to Cordeiro et al. [11], who found general users did not feel strong positive emotions for eating under their calorie budget and seeing the green did not make them feel rewarded, which highlights how different users are impacted differently, showcasing the interaction between eating disorders and app design. Thus, we should reconsider how we visualize being over or under budget as red and green have strong emotional responses based on how they are used throughout society. These visuals need to be more nuanced, perhaps using different colors. Future work needs to explore different types of feedback and visualizations and test for their impact on different types of users, including those with eating disorders.

Our findings also show users often become obsessed with logging, which is in line with Cordeiro et al. [11]. HCI has typically viewed breaks from logging as negative or a barrier; however, we should reconsider this viewpoint as breaks can be healthy for users to eat "normally" and listen to their body's signals. For instance, users with eating disorders often find taking a break from using the app helps them in the process of recovery. However, contrary to Cordeiro et al. [11], users with eating disorders do not really "lose the habit" of logging because they feel the need have control over their food, diet, weight, etc. This begs the question of how much and how often we should tell users to log? For some, we should encourage logging breaks, monitor how often they use the app, and recommend less use.

We found weight loss apps create a need to be exact and an acute awareness of numbers. While this awareness was mentioned in Cordeiro et al. [11], it was not as extreme. In HCI, this awareness is often viewed as a positive, but our work shows that it can promote an unhealthy relationship with food. While Cordeiro et al. [11] found users were challenged to log because of the variety of foods they eat, for users with eating disorders, such an awareness is created around calories that users eat the same types of foods repetitively because they are "safe" foods. To counteract these issues, apps should focus more on healthy behaviors like eating nutrient-rich foods and a variety of foods. This number focus is not necessarily in line with healthy lifestyle promotion, as echoed in Cordeiro et al.'s [11] findings about apps being about ease of tracking (easy to log fast food and pre-made food).

Contrary to Cordeiro et al. [11] who found the eating context was a barrier to journaling, instead of not logging, users with eating disorders will preplan for or avoid social engagements or scenarios where they might be challenged to log; if they cannot preplan or avoid it, they feel anxiety, which helps to perpetuate their eating disorder.

When we try to discourage users from certain behaviors, we have to make sure we're not unintentionally encouraging negative habits. For example, users saw a warning message of eating too little as an accomplishment. It may also be helpful to eliminate the ability to cancel out calories through exercise and instead allow users to track exercise but do not show a deduction in calories consumed.

Because users manipulate the app to lose weight, perhaps we can find other ways to determine user needs besides self-entering. For instance, apps could synchronize with wearables that give users a sense of what they need but do not show the quantifications to users. This falls in line with Purpura et al. [32] who cautioned that weight technology focuses too heavily on quantitative measures and "promotes behaviors based on limited understanding of users' actual personal situations" p429.

Currently these types of apps do not support recovery goals or weight gain goals, which helps explain why users may fall back into old habits even when they have recovery goals. Some apps do not allow weight gain goals, and if they do, then they are not designed to persuade users to gain (green if under not over even if you have a weight *gain* goal). More personalization could help. For instance, if users have a weight gain goal, then when they exceed their budget, they should feel a sense of accomplishment as they are moving toward their goal. Current apps do not support this nuanced aspect of goal setting. We need to reconsider how we motivate users based on their individual needs.

There should be a shifting focus away from just weight loss as a marker for health, and we need to find ways to support this in apps. Future research needs to study the effects of design in more detail on various types of users.

CONCLUSION
We trouble the binary view of technology by showing that as users reflect on their health journey, they report both positive and negative effects and perceptions of weight loss apps. In fact, women go through a journey of weight loss apps use as they change and go through different stages of their eating disorders. While every user's journey is somewhat different and the timeframe between disordered use and making a change varies, there are patterns of use that exist across users with eating disorders. This study demonstrates the dynamic nature of weight loss app use, which is important for designing weight loss apps that promote health.

ACKNOWLEDGMENTS

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