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1 **Title**

2 Engagement with *MyFitnessPal* in eating disorders: Qualitative insights from online forums

3

4 **Running title**

5 MYFITNESSPAL USE IN EATING DISORDERS

6

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18

1 Abstract

2 *Objective:* Using calorie-counting and fitness-tracking technologies is concerning in relation to eating
3 disorders. While studies in this area typically assess one aspect of use (e.g., frequency), engagement
4 with a device or application is more complex. Consequently, important relationships between use of
5 these technologies and eating disorder symptomatology might remain undetected. The current study
6 therefore used comments from online eating disorder-related forums to generate comprehensive
7 qualitative insights into engagement with a popular calorie-counting and fitness-tracking application,
8 *MyFitnessPal*. *Method:* First, we extracted every comment mentioning *MyFitnessPal* made on three
9 eating disorder-related forums between May 2015 and January 2018 (1695 comments from 920
10 commenters). Then, we conducted an inductive thematic analysis using these comments to identify
11 important aspects of engagement with *MyFitnessPal*. *Results:* The analyses resulted in three themes:
12 *Preventing misuse*, describing ways in which *MyFitnessPal* attempts to prevent pathological use, and
13 actions taken by users to circumvent its interventions; *Accuracy*, outlining distrust of *MyFitnessPal's*
14 accuracy, and ways in which perceived inaccuracy is reduced or compensated for; and *Psychosocial*
15 *factors*, comprising cognitive, behavioural and social factors that influence, or are influenced by,
16 engagement with *MyFitnessPal*. *Discussion:* The qualitative insights provide a detailed overview of
17 how people with high levels of eating disorder symptomatology likely engage with *MyFitnessPal*. The
18 insights can be used as a basis to develop valid, quantitative assessment of pathological patterns of
19 engagement with calorie-counting and fitness-tracking technology. The findings can also provide
20 clinicians with insight into how their patients likely engage with, and are affected by, these devices
21 and applications.

22

23 **Keywords:** eating disorders, self-monitoring, MyFitnessPal, social media, Reddit

1 Introduction

2 The ubiquity of commercially available calorie-counting and fitness-tracking technologies is a
3 cause for concern regarding eating disorders, as more patients with eating disorders view these
4 technologies as contributing to the maintenance of their condition than to their recovery (Tan, Kuek,
5 Goh, Lee, & Kwok, 2016). Accordingly, these devices and applications have been the focus of recent
6 research, which has been predominantly cross-sectional in nature. While results vary, these studies
7 generally suggest that use of these technologies – particularly fitness-trackers – is positively
8 associated with eating disorder-related symptomatology (Embacher Martin, McGloin, & Atkin, 2018;
9 Hefner et al., 2016; Plateau, Bone, Lanning, & Meyer, 2018; Simpson & Mazzeo, 2017).

10 A complicating factor for research concerning calorie-counting and fitness-tracking
11 technologies is that they vary in their functionality, such as providing different information (e.g.,
12 calorie-intake, steps), or influencing behaviour in different ways (e.g., facilitating self-monitoring,
13 rewarding behaviour; e.g., Lyons, Lewis, Mayrsohn, & Rowland, 2014). Reducing this complexity,
14 three studies have focused on the use of one application, *MyFitnessPal*, in relation to eating
15 psychopathology (Jospe et al., 2018; Levinson, Fewell, & Brosos, 2017; Linardon & Messer, 2019). The
16 main functions of *MyFitnessPal* enable users to set goals concerning weight, and calorie- and
17 macronutrient-intake, and assess their goal progress by: 1) estimating and tracking their calorie- and
18 nutrient-intake (e.g., consulting a food database, scanning barcodes, creating their own entries for
19 foods); 2) estimating and tracking calorie-expenditure (e.g., logging exercises, tracking steps); and 3)
20 recording their weight with optional photos of their body (Under Armour Inc., 2019). In two cross-
21 sectional studies focusing on *MyFitnessPal*, 73% (57/78) of predominantly female patients with
22 eating disorders who had used the application viewed it as, at a minimum, having somewhat
23 contributed to their condition (Levinson et al., 2017). A smaller proportion (47%, 26/55) of male users

1 recruited from health and fitness websites described it as, at least, somewhat contributing to
2 disordered eating (Linardon & Messer, 2019). However, in contrast to these cross-sectional studies,
3 an experimental study found no evidence for a causal effect of using *MyFitnessPal* on eating disorder
4 symptomatology (Jospe et al., 2018; Jospe et al., 2017). Given the inconsistent results, it is important
5 to explore factors that could influence the nature of these relationships.

6 One factor that could explain conflicting findings is that engagement with the same calorie-
7 counting and fitness-tracking technology can vary between users. Engagement is a complex
8 construct, comprising several aspects of how devices or applications are used (e.g., attention,
9 duration, frequency), which are influenced by other factors (e.g., demographics, motivations; cf.
10 Perski, Blandford, West, & Michie, 2016). However, in relation to eating psychopathology, the
11 previously outlined research has assessed a narrow conceptualisation of engagement. Specifically,
12 the self-report studies either assessed use dichotomously (i.e., user vs. non-user; Embacher Martin
13 et al., 2018; Levinson et al., 2017; Linardon & Messer, 2019; Simpson & Mazzeo, 2017; Tan et al.,
14 2016), or assessed the frequency of use (Hefner et al., 2016; Plateau et al., 2018). The risk of such
15 narrow assessment of engagement is that patterns of use that are particularly indicative of eating
16 disorders might remain undetected. Similarly, while no causal effect of *MyFitnessPal* use on eating
17 disorder symptomatology was detected in the experimental study (Jospe et al., 2018), this finding
18 could be due to the duration (or consistency) of engagement being insufficiently manipulated.
19 Specifically, the participants in the '*MyFitnessPal*' condition used the application daily for the first
20 month, but for only one week of each remaining month in the 12-month period (approximately 15
21 weeks in total; Jospe et al., 2017). As a result, the conclusions of existing research into calorie-
22 counting and fitness-tracking technology cannot eliminate the possibility that null findings simply
23 reflect that important pathological aspects of engagement have not been assessed or manipulated.

1 Therefore, a consideration of broader aspects of engagement with these devices and applications is
2 vital.

3 Qualitative research is particularly valuable to understand the breadth of the engagement
4 construct, and should ideally reflect ‘how participants think about the focal construct in their own
5 words’ (p382; Gehlbach & Brinkworth, 2011). If such research identifies potentially pathological
6 attributes of engagement in relation to eating psychopathology, the qualitative insights could be used
7 to facilitate more precise research questions and develop more rigorous interventions. For example,
8 if frequency of engagement were supported as being important, future experimental studies should
9 assess this attribute (e.g., developing an application that records when it is used), and include it in
10 their statistical analyses (e.g., as a covariate). Given the issues with self-report items used in previous
11 research, the qualitative insights could also be used to develop a standardised scale of engagement
12 with calorie-counting and fitness-tracking technologies in relation to eating disorders. Specifically,
13 the insights could be used to develop an initial set of items (and response scales) that represent a
14 sufficiently broad range of engagement attributes, have a high level of substantive validity evidence,
15 and could then be subjected to structural and external validity testing (cf. Flake, Pek, & Hehman,
16 2017).

17 Two studies offer a degree of substantive evidence for engagement with calorie-counting and
18 fitness-tracking technologies in relation to eating disorders (Eikey & Reddy, 2017; Eikey et al., 2017).
19 Both studies developed qualitative insights from 13 users who posted comments including eating
20 disorder-related terms (e.g., ‘anorexia’) on an unspecified weight-loss application’s forum (Eikey et
21 al., 2017), and from 16 young women who self-reported eating disorder symptoms (Eikey & Reddy,
22 2017). The insights from both studies mainly identified cognitions and emotions (e.g., obsessiveness,
23 perfectionism, guilt), and behaviours (e.g., restricting, binge eating, purging) related to use of these

1 technologies. In contrast, the studies identified fewer insights into patterns of engagement, except
2 for use multiple times a day, and selectively not reporting information (e.g., exercise, calorie-intake
3 exceeding a goal). While Eikey and colleagues' studies offer valuable insights into use of calorie-
4 counting and fitness-tracking technologies, the small sample sizes might have limited their ability to
5 capture the full range of patterns of use.

6 The aim of our current study was therefore to generate more comprehensive substantive
7 evidence (i.e., qualitative insights) for the patterns of engagement with *MyFitnessPal*, as discussed
8 by a large sample of commenters on online eating disorder-related forums. *MyFitnessPal*
9 represented a particularly important calorie-counting and fitness-tracking technology to consider, as,
10 of these types of technology, it has been found to be the most downloaded (Ferrara, Kim, Lin, Hua,
11 & Seto, 2019) and the most commonly discussed in eating disorder-related online forums (McCaig,
12 Bhatia, Elliott, Walasek, & Meyer, 2018), and is the focus of three previously discussed studies in the
13 area of eating psychopathology (Jospe et al., 2018; Levinson et al., 2017; Linardon & Messer, 2019).
14 Furthermore, as *MyFitnessPal* facilitates *both* calorie-counting *and* fitness-tracking, it is more
15 representative of the varied functionality of these technologies than devices or applications
16 dedicated to only one of these functions.

17 To achieve our aim, we extended our previous study that quantitatively assessed the
18 mentions of fitness-tracking technology across three eating disorder-related forums on *Reddit*
19 (McCaig et al., 2018), and we qualitatively analysed comments from these forums that mentioned
20 *MyFitnessPal*. *Reddit* is one of the largest online discussion platforms, and several researchers have
21 used data from the platform to investigate eating disorder-related topics (McCaig, Elliott, Siew,
22 Walasek, & Meyer, 2019; Moessner, Feldhege, Wolf, & Bauer, 2018; Sowles et al., 2018). In line with
23 Gehlbach and Brinkworth's recommendations (2011), content from social media is particularly

1 beneficial for developing substantive evidence, as it is uninfluenced by researchers, and so the focal
2 construct is undoubtedly represented in the commenters' own words. Our approach also expands on
3 Eikey and colleagues' previous study (2017) in three main ways. First, our approach ensures the
4 relevance of the content to eating disorders by extracting comments from well-studied eating
5 disorder-related forums, rather than a weight-loss application's forum. Second, our study provides
6 more comprehensive substantive evidence by greatly increasing the sample size, established through
7 scoping the data for relevant content in previous work (McCaig et al., 2018). Third, we focused on
8 *MyFitnessPal*, which, as discussed, is important to consider for several reasons (i.e., popularity, focus
9 of previous studies, supporting a wide range of functionality).

10 **Methods**

11 ***Corpus selection***

12 The current study represents an extension of a previous study (McCaig et al., 2018). As such,
13 we used the previously written Python code (Python Software Foundation, 2017) to extract public
14 comments posted on *Reddit* between May 2015 to January 2018 (inclusive) from a freely available
15 archive (Complete Public Reddit Comments Corpus, 2018). In contrast to the previous study, we
16 restricted the current data corpus to comments made on the three eating disorder-related forums
17 (*r/proED*, *r/fuckeatingdisorders*, *r/EatingDisorders*), and only extracted comments that included an
18 explicit reference to *MyFitnessPal*, which constituted the use of at least one of the following terms:
19 'mfp', 'fitness pal', or 'fitnesspal'. Our institutional research ethics committee granted approval for
20 the current study.

21 ***Data analysis***

1 We thematically analysed our data corpus, using Braun and Clarke's (2006) six-step guide as
2 a reference. In brief, after reading through the comments to become familiar with the data (step 1),
3 we developed an initial set of codes that each represented a meaningful aspect of the data (e.g., a
4 pattern of engagement, an emotional consequence; step 2). The qualitative software *NVivo* (QSR
5 International Pty Ltd., 2018) was used to facilitate this initial coding. We then grouped codes that
6 were similar in meaning (step 3), and subsequently revised these groups (step 4), to create the
7 themes and subthemes. Finally, we labelled and defined the themes and subthemes (step 5), and
8 formalised the analysis in the production of this report (step 6). We used an inductive approach to
9 the thematic analysis due to the exploratory nature of the research, and adopted a realist perspective
10 focusing on themes at the semantic level – i.e., we were interested in the commenters' experiences,
11 and focused on themes that were explicit within their comments.

12 Throughout all steps in the thematic analysis, the first author (DM) conducted the analyses,
13 and the remaining authors acted as 'critical friends' (e.g., Smith & McGannon, 2017; Smith & Sparkes,
14 2006). In this role, the remaining authors challenged and offered alternatives to the first author's
15 coding and interpretations, which facilitated reflexivity in the analysis, and ensured that the final
16 thematic structure was rigorous and coherent. In line with current ethical guidance for internet-
17 based research (cf. British Psychological Society, 2013; Williams, Nielsen, & Coulson, 2018),
18 quotations provided in this report have been paraphrased to prevent identification of individual
19 commenters, and are brief and used sparingly.

20 **Results**

21 ***Corpus characteristics***

22 In total, 1695 comments including at least one reference to *MyFitnessPal* were made on the
23 three eating disorder-related forums between May 2015 and January 2018, inclusive. These

1 comments were made by 920 commenters, who made on average (mean) 2 comments each that
 2 mentioned *MyFitnessPal* ($SD=2$, median=1, minimum=1, maximum=27). Overall, the corpus
 3 consisted of 157,278 words, and the average (mean) length of a comment was 93 words ($SD=105$,
 4 median=59, minimum=1, maximum=1281).

5 **Themes**

6 Overall, we identified three themes: *Preventing misuse*, *Accuracy*, and *Psychosocial factors*.
 7 Each theme comprises subthemes, which we summarise in Table 1.

8 [insert Table 1 here]

9 *Preventing misuse*

10 The theme *Preventing misuse* comprises two subthemes: *Interventions* and *Circumventing*
 11 *interventions*. *Interventions* describes measures that *MyFitnessPal* have ostensibly implemented to
 12 intervene if its users demonstrate symptoms associated with eating disorders. Commenters indicated
 13 experiencing the measures if they: recorded a daily calorie-intake below a minimum (with 1000kcal,
 14 1200kcal, or a male-specific amount of 1500kcal being reported); were underweight; had an
 15 underweight or extreme weight-loss goal; were known or reported to have an eating disorder; or
 16 contributed content that encourages eating disorders to *MyFitnessPal* (e.g., creating a ‘pro-eating
 17 disorder’ forum). The nature of the interventions were indicated to vary, including notifications that
 18 users had recorded low daily calorie- or nutrient-intake, or that their weight was too low.
 19 Interventions restricting use included: not recording a day’s data; not providing a weight-loss
 20 prediction; and banning users, suspending or deleting their account, and directing them to an eating
 21 disorders ‘crisis’ website. Despite violating some of the limits (e.g., daily calorie-intake under
 22 1000kcal), other commenters reported not experiencing any of the interventions, which was

1 suggested to be due to using an older or less common version of the application (e.g., on a ‘tablet’
 2 device).

3 Perhaps reflecting negative views of the interventions (e.g., ‘punitive’, ‘judgemental’,
 4 ‘abusive’), commenters discussed how they could circumvent these measures (*Circumventing*
 5 *interventions* subtheme). Commenters reported altering specific characteristics, with men entering
 6 that they are women to have a lower minimum daily energy-intake, and others altering their height
 7 to enable a lower actual weight or weight-loss goal. On a more daily basis, the commenters indicated
 8 being able to record their actual energy-intake if they did not formally ‘complete the day’.
 9 Alternatively, commenters recorded extra energy-intake to meet the minimum, with some labelling
 10 the additional calories as fake (e.g., ‘padding’, ‘false’, ‘ghost calories’), and others keeping a physical
 11 record of their actual energy-intake to compare to their *MyFitnessPal* data (e.g., in a ‘notebook’).
 12 Commenters also described offsetting or correcting the additional energy-intake by adding an
 13 equivalent amount of energy-expenditure (e.g., exercise) or adding the extra energy-intake, then
 14 completing the day before deleting the extra calories. Regarding the notifications, some commenters
 15 mentioned ignoring these or disabling ‘pop-up messages’, while one commenter changed their
 16 device’s colours to greyscale so that the notifications were less salient. Others did not use
 17 *MyFitnessPal*’s associated forums, so that they were not discovered or reported to have an eating
 18 disorder. Last, many commenters simply stated that they used a different application or device that
 19 did not have the same interventions.

20 *Accuracy*

21 The theme *Accuracy* comprises three subthemes: *Inaccuracy*, *Improving accuracy* and
 22 *Deliberate misrecording*. *Inaccuracy* details commenters’ distrust in the accuracy of *MyFitnessPal*.
 23 While some commenters expressed distrust generally, others did not trust certain functionality.

1 Specifically, calorie-content estimates of food and drink were seen to be inaccurate, with suggestions
2 that: *MyFitnessPal* underestimates the calorie-content; there are discrepancies in estimates for the
3 same item; and food and drink packaging does not match the entries in *MyFitnessPal*. The main
4 reason for this distrust was seemingly due to the fact that anyone can create an entry for an item of
5 food or drink in *MyFitnessPal*'s public database. Other functionality described as inaccurate were
6 energy-expenditure estimates, which were viewed as overestimates and unreliable over time, and
7 weight-loss or weight-maintenance predictions.

8 Several ways of improving *MyFitnessPal*'s accuracy were described, represented by the
9 *Improving accuracy* subtheme. Regarding energy-intake, commenters ensured calorie-content
10 estimates were as accurate as possible by comparing estimates to more trustworthy sources of
11 information (e.g., packaging, governmental agencies), always creating their own estimates, and
12 avoiding unverified entries in *MyFitnessPal*'s database. Some commenters also mentioned using a
13 food scale to ensure the quantities of food or drink they entered were accurate. Similarly, the energy-
14 expenditure estimates were reportedly improved by syncing *MyFitnessPal* with a more accurate
15 device. Some commenters also described reviewing weekly or average data, as they saw this
16 information as more accurate than daily results (i.e., minimising the impact of days that were
17 outliers).

18 *Deliberate misrecording* describes strategies the commenters reported using to account for
19 inaccuracy in *MyFitnessPal*, or their own perceived transgressions (e.g., overeating, underexercising).
20 Such strategies included deliberately overestimating their energy-intake or weight, or
21 underestimating their energy-expenditure. Concerning overestimating energy-intake, commenters
22 detailed recording the meal they were going to eat, but then deliberately not eating all of it. Some
23 stated that, if they exceeded their daily energy-intake, they added the excess to the following day.

1 However, others reported not recording excess energy-intake or episodes of binge eating, or entering
 2 a set amount of energy-intake for a binge eating episode rather than tracking it accurately.
 3 Additionally, commenters described underestimating or not recording energy-expenditure or purges,
 4 viewing any calories expended through these behaviours as a 'plus'.

5 *Psychosocial factors*

6 The theme *Psychosocial factors* comprises three subthemes: *Cognition and affect*, *Behaviour*,
 7 and *Interpersonal factors*. *Cognition and affect* describes thoughts and feelings that influence, or are
 8 influenced by, the use of *MyFitnessPal*. Commenters indicated that recording energy-expenditure or
 9 deleting energy-intake (e.g., if planned calorie-intake was not consumed) improved their mood, and
 10 described more positive experiences the better their progress was regarding their goals (e.g.,
 11 'satisfied', 'in control', 'reassured'). Some commenters also indicated that they felt satisfied when
 12 they received a notification that their energy-intake was too low. Planning energy-intake or
 13 prerecording calorie-content before consumption was described as making the commenters feel
 14 more relaxed, and able to stop thinking about food or drink. Using *MyFitnessPal* also reportedly
 15 helped alleviate negative experiences (e.g., 'stressed', 'anxious'), particularly when estimates were
 16 perceived as accurate. However, some commenters reported not using *MyFitnessPal* to avoid
 17 negative feelings associated with its use (e.g., 'stress', 'worried', 'guilt'), which they described
 18 experiencing when they violated their goal by as little as one calorie, or even when they achieved
 19 their goal. Others also felt judged by *MyFitnessPal's* standard functionality, such as notifications of
 20 consuming too much of a specific nutrient (e.g., fat). *MyFitnessPal* was reported to result in a greater
 21 awareness of the nutrient- or calorie-content of food and drink, with commenters explaining that
 22 they used it when starting a diet to learn about nutrient and calorie content or requirements, or that
 23 they stopped using it when they knew this information. The application was also seen to aid

1 motivation, such as feeling ‘accountable’ to something, but it was also suggested to increase
 2 competitiveness with oneself and others. Several commenters, including some who indicated being
 3 in recovery from eating disorders, reported feeling addicted to *MyFitnessPal*, and felt it contributed
 4 to overthinking about calories and food, and ruminating on binge eating episodes.

5 The *Behaviour* subtheme represents behaviours that are influenced by the use of
 6 *MyFitnessPal*, and related outcomes. The application was indicated to assist in restricting energy-
 7 intake, preventing overeating and binge eating, and interrupting the binge eating-purge cycle.
 8 Similarly, non-use was mentioned by some to trigger overeating. The assistance in restricting energy-
 9 intake reportedly resulted from *MyFitnessPal* helping them not to eat without thinking about calorie
 10 or nutritional content, with the habit of prerecording food or drink in the application (i.e., calculating
 11 its content before ingestion) indicated to be particularly helpful. Resulting from *MyFitnessPal*'s effect
 12 on behaviour, some commenters suggested that it facilitated a reduction in body size, shape and
 13 weight. However, others reported that the application did not assist restriction, and triggered
 14 purging, and overeating or binge eating, particularly when they had remaining calorie-intake for a
 15 day (i.e., calorie-intake was below their allowance). Due to *MyFitnessPal*'s influence on eating
 16 disorder-related behaviours, commenters mentioned avoiding or deleting *MyFitnessPal* in recovery,
 17 and expressed that its use facilitated relapse.

18 The subtheme *Interpersonal factors* represents social factors associated with using
 19 *MyFitnessPal*. Using its social functionality, commenters reported adding other people on the
 20 application, meaning others could view their data. While commenters mentioned adding friends and
 21 family, they also shared their usernames in the *Reddit* eating disorder-related forums, so they could
 22 connect with members of these online communities on *MyFitnessPal*. While *MyFitnessPal*'s own
 23 forums were mentioned, they were described as being a platform for people to criticise others for

1 their performance or lack of self-control. In contrast to being open about their use of *MyFitnessPal*,
2 some commenters made their diary private to stop others from viewing their data, and, more
3 generally, described concealing their habits of using the application from their friends and family
4 (e.g., pretending to use a different application).

5 **Discussion**

6 Our study aimed to provide comprehensive qualitative insights into engagement with a
7 popular calorie-counting and fitness-tracking application, *MyFitnessPal*, as described by commenters
8 on online eating disorder-related forums. By thematically analysing a large sample of 1695 comments
9 from eating disorder-related forums that mentioned *MyFitnessPal*, contributed by 920 commenters,
10 we generated three themes – *Preventing misuse*, *Accuracy*, and *Psychosocial factors*. In addition to
11 identifying patterns of engagement with calorie-counting and fitness-tracking technology, the
12 themes also expand on previous findings of psychosocial factors that influence and result from using
13 these devices and applications.

14 Within *Preventing misuse*, we describe several interventions ostensibly implemented by
15 *MyFitnessPal* to address pathological use, and ways in which commenters reported circumventing its
16 interventions. While Levinson and colleagues (2017) mentioned notifications of low calorie-intake,
17 *MyFitnessPal* also reportedly intervenes in other ways if a user is suspected of having an eating
18 disorder. For example, the application appears to limit its functionality in such users (e.g., preventing
19 the recording of data, not providing weight-loss predictions), or ban them and delete their accounts.
20 However, the interventions appear to be inconsistently applied, or are easy to circumvent, such as
21 by simply using a different application or device. The use of alternative technology parallels findings
22 concerning pro-eating disorder content, which indicated that banned ‘hashtags’ (i.e., ways of flagging
23 content to other interested users) were simply replaced with new ones (Gerrard, 2018). While a

1 change in policy could mandate the inclusion of interventions in commercially available calorie-
2 counting and fitness-tracking technology, this approach would likely be ineffective as older versions
3 would still be available, or motivated users could create their own. As such, there is a need for
4 researchers and companies to take shared responsibility for developing and implementing more
5 effective interventions in these technologies. To prevent users from disengaging and using a different
6 application or device, interventions could potentially be more effective if they are subtle, so that they
7 are not viewed as 'punitive', 'judgemental', or 'abusive'. Such interventions could involve the
8 provision of psychoeducation to current users (cf. Levinson et al., 2017), as, currently, *MyFitnessPal*
9 only appears to provide this information to users whom it bans.

10 The *Accuracy* theme describes a reported distrust in the accuracy of various aspects of
11 *MyFitnessPal's* functionality, and several ways in which the commenters reported reducing this
12 inaccuracy. Of concern, the commenters also reported deliberately misrecording their data to create
13 'room for error'. Supporting previous findings (Eikey & Reddy, 2017), the commenters in our study
14 indicated underestimating their energy-expenditure, or not recording this information or purges,
15 instead viewing any calories expended as a bonus. We also found that commenters reported
16 overestimating their energy-intake, using heuristics (e.g., a set calorie-content for a binge eating
17 episode), or pre-recording energy-intake but planning not to consume it. Taken together, the findings
18 suggest a degree of self-deception in how users engage with *MyFitnessPal*, with deliberate
19 misrecording seemingly in a direction that facilitates weight-loss (i.e., overestimating energy-intake,
20 underestimating energy-expenditure). Due to the potential self-deception, improving the accuracy
21 of calorie-counting and fitness-tracking technologies might have a minimal effect on these
22 behaviours. Tentative evidence supports improved accuracy having little effect, as, compared to
23 people with low dietary restraint, the energy-intake of more highly restrained people is less
24 influenced in the short-term by energy-expenditure feedback (McCaig, Hawkins, & Rogers, 2016).

1 Last, we identified psychosocial factors that reportedly influence, or are influenced by,
2 engagement with *MyFitnessPal*. As with previous findings (Eikey & Reddy, 2017; Eikey et al., 2017),
3 there was variability in whether commenters viewed engagement as facilitating or worsening
4 psychosocial factors, such as negative feelings (e.g., 'stress'), and eating disorder-related behaviours
5 and outcomes (e.g., restricting, weight-loss). Such heterogeneity suggests moderators in the
6 relationship between engagement with calorie-counting and fitness-tracking technologies, and
7 eating disorder-related symptomatology, which could explain the inconsistencies in previous
8 research (Embacher Martin et al., 2018; Hefner et al., 2016; Plateau et al., 2018; Simpson & Mazzeo,
9 2017). A user's motivational stage of change regarding eating disorder recovery (cf. Geller, Cockell,
10 & Drab, 2001) is likely a key moderator in this relationship, as the current and previous findings (Eikey
11 & Reddy, 2017) suggest that people in recovery alter their use of calorie-counting and fitness-tracking
12 technologies (e.g., deleting the application). Our findings also emphasise the likely importance of
13 perfectionistic, dichotomous and obsessive thinking styles in this context, as suggested by previous
14 researchers (e.g., experience anxiety if exceed goal by one calorie; Eikey & Reddy, 2017; Levinson et
15 al., 2017; Linardon & Messer, 2019; Simpson & Mazzeo, 2017). Last, in addition to supporting findings
16 that users viewed *MyFitnessPal* as increasing competitiveness with oneself (Eikey & Reddy, 2017),
17 commenters in our study also viewed it as increasing their competitiveness with others. Together
18 with our observation that people exchanged their *MyFitnessPal* usernames on the *Reddit* forums, the
19 higher competitiveness with others could facilitate members of pro-eating disorder online
20 communities encouraging each other's pathological behaviours.

21 Regarding the limitations of our study, it is not possible to characterise the commenters on
22 eating disorder-related forums in terms of their type or degree of eating disorder symptomatology.
23 Consequently, future research is required to investigate whether varying diagnoses and levels of
24 eating pathology are related to different patterns of engagement with *MyFitnessPal*. A limitation of

1 our data extraction method is that it is possible that we did not identify relevant content that referred
2 to *MyFitnessPal* with a pronoun (e.g., 'it') rather than one of our search terms ('mfp', 'fitness pal',
3 'fitnesspal'). However, the effect of this limitation is mitigated by the large sample size. Last, our
4 study focused on *MyFitnessPal* and, consequently, the conclusions cannot be applied uncritically to
5 similar devices and applications. However, due to *MyFitnessPal* supporting both calorie-counting and
6 fitness-tracking, we consider it likely that our findings would also apply to technologies with the same
7 functionalities.

8 The qualitative insights obtained in the current study have several implications for future
9 research. First, the findings can be used in the development of a standardised measure of
10 engagement with calorie-counting and fitness-tracking technology in relation to eating
11 psychopathology. Specifically, the insights can guide the generation of a set of items, which can then
12 be subjected to structural and external validity testing (cf. Flake et al., 2017). While previous self-
13 report items assess a narrow conceptualisation of engagement (e.g., assessing use dichotomously;
14 e.g., Simpson & Mazzeo, 2017), our findings outline other patterns of engagement that should be
15 assessed (e.g., recording calories that are not actually consumed), and indicate ways in which existing
16 self-report items might be improved. For example, we identified pre-recording calorie-containing
17 items before consumption as a potentially important pattern of engagement in people with high
18 levels of eating psychopathology. However, if such pre-recording is characteristic of someone who
19 has, on average, few daily eating episodes (i.e., is restricting), this pattern of engagement could
20 explain the previously observed lack of an association between the frequency of calorie-counter use
21 and eating disorder symptomatology (Plateau et al., 2018). In contrast, such an association might be
22 found if frequency of use were assessed differently – e.g., 'When you consume calories, how often
23 do you use a calorie-counting application or device?' ('Never' to 'Every time' response options).
24 Through developing a more valid, quantitative measure of engagement, the degree to which each

1 aspect of engagement is associated with eating disorder-related factors (e.g., symptoms, diagnoses,
2 stage of recovery) could be assessed. If an aspect of engagement were identified as indicative of a
3 factor (e.g., a specific symptom), intervention content could be tailored to the factor, and then
4 targeted at users displaying the related pattern of use. More generally, future research should
5 investigate the causal relationships between the aspects of engagement and psychosocial factors
6 identified in the current study. For example, whether higher dietary restraint *leads to* overestimating
7 energy intake, *is a result of* overestimating energy intake, or both.

8 Overall, through using an inductive (i.e., bottom-up') approach, our study found support for
9 engagement with calorie-counting and fitness-tracking technology being a multifaceted construct.
10 Future research in the area of eating disorders should therefore consider and assess the breadth of
11 the construct. Additionally, our findings can provide clinicians with insight into how eating disorder
12 patients might use (or have used) calorie-counting and fitness-tracking technology. Consequently,
13 after asking whether or not patients have used such devices or applications, clinicians can pose
14 questions that lead to potentially more informative responses (e.g., 'How accurately do you record
15 your energy intake and expenditure?').

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1 **Conflict of interest statement**

2 The authors declare no conflict of interest.

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1 Table 1. A summary of the identified themes and subthemes

Theme	Subtheme	Description
Preventing misuse	Interventions	Interventions implemented by <i>MyFitnessPal</i> aimed at preventing use in people who pursue underweight goals, severely limit energy-intake, or endorse 'pro-eating disorder' ideals (i.e., encourage eating disorders)
	Circumventing interventions	Ways in which people change their engagement with <i>MyFitnessPal</i> in response to its interventions
Accuracy	Inaccuracy	Distrust in the accuracy of <i>MyFitnessPal</i>
	Improving accuracy	Ways in which people improve <i>MyFitnessPal's</i> accuracy
	Deliberate misrecording	Deliberate misrecording to allow room for error (e.g., <i>MyFitnessPal's</i> inaccuracy, perceived goal violations)
Psychosocial factors	Cognition and affect	Cognitions and affect that influence, or are influenced by, the use of <i>MyFitnessPal</i>
	Behaviour	Behaviours that are influenced by the use of <i>MyFitnessPal</i> , and their associated outcomes (e.g., weight)
	Interpersonal factors	Interpersonal factors associated with using <i>MyFitnessPal</i>

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