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Identifying and Evaluating User Requirements for Smartphone Group Fitness Applications

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ABSTRACT Social support can improve adherence to physical activity and healthy eating behavior change, and recently, smartphone fitness applications which provide interventions to groups of users are increasingly popular. However the types of social support provided in the applications, and the features/approaches used to offer the support, vary widely. It is unknown which approach best meets users' requirements. We conducted a mixed methods study to identify user requirements for social support in group fitness applications. We then developed MyFitnessTeam based on these requirements and evaluated it in a six-week field study. We found that participants desired informational and emotional support, and for group fitness applications to provide daily challenges that they could complete with their support network. MyFitnessTeam significantly improved adherence to fitness behaviors, with men having significantly higher adherence levels than women and participants who were inactive at baseline achieving similar adherence levels to the most baseline-active participants. Groups of friends were more likely to exchange informational support but emotional support was low for both friends and strangers, due to lack of knowledge on when and how to offer such support. We propose 5 design recommendations to promote supportive interactions in group fitness applications.

INDEX TERMS Behavior change, Fitness, Groups, Mobile applications, Social network services, User centered design

I. INTRODUCTION

Healthy eating and increased physical activity are important components of healthy living that can decrease the risk of developing chronic diseases such as cardiovascular disease, diabetes, cancers and musculoskeletal disorders [1]. It is therefore important to provide tools that support adherence to such behaviors.

Many people turn to smartphone applications to support them in engaging in fitness behaviors, but around 45% of users quit the applications due to abandoning the health goal (31% of users) and due to missing features (25.5% of users) [2]. Several studies [3] [4] [5] have confirmed that the number of theory-based strategies and persuasive features in existing applications is low. However social support, which has consistently been shown to support adherence to health and fitness behavior change [6], is one of the four widely included strategies in existing applications. Usually, a social sharing feature is provided. Users post an update of their fitness activities and progress towards a goal either to social network services (SNS) or to friends who are also using the application. The ineffectiveness of social sharing at promoting social support and adherence to behavior change may be due to several factors such as user concerns over privacy, which leads to the low use of the feature, and lack of desired feedback once fitness updates have been shared [7] [8].

Recently, researchers have aimed to promote social support by providing behavior change interventions to groups of users with a similar goal [9]–[15]. This approach has proven popular with users and effective at supporting behavior change. However, the interventions offered vary widely. In some studies, e.g. [9], [14], users were given goals set by the application whereas other studies used user-set goals [11]. Likewise, some studies left group members to initiate social interactions, e.g. [10], [15], while others promoted specific

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interactions such as collaboration or competition [12], [13].

In order for social support to be effective, the extended/received support should match a person's needs [16]. It is currently unclear which design approaches for group fitness applications best meet users' needs, and therefore which designs may be most effective over the long-term. In addition, existing studies have focused on primarily quantitative research, and thus, although potential benefits of group-based fitness applications have been demonstrated, the reasons behind their efficacy, and how to improve the existing designs remains unknown.

The aim of our study was to determine which of the four types of social support (informational, emotional, tangible/instrumental or appraisal i.e. feedback for improvement) [17] users require from group fitness applications, and how they feel applications should be designed (features, interactions, interfaces) in order to aid the exchange of such support.

We present results from 4 focus group studies (n=8, n=14, n=14, n=6) where participants designed their ideal group fitness application based on prior experiences with smartphone fitness applications, and a field evaluation (n=23) of MyFitnessTeam, an application we developed based on the requirements gathered. We also present results from surveys and interviews conducted after the field study to show: (i) users' experiences and how these many have affected the efficacy of MyFitnessTeam, and (ii) how user requirements changed after in-situ use. We believe our results provide useful insight on features current group fitness applications should include to better support users. We also hope our study will inspire further works on identifying and evaluating user requirements, thus allowing more conclusive results to be drawn.

The primary contributions of our work are:

- A requirements specification detailing the type of social support, features and interactions users require in group fitness applications, and an accounting of why users desire the proposed design.
- A demonstration of the effectiveness of the proposed application design (MyFitnessTeam), and an examination of how user experiences with the various application features may have affected social support interactions between group members, and adherence to fitness behaviors.
- A discussion of how to promote supportive social interactions within group fitness applications.

II. RELATED WORK

A. SOCIAL SHARING OF FITNESS ACTIVITY DATA

Social sharing has been the predominant means of offering social support in both commercial (e.g. *MyFitnessPal, FitBit*) and research applications (e.g. [18] [19] [20]). In most applications, a message is automatically generated and posted on the user's SNS account. The method has several challenges such as user concerns over privacy, fear of overburdening friends with updates and fear of appearing boastful or narcissist [7] [8]. In addition, those who share updates do not always receive the support they desire. Posts are often ignored [18] [7] or receive 'likes' without additional feedback [8]. A framework for making auto-generated and user-generated updates more likely to receive the desired feedback has been developed by Epstein et al [7].

Other applications e.g. [21] [20], Nike+, and Endomondo, share updates to a small group of friends within the application. The friends are usually drawn from the user's existing social network e.g. real-life friends and co-workers. This approach was shown to inspire social comparison and competition in [21].

Some people opt to broadcast their fitness journeys independently on SNS such as Twitter, Instagram, and Facebook. Twitter posts mostly focus on physical activity (goals and completed activities) [22], while Instagram has been used to share both food and physical activity posts [23]. Users on both platforms usually share to the general public. Facebook users tend to share updates with friends and they have a preference on which friends should receive the updates [24].

B. INTEGRATING INTERVENTIONS INTO EXISTING SOCIAL MEDIA PLATFORMS

Social media applications have high user retention rates and researchers have attempted to improve adherence to fitness interventions by offering them within such platforms. Merchant et al [11] created a private Facebook group to deliver weight loss information from a health coach. Over 72% of the posts received at least one interaction from users, with polls and photos being most popular, but user engagement visibly declined with time. Maher et al [14] used a Facebook application to provide existing Facebook friends with physical activity self-monitoring and gamification (virtual awards) features, and results showed the application significantly improved weekly moderate to vigorous intensity exercise minutes. The effect was larger for participants who logged in more frequently and those who were insufficiently active at baseline. Likewise, Foster et al [25] used a Facebook application to post users' daily step counts from a pedometer to their newsfeeds, and then send push notifications to other users of the application. Users in this social condition had significantly higher number of steps than those in a non-social condition, whose step counts were not posted. On Twitter, a study [26] found that Twitter use predicted weight loss, but there was a significant decline in both active engagement (posting) and passive engagement (reading posts only) after 3 months.

C. GROUP FITNESS APPLICATIONS FOR COLLABORATION AND COMPETITION

In several applications, users are grouped together to collaborate or compete towards a common goal. In [9], [15], and [10], users posted updates on how they completed an application-given daily goal (challenges). The studies found social conditions improved performance, with [10] finding groups with more non-challenge based interactions had higher levels of performance.

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Other works have included both competition and collaboration elements, and evaluated the efficacy of the approaches against each other. In Pass the ball [27], users took turns tracking their physical activity for 1-hour intervals using their smartphone accelerometers, and competed against other teams. In HealthyTogether [12] users were paired up and required to track their FitBit steps in order to earn badges. Badges could be earned independently i.e. users competed against their paired partner, or both users' performances contributed to the score either equally or with each user's personal score contributing slightly more. The competitive element was less effective than the collaborative elements. Nishiyama et al [13] studied 5 forms of collaboration and competition and found teams where members could see their own team's progress towards a goal and compare against other teams' progress performed best. When team members could see their teams' progress and the individual contributions of each member, overall performance lowered but individual performance had a lower variance. Likewise, when team members could collaborate towards a goal, but not compete against other teams, performance lowered.

Overall, researchers have explored the effectiveness of various social support interventions on promoting health and fitness behavior change. However, the reasons behind the efficacy of these applications have largely been unexplored. We build upon prior research by conducting a primarily qualitative study that aims to identify users' requirements, and to evaluate their experiences, thus revealing factors that may contribute and detract from the effectiveness of group fitness applications.

III. OVERVIEW OF THE STUDY

Our study consisted of 2 phases, with 4 stages in each phase, as depicted in Fig. 1.

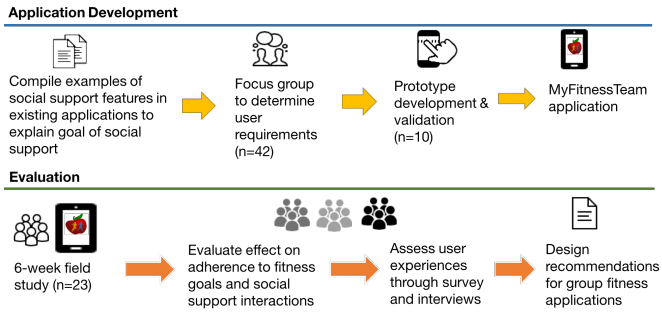

FIGURE 1: Overview of the study method

A. PHASE 1: USER REQUIREMENTS AND MYFITNESSTEAM DEVELOPMENT

1) Social Support in Existing Applications

We listed the social support features in 2 existing applications: *MyFitnessPal* (in-application social feed and share to Facebook/Twitter), and *Nike+* (social feed and competition). We presented these, along with a description of the 4 types of social support, i.e. emotional support is offering empathy, praise, and acceptance, informational support is providing useful information, instrumental support is the provision of tangible assistance, and appraisal support is providing information for self-evaluation, to explain the meaning of social support, and how using of social features in applications may lead to obtaining such support. The explanation was to aid the non-native English participants.

2) Focus Groups to Determine User Requirements

We conducted 4 one-hour focus group sessions with 42 participants in total (n=14, n=6, n=8 and n=14), where 23 were male and the average age was 26.75 years. Each session had 2 facilitators. Participants had used dietary, physical activity and weight loss smartphone applications in the previous year for more than a month, and were interested in using group fitness applications to support adherence to their fitness goals. The number of participants was not predetermined. Successive focus groups were conducted until data saturation was reached. Participants were recruited from a university mailing list and Facebook groups and the study was conducted in Japan. Thirty-six (36) participants were full time graduate students and six (6) were full time employees. Participants came from Japan (5), South-east Asia (16), the middle east (3), Africa (6), Europe (9), North America and South America (3). Sixteen participants (38.5%) had previously achieved their fitness goals through the use of fitness applications.

The first 5 minutes were used to fill out a paper survey collecting demographic data and previous experiences with fitness applications (Name of application, participant's goal, duration of use, goal achievement i.e. succeeded, failed, ongoing and reason for quitting).

A semi-structured discussion around the following points was then conducted:

- What type of fitness application did you use most in the previous year?
- What challenges did you face, and what type of social support would help you overcome them?
- Imagine a group fitness application through which you can gain the desired social support.
  - How should the application be designed - application flow, inputs, group member interactions etc.?
  - Who would you like to have in your support network - strangers, only, current acquaintances, both, people with a similar goal etc.?

When discussing the questions, probes e.g. *"Can you tell me more about that?"* and *"Can you draw what you mean?"* were used to gain further insight. Participants called out their answers, which were then written on a whiteboard and discussed. The whiteboard was also used to draw proposed use cases and interfaces, and count votes for the various ideas. To ensure various participant opinions were collected, facilitators directed questions and probes to different areas of the room, and each participant had paper on which they could

write down further remarks or draw alternative ideas to those on the white board. The focus groups were video recorded and notes were taken during the sessions. Participants gave informed consent to both.

The sessions were intelligently transcribed, and the transcripts and field notes were independently coded by 2 people on word processing software. To identify desired social support, a priori codes (information, emotion, appraisal, instrument) were used to categorize which type of social support each response corresponded to, while open coding was used for responses on application design. The keywords and memos from both were compared and discussed, and the final concepts and keywords decided on. The user requirements specification outlining: required social support, list of interfaces and their designs, required inputs, outputs, user-user and user-application interactions for each of the interfaces was then typed out.

3) Application Development and Validation

We used extreme prototyping and web-based tools (HTML, CSS, Javascript) to develop the application prototype. The dynamic prototype was presented to 2 participants from the focus groups in order to verify that the interfaces and application flow met the requirements specification. A functional specification was then developed by 2 members of the research team, followed by the implementation of the service layer. The final prototype was tested in-situ by 10 participants from the focus group. Participants reported bugs and gave feedback on the interface design and interactions during a 1 hour group interview. All comments were noted on a whiteboard and photographed. We then developed the final application, MyFitnessTeam (Fig. 3).

B. PHASE II: EVALUATION OF MYFITNESSTEAM

We conducted a 6-week field study followed by individual surveys and interviews (n=23, 16 males, 7 females, average age: 26.80 years) to evaluate MyFitnessTeam. All participants were full-time graduate students in Japan recruited via email. One participant was Japanese, with the others being from East Asia (2), South East Asia (11), the Indian subcontinent (3), Europe (3), Africa (1) and Latin America (2). The participants registered and self-divided into 5 groups (n=5, n=3, n=6, n=5, n=4).

1) Field Deployment

The field study consisted of 1 week of baseline, 4 weeks of intervention and 1 week of post-intervention. During baseline and post-intervention, participants had access to exercise plans and calorie data but not social features or daily challenges.

The primary measure was frequency of adherence to fitness behaviors i.e. number of days in a week on which participants did at least 30 minutes of physical activity and ate at least 1 healthy meal (during baseline and post-intervention) and number of days on which users completed the daily challenges (during intervention). At the end of the second week of the intervention phase, we released an updated version of MyFitnessTeam, which added a “public sharing" feature. By default, photos uploaded on MyFitnessTeam were only shared with the user’s group mates. In “public sharing" mode however, the photos could be viewed by all MyFitnessTeam users. This feature was added at the request of participants as a means of gathering more social support.

The study received ethics approval (approval no: 2017-I-16) after review by the committee of the Graduate School of Information Science at the Nara Institute of Science and Technology.

2) Research Questions

RQ1: Is MyFitnessTeam effective at supporting behavior change?

We hypothesized using MyFitnessTeam would lead to higher adherence compared to both baseline and post-intervention, due to the motivational aspect of seeing others’ fitness posts, and from social support extended by group members. We also hypothesized that the “public sharing" feature would lead to increased adherence, due to users having a wider audience responding on their posts.

We used a Friedman test to compare the participants’ adherence levels during the baseline, intervention (weekly average during the 4 intervention weeks) and post-intervention periods, and the Nemenyi test for posthoc analysis. Although comparing to the 4-week average may reveal high differences in adherence partly due to novelty, Klasnja et al argued [28] that demonstrating the use of a technology leads to a pattern consistent with how the intervention works (providing social support increases adherence in this case) is sufficient to demonstrate the efficacy of the technology with reasonable confidence. We used the Friedman test due to the nonparametric nature of our data.

A Wilcoxon signed rank test was used to compare the participants’ adherence levels in the first 2 weeks of the intervention phase (before the public sharing feature) to the final 2 weeks (after the public sharing feature).

RQ2: Is MyFitnessTeam more effective for certain users e.g. those active at baseline?

We had two conflicting hypothesis. We felt people with higher baseline fitness levels would likely have overcome barriers to behavior change and therefore be more likely to successfully adhere to fitness goals. However we also felt the social comparison opportunities in MyFitnessTeam would motivate less active users to perform to a similar level as the baseline active ones. We first grouped participants into 4 baseline fitness groups: *low* (0 days of adherence), *light* (1-3 days of adherence), *medium* (4-5 days of adherence) and *active* (6-7 days of adherence). We then calculated the average number of challenges completed in each week of the intervention phase by the 4 groups, and applied a Kruskal-Wallis test.

Men are also generally more physically active than women [29] but social support has been shown to double womens’

participation in exercise [30]. We wondered whether MyFitnessTeam would lead to similar performance from male and female participants, and we used a Mann-Whitney U test to compare the adherence of male and female participants.

RQ3: Does MyFitnessTeam support adequate exchange of social support, and what factors/features are responsible?

The purpose of group-based interventions is to provide social support opportunities to users, and an inadequate level of social support could limit the efficacy over the long-term.

We assessed: (i) how much social support was extended by users of MyFitnessTeam, (ii) whether users felt the level of social support was adequate or inadequate, and (iii) what factors influenced users in offering support.

To evaluate extended support, 2 individuals open coded the comments participants posted on each other's photos. Each identified theme was then assigned to one of the 4 types of social support. The total number of comments for each type of social support exchanged by each group was counted. Participants in each group then reported via survey, whether the social support extended to them, met, did not meet or exceeded their expectations, and what influenced their decision to extend support to others.

We hypothesized that participants who posted more actively on social media would be most active at extending support on MyFitnessTeam. We used self-reported social media posting levels to group participants into: *low* (Infrequent use or never post), *light* (post 1-3 times a week), *medium* (post 4-6 times a week) and *active* (post daily) social media use level. We then used a Kruskal-Wallis test to compare the number of comments posted by these 4 types of participants.

We also felt the public sharing feature would lead to more extended support due to the wider audience for posts, and we used a Wilcoxon signed rank test to compare the number of comments posted before and after the addition of the public sharing feature.

RQ4: How have the user requirements changed after in-situ use?

Studies have shown that day-to-day use of a technology can reveal implications that were not thought of or intended during design [31], and therefore, we asked participants to complete a 10-question online survey consisting of open-ended and multiple-choice questions after the field study. Open-ended questions focused on user experience, specifically, perceived social support, frequently used features in the application, and how the application design could be improved. Multiple choice questions assessed factors that affected motivation and preferences for the application design. The order of options in multiple-choice questions were randomized to prevent bias. Follow-up interviews were conducted with individual participants (n=9) to gain further insight into their open-ended survey responses. Notes were taken during the interviews. Both open-ended responses and interview notes were independently, openly coded by two people using word processing software. The coded data were then compared and discussed to decide the final categories.

IV. STUDY 1: USER REQUIREMENTS FOR GROUP FITNESS APPLICATIONS

A. SOCIAL SUPPORT SOUGHT

Table 1 summarizes the challenges faced with existing applications, proposed solutions, and the number of participants who voted for each solution. The challenges faced were similar to those identified in [32], [33], and [34]. All the proposed solutions (Table 1, "Proposed Solutions") involved gaining knowledge (informational support) from fitness experts or people pursuing a similar fitness goal.

In addition to informational support, 22 participants (52%) felt getting emotional support from others would motivate them. The types of emotional support most desired were: encouragement, respect and empathy.

B. APPLICATION DESIGN

1) Overall design and interfaces

Twenty-nine participants (69%) wanted an application that provided daily exercise and healthy eating challenges created by a fitness expert to groups (*"I want something like a game with a daily mission that says all the tasks you need to do for that day."* - P28). Group members would then post updates on how they completed the challenges. They remarked that completing the same goal with others would enable them to learn from each other through observation (*"I'd like to see how other people stay focused and reach their goal."* - P15), create a common experience which they could use to offer informational and emotional support (*"It will be easier to get proper advice and help from people who are going through the same thing."* - P18), and keep them motivated (*"It's more fun to do something with others than to do it alone so I think it will help with motivation"* - P5). The other designs suggested were to pair up users in order to keep each other accountable (n=3, 7%), and to pair users with a coach who provides daily goals and feedback (appraisal & emotional support) (n=10, 24%). However, participants were concerned the latter approach could be costly and coaches may not provide adequate emotional support.

Participants proposed interfaces for the home page and input page (Fig. 2). The home page interface contained a description of the daily challenge, a link to the calorie content of various foods, followed by a list of all group members. Under each member's name, a grid of photos they uploaded for the daily challenge would be displayed along with a message button, "favorite post" button and the caption/status of the last uploaded image. It was felt that showing a summary of every member's uploads would allow them to see inactive members so that encouraging messages could be sent.

In the validation stage however, participants felt this interface had several challenges. First, new photos did not appear at the top of the page. Instead, users had to scroll down to the name of the person who uploaded the photo and select the new photo from the grid in order to view it in full-size.

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TABLE 1: Challenges faced with existing fitness applications & proposed solutions

Application type	No. of participants	Main challenges faced	Proposed solutions
Calorie counter	8	1. Lack of knowledge on meals to eat to achieve calorie goal (n=8, 100% of participants) 2. Lack of time to search for calorie or nutrition information of foods (n=6, 75% of participants)	1. Provide information on foods and exercises which are suitable for goal (n=8) *"Recommend healthy foods to help me meet my goal, and the right serving size. But the app should consider my location so it doesn't recommend foods I can't make in Japan."* - P34 2. Help users gain knowledge and skills from others (n=5) *"I struggled with healthy eating because I can't cook. I want an app that also allows things like recipes and cooking instructions or advice from other people."* - P23 3. Provide tips for handling barriers such as cravings and low motivation (n=3). *"I want information like 'Drink water before eating to feel fuller'"*- P17
Walking, running tracker	11	1. Lack of motivation/time to achieve set goal (n=7) 2. Lack of knowledge on what goals to set after achieving the recommended goals e.g. 10,000 steps per day (n=4)	1. Provide progressively difficult goals (n=9) *"Make it like a game where you start with easy goals and progress. "* - P18 2. Provide information on alternative fitness goals that are similar to the achieved goal (n=3) *"It would be great to have a search function to see goals other people are doing or find a fitness plan" - P31*
Diet and exercise plans	23	1. Plans do not consider users' preferences, diet restrictions, access to resources or cooking skills (n = 22). 2. Plans focus on short term diets not long term behavior change (n=1)	1. Provide generic instructions on what a meal should contain and what exercise should be done (n=23) *"Instead of saying 'Eat this food' then say 'Make sure your meal is less than this calories and has this much protein'" - P40* 2. Assist the user to meet recommended guidelines e.g. calorie control, portions of fruits, 150 min. of exercise (n=23) *"It's important to focus on overall health not just short-term things like low-calorie diet for weight loss." - P15*

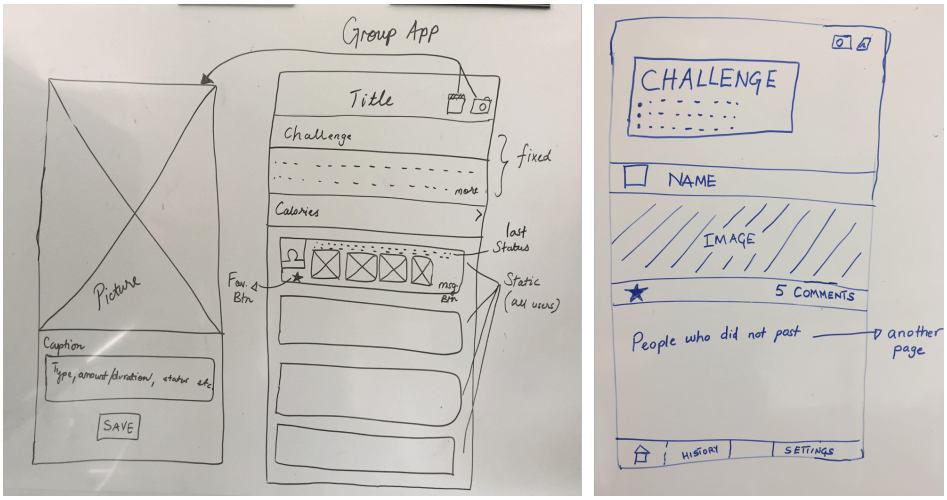

FIGURE 2: The left and center sketches show the proposed photo upload page and the home pages from the user requirements focus group. The sketch on the right shows the redesigned home page proposed at the validation group interview.

Second, if group members had not uploaded any photos, a list of names with no images was displayed, which was reported to be unmotivating and confusing. Participants proposed a new home page design where all uploaded photos appear in reverse chronological order with the uploader's name and caption on top of the photo (Fig. 2). Information on inactive participants could instead be obtained by going through an additional history page.

2) In-group & inter-group interactions

Participants wanted to be able to comment i.e. write short text messages on group members' updates and to select their

favorite post (photo). Commenting would enable them to ask questions and to exchange tips and emotional support, while the favorite post feature would encourage competition and provide further emotional support through recognition. Some participants were also interested (n=12, 28.6%) in inter-group competitions as a way of motivating them to adhere to challenges.

3) Input method

Most participants (n=36, 83%) preferred group members' posts to be limited to photo or video only, because they were deemed more interesting and more believable than text updates (*"It would make me believe people are really doing these challenges with me."* - P8). Moreover, they felt that sharing photos or videos would encourage them to choose healthier meals (*"If I know I am going to be sharing evidence of my meals I'll eat better."* - P18) and provide a better opportunity to learn about portion sizing and the correct way to execute certain exercises from others.

4) Support Network and Privacy

Participants preferred to form a group with people who shared a similar goal even if they were strangers rather than with friends or acquaintances due to the high interest in informational support (Table 1, "Proposed solutions"). They felt the advice and tips from people pursuing a similar goal would be most relevant. To ensure privacy, they suggested limiting group sizes to less than 10 members. There were concerns that a group of strangers or acquaintances might not exchange comments frequently and participants were interested in features to prompt interactions.

5) Outcome expectations

Participants wanted *adherence* to daily challenges as the primary outcome, with weight loss, improved walking distances etc. being the secondary outcomes. Many (n=34, 81%) felt that focusing on the effort (adherence) rather than progress towards a goal would protect them from discouragement if they failed to achieve these goals. They also felt focusing on the discipline of adhering to a plan would enable them to better meet their health and fitness goals in the future.

Table 2 summarizes the identified user requirements.

TABLE 2: User requirements specification for group fitness applications

Application goal	Provide daily challenges (exercise & healthy eating) to groups of users. Group members share updates on how they completed the challenge. Also provide advice on how to achieve the challenges.
Group membership	Allow users to create or join an existing group where members are pursuing a similar fitness goal/plan.
Input	Limit user challenge updates to photos or videos only
Group member interactions	Provide commenting feature & a "favorite" button
Inter group interactions	Support inter-group competitions

V. THE MYFITNESSTEAM APPLICATION

MyFitnessTeam is an Android and iOS application that offers daily fitness challenges to small groups (<10 members). MyFitnessTeam contains four tabs: home, team history, personal history and account. On application startup, the home page (under home tab) is shown with instructions on how to register and create or join a group. Once the user belongs to a group, the home page shows a list of all the tasks in the daily challenge (Fig. 3(a)) and the photo input controls. Group members post photos showing how they completed the challenges, and these appear below the challenge description in reverse chronological order ((Fig. 3(b)). Users can see all the posts made by different group members on previous days under the "team history" tab, or view their personal posting history under the "personal history" tab. The account tab contains register and login/logout functions as well as group membership functions (create a group, join a group, quit a group).

In this study, MyFitnessTeam offered one fitness plan consisting of 28 days of daily challenges developed by a nutritionist and physical trainer. Table 3 shows the weekly goals of the plan. During recruitment, participants were informed that the fitness plan consisted of daily exercise and healthy eating tasks, and completion of all challenges could lead to slight weight loss. This was partly due to ethics requirements, and partly to ensure only participants who could safely lose weight and whose fitness goals aligned with weight loss (and not weight gain or muscle toning for example) would participate.

Each daily challenge consisted of a physical activity and healthy eating task. For exercise tasks, users had to complete a specific number of minutes of exercise e.g. *"Do 30 minutes of moderate-intensity cardio exercises"*. Every week, users had 3 days of cardio exercises, 2 days for strength training and flexibility exercises, 1 day to do any exercise they wanted and 1 rest day. The healthy eating tasks required eating meals within a specified calorie range, eating a portion of fruits and vegetables, and replacing sugary snacks. Three times a week, an optional team bonding task to prompt social interactions, and hence address users' concerns over low social interactions amongst strangers, was also included. Team bonding tasks were of three types: (i) sharing bits of personal information, e.g. *"post a photo of your favorite healthy snacks"*, to help users learn more about each other and therefore feel more comfortable interacting, (ii) sharing information and emotional support messages e.g. *"share a fitness tip", "post an encouraging comment on your group mates' photos"*, and (iii) group activities e.g. arranging to eat/work out with groupmates.

To help users complete the challenges, MyFitnessTeam included a list of meals and exercise plans grouped by type e.g. Rice dish, soft drinks, cardio exercises. Each food item had a calorie amount, numerical serving size and a photo to help users visually see the serving size and ingredients. Each exercise had a description of how to complete the ex-

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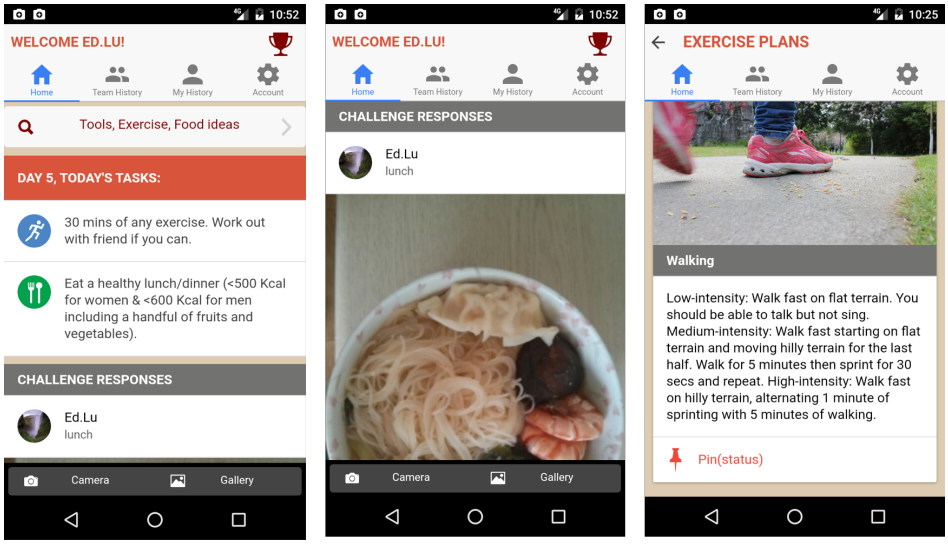

FIGURE 3: MyFitnessTeam application: (a) and (b) show the daily challenge and timeline respectively. (c) shows the exercise plans page.

TABLE 3: Weekly goals of the challenges

Week	Weekly Goal
1	90 minutes of exercise (60 min. low-intensity cardio, 15 min. strength training, 15 min. flexibility exercises), Eat 5 healthy meals
2	135 minutes of exercise (90 min. low-intensity cardio, 30 min. strength training, 15 min. flexibility exercises), Eat 10 healthy meals
3	145 minutes of exercise (90 min. mid-intensity cardio, 40 min. strength training, 15 min. flexibility exercises), Eat 14 healthy meals
4	200 minutes of exercise (90 min. mid-intensity cardio, 40 min. strength training, 15 min. flexibility exercises), Eat 19 healthy meals

ercise as a low-intensity, moderate-intensity or high-intensity workout. Tips on how to maintain motivation and substitute exercise equipment were also provided. Fig. 3(c) shows a cardio exercise plan from MyFitnessTeam.

VI. STUDY II: FIELD EVALUATION OF MYFITNESSTEAM

A. USAGE AND GENERAL FEEDBACK

All 23 participants completed the study. They completed an average of 17.65 (63.04%) challenges, and participants gave MyFitnessTeam an average score of 3.04 out of 5 (60.8%). The most popular features were photo sharing and the food calories list and exercise plans. Participants were motivated by both social comparison and inter-group competition. They expressed: *"It was very motivating to see my groupmates post photos. When I didn't feel like doing a challenge but I received a notification for an uploaded photo and saw others commenting on the photos, I changed my mind. And my teammates also said the same thing."* - P2, and *"I want to win. I will do as many challenges as possible to win. The application by itself is great, but competition really increases the motivation to do challenges."* - P8.

B. COMPOSITION OF PARTICIPANT GROUPS

Participants self-divided into 5 groups. Group 1 had 5 members (4 male) who considered themselves *"very close"* friends. Group 2 had 3 male members who were strangers, while group 3 had 6 members (5 male) who considered themselves casual acquaintances. Group 4 had 5 members (3 male) who were *"relatively close"* friends and group 5 had 4 members (1 male) who were strangers.

C. EFFECT OF MYFITNESSTEAM ON ADHERENCE TO FITNESS BEHAVIOR

Fig.4 shows the baseline, intervention and post-intervention adherence of each of the 23 participants. There was a significant difference in the median adherence during the three phases of the study (χ^2 = 27.07, p=0.00001). Posthoc testing showed a significant difference between baseline and intervention (p=0.000003) and between intervention and post-intervention (p=0.0026), but no significant difference between baseline and post-intervention (p=0.27). The median adherence of the participants before and after inclusion of the public sharing feature (median=10 days and median=9 days respectively) was not statistically significant (p=0.06).

Fig.5(a) shows the intervention phase adherence levels for participants with different levels of baseline adherence (low, light, medium and active). The difference in adherence during the 4 weeks of intervention across the groups was insignificant (χ^2 = 1.91, p = 0.59). Male and female participants (Fig. 5(b)) on the other hand had significant differences in median adherence levels (20 days for men, 13 days for women, p=0.04).

The difference in adherence between male and female par-

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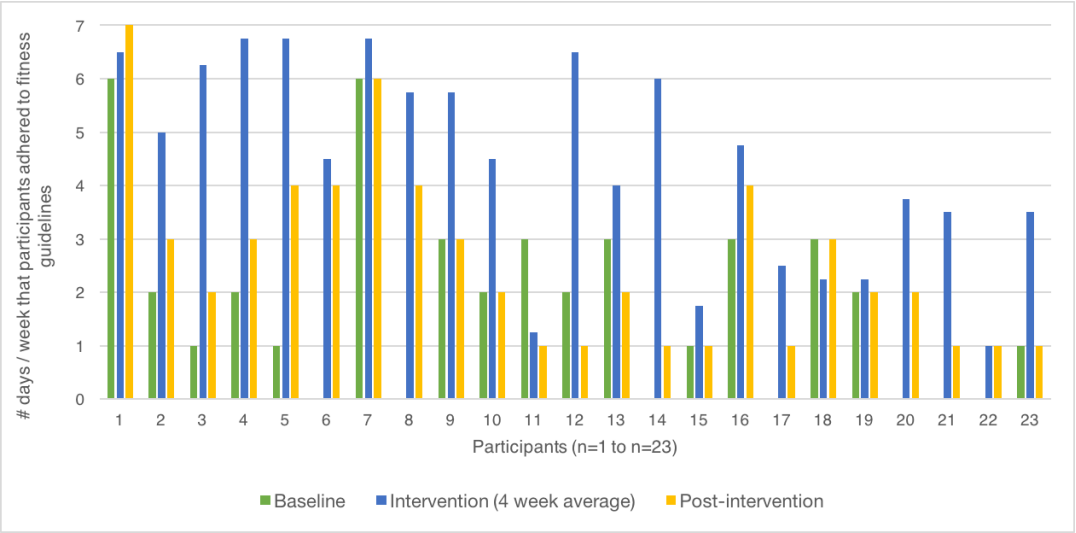

FIGURE 4: Baseline, intervention and post-intervention adherence to physical activity and healthy eating for the 23 participants

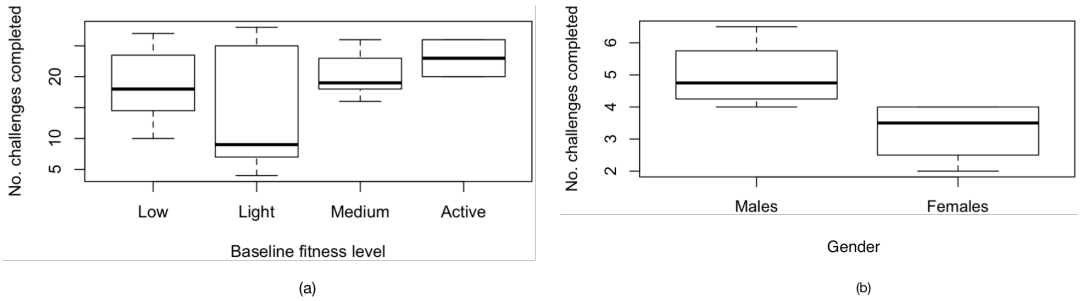

FIGURE 5: Box-plots of the adherence levels of participants based on: (a) their baseline fitness adherence levels, (b) their gender

ticipants was due to different primary motivation and location of exercise. Male participants were primarily motivated to determine their limits for physical activity in each week (*"I don't usually go to the gym but I thought it would be a great time to work harder."* - P15) or to compete against others (*"Whenever I had time, I did a challenge and I encouraged everyone in my team to do the same so we could be the best team."* - P10), while female participants had a fixed idea of how much physical activity they wanted to achieve in a week and only strived to reach this personal goal (*"I usually exercise on Sundays but I wanted to exercise 3 times a week so I only did 2 more challenges each week."* - P21, female). In addition, 6 of the 7 female participants did not participate in strength training challenges due to misconceptions on the effect of these exercises on physique. Additionally, male participants primarily exercised in the gym, sports facilities or outdoors, and they encouraged their group mates to join them, making the experience more fun (*"This (study) was fun for me because I usually exercise alone but now I was able to encourage my friends to join me in the gym."* - P14), while female participants chose to exercise alone at home despite having free, daily access to both sports facilities and the gym.

D. EXTENDED AND PERCEIVED SOCIAL SUPPORT

Participants posted 7 types of comments on each others' posts: encouragement, chatting, negative remarks, advice, accountability e.g. reminders of the group's goal, and an explanation of the uploaded post (photo and caption) by the uploader. Comments in the chatting category were mostly questions and answers on portion sizes, exercise facilities and strategies used to achieve the challenges.

Comments in the encouragement category were an extension of emotional support while advice, accountability and chatting categories were an extension of informational support. Fig. 6 shows the number of comments (messages) for each of the 4 types of social support shared by the groups. Only group 1 participants (n=5, 21.7%) perceived an adequate level of social support. All other participants reported '*"low"* levels of perceived support.

The median number of messages exchanged in the groups before and after including the public sharing feature (Median=7 messages and median=10 messages respectively) did not vary significantly (p=0.875). Participants confirmed that the feature did not lead to increased levels of perceived support because they felt self-conscious about posting their

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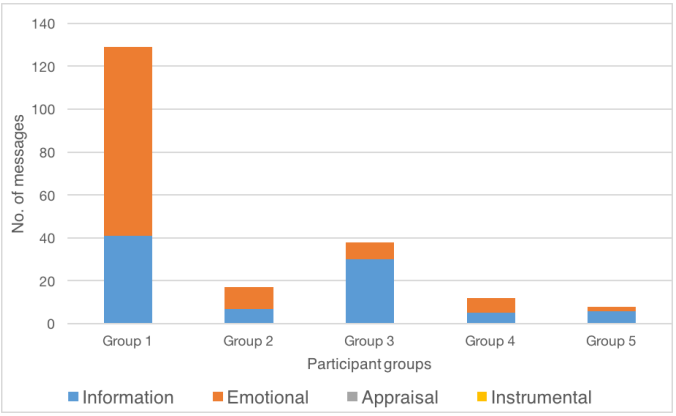

FIGURE 6: The number of messages exchanged by the 5 groups for each of the 4 types of social support messages

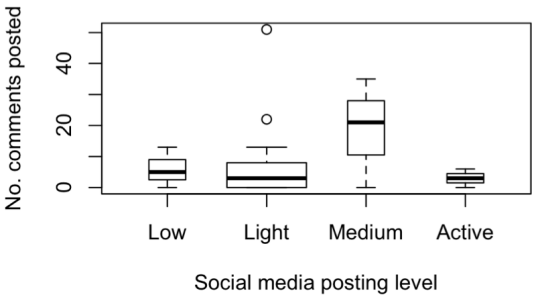

FIGURE 7: The number of social support messages exchanged by participants of low, light, medium and active social media use behaviors

food and activity updates to a wider audience. They instead shared general information such as the healthy food options in different restaurants.

1) Factors affecting extension of emotional support

More than half of the emotional support messages posted by participants in groups 2 to 5 was on days when the team bonding task in the challenge provided a prompt of what to post e.g. *"Write a 'well done' comment on your favorite post"*. Members of these groups reported feeling *"awkward"* and *"unsure"* of what type of emotional support to offer, apart from praise, and when to offer the support. They were also wary of offering praise frequently because it would seem insincere. Group 1 participants (P1 to P5) however extended emotional support consistently throughout the study because they had agreed at the beginning of the study to comment on each uploaded photo, in hopes constant feedback would support their motivation.

2) Factors affecting extension of informational support

Participants in groups 1, 3 and 4, who were friends in real life, often exchanged information support outside the application, especially on meal choices and exercises to do in order to meet personal fitness goals. Group 1 and 5 members were strangers and they feared offending their group members by extending unsolicited advice and information. They did ask questions about others' meal and exercise choices, but were careful to *"not be too intrusive"* (P23).

3) Level of extended social support based on social media posting behavior

Fig. 7 shows the number of social support messages posted by participants based on their social media posting behaviors. Participants in the "Medium" category, and the 2 outliers in the "Light" category all belonged to group 1, which had a pre-agreed strategy to post comments on each others' photos. Discounting these participants, the level of social support extended by the remaining participants did not vary with social media use behavior. This was confirmed by a Kruskal-Wallis test (χ^2 = 0.74, p = 0.86). Interviews revealed that even participants who posted on social media actively felt unsure on how to best support others through comments.

E. CHALLENGES FACED AND CHANGES IN USER REQUIREMENTS

Several participants (n=13, 56.5%) reported that increasing knowledge and confidence with healthy eating and exercising over the course of the study made the daily challenges feel *restrictive* (*"I think some of the calorie restrictions became inappropriate for my goal - muscle toning and weight maintenance. I would prefer to choose my own challenges."*-P12, *"I enjoyed cardio more and I would prefer to focus more on that than."*-P23). They suggested overcoming this challenge by giving users the ability to personalize the fitness plans. One way to achieve this would be to specify the duration of physical activity a user should aim for, and let them decide which type of exercises to do, and to let users specify their own healthy eating goals.

Another challenge faced was the low level of social support exchanged despite the team bonding tasks (*"I didn't get enough support from my group."*-P8). Some participants (n=10, 43.5%) felt pairing up with friends and acquaintances instead of strangers, even if they had different fitness goals, would address this. A more popular suggestion (n=20, 87%) was to encourage increased use of the public sharing feature to solicit support, especially when users had achieved a goal or were struggling with the challenges (*"My group isn't very active. I have lost quite a bit of weight but there were no comments on my post. I want to share it with more people, maybe I can get more responses."*-P9).

Although team bonding tasks were effective in prompting supportive interactions, they were unpopular with most participants (n=18, 78.3%). They felt social sharing was something to be on SNS with friends, and group fitness applications should focus on sharing challenge-related information only.

Finally, participants revealed that inter-group competitions were initially motivating, but as the performance gap between groups increased, they quickly became demotivating (*"No,*

TABLE 4: Overview of the results from MyFitnessTeam field study

Measure	Findings
Efficacy (Supporting adherence to fitness behaviors)	1. Significantly improved adherence levels compared to both baseline and post-intervention. 2. Participants across different levels of baseline fitness had similar adherence levels i.e. people who were baseline inactive achieved similar adherence to baseline active individuals 3. Male participants significantly outperformed females.
Extended social support in groups	Group members mostly offered encouragement or exchanged information about their food and exercise choices. Groups comprised of friends were more likely to ask for/offer information. Participants who actively post on social media did not extend more support than inactive participants.
Perceived social support in groups	18 of 23 participants (78%) perceived low levels of both emotional and informational support. They wanted the application to engineer emotionally-supportive interactions.
Preferences for application design	1. Offer daily challenges developed by a fitness expert to groups of users 2. Allow groups to either follow the same fitness plan or different fitness plan 3. Provide a public-sharing space for members of different groups to exchange information and gain more support.

I don't like inter-group competitions. It's just demotivating when you realize you can't win."-P12). Participants felt more frequent, short-term competitions e.g. daily or weekly would be more appropriate, as low-performing groups would have a chance to start over.

VII. DISCUSSION AND DESIGN RECOMMENDATIONS

Our work aimed to determine users' design preferences for group fitness applications and to evaluate the effectiveness of the proposed design. Tables 2 and 4 summarize our findings.

We found that users look to group fitness applications to gain information and emotional support in the form of guidance from experts and advice and tips from peers for the former, and through exchanging empathy, respect and encouragement for the latter. They envisioned an application that provides daily, common goals (challenges) to a small group of users, who then post photo or video updates on their progress and comment on others' posts, would best provide the needed support. Our field study showed that the design proposed is effective at supporting increased adherence to fitness, with baseline inactive users managing to achieve similar levels of adherence to baseline-fit users due to social comparison. However social support exchanges through comments were low, with most exchanges occurring when the application prompted users on what to say, which may lower the efficacy of the application with time. Engineering social interactions is therefore important. Socio-cultural factors also prevented the application from being as effective for females as for male participants.

Informational and emotional support are the main forms of social support found in online support groups [35] [36] and studies have found that people usually seek/gain informational support first, through lurking on online communities and following health and fitness social media accounts [22] [35]. Those who require emotional support usually start posting after gaining the required information [22] [35] [8]. The higher preference for informational support compared to emotional support during the focus group could be explained by this need to address gaps in knowledge. Due to the short length of the field study, we were unable to assess whether users' preferences for support would change with time. However, we did see indications that emotional support became more important over the course of the study. Firstly, some participants expressed a desire to change their social networks (fellow group members) from anyone who had a similar goal and plan to real-life friends (even those pursuing different goals) in order to gain more emotional support. Secondly, participants frequently commented on the need for group applications to engineer emotionally-supportive interactions among group members due to the low levels of support extended in the groups.

The small groups, common goal and daily challenges format proposed by the focus group participants has been implemented in several group fitness applications in literature [15] [9] [14] [10]. Similar to MyFitnessTeam, these applications led to a significant improvement in outcome measures, thus demonstrating the potential benefits of this approach. In MyFitnessTeam and [15], users were required to post photos to challenges, but the challenges in [15] were not from a structured fitness plan. In [10], [9] and [14], users could show they completed a challenge through a text update and/or clicking a 'Done' button. It is unclear whether one approach has advantages over the other, and thus follow-up studies may need to assess this.

Several free and commercial group fitness applications implement one or two of the 3 (small groups, common goal and daily challenges) elements. *Teemo* for instance employs both small groups and a common goal. Up to 9 Facebook friends can form a group and collaborate towards completing a goal such as "Climb Mt. Everest" through their individual workouts. *Yog*, *Running Club* and *FitRockr* provide a common goal. The first 2 allow users to schedule a virtual run (start time, duration) and provide real-time updates of the progress of every user taking part in the run, while *FitRockr* converts any physical activity into points, thereby allowing users doing different activities to have a common comparison metric either for competition or for striving towards a common goal e.g. achieving a specific number of points. *Fit Friendzy* and *Fitocracy* provide both a common fitness goal/plan and regular challenges. However, the challenges are usually user-defined, and group sizes are often very large (up to thousands of users per group). Fitocracy does offer

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fitness plans with daily or weekly challenges created by professional coaches that users can enroll to, but the bulk of social interactions and thus support is between a coach and each individual user, not within peers. The user satisfaction with, and relative efficacy of these different applications has not been studied, and it is therefore unclear whether it is necessary to have all 3 elements, or whether a subset of the 3 is adequate.

The low levels of social support observed in MyFitnessTeam were also observed by Cavallo et al [37], and [15] found participants desired more social interactions. We found that groups of friends were more likely to exchange unsolicited information but extending emotional support was low for both friends and non-friends, due to lack of knowledge on when and how to offer such support. Providing prompts to offer praise or encouragement via team-bonding tasks resulted in more messages of support, which shows the need for applications to be more proactive at engineering social interactions. Most existing applications provide social features such as a discussion wall, 'comment' buttons on posts and 'like' buttons, but many do not prompt use of these features or provide guidance on what to say, and therefore small groups may still face experience the low-usage challenge. Fortunately, an increasing number of applications now try to engineer interactions. Some like *RunKeeper Live* notify users when their friends start an activity, and they can view their friends' progress and statistics in real-time so they can send appropriate support. Others like *Nike+* provide features to "nudge" inactive friends. We propose other methods applications can use to promote social interactions in the following section.

Finally, the different performance of male and female participants due to socio-cultural factors such as fear of appearing manly have also been observed in [38]. Neither MyFitnessTeam nor existing applications (to the best of our knowledge) explicitly address these factors either through information or other means. Other barriers to female participation such as lack of confidence and fear of judgment over skills and abilities [39] are also not explicitly addressed, although many applications provide a 'tips' feature through which users can get both application-specified and user-shared guidance on overcoming common barriers. It would be interesting to see whether providing gender-specific advice and interventions could promote efficacy of fitness applications for female users.

A. DESIGN RECOMMENDATIONS FOR GROUP FITNESS APPLICATIONS

We propose 5 additional ways applications can promote more social support in group fitness applications, based on participants' experiences and comments in the field study.

1) Assist Users to Form a Social Interactions Strategy

The top performing group in our study had members who realized the positive impact of encouragement, praise, and pairing up for challenges, which resulted in their pre-agreed social support strategy. Applications should inform users on the importance of collaborating both in-application and face-to-face (if possible). This could be achieved through statistics on the impact of social interactions on adherence to goals or applications could propose ways members can collaborate (pairing up, assigning roles such as "motivator" and "exercise scheduler" to members).

2) Provide Prompts to Interact with Other Members

Applications typically issue notifications updating a social circle of a friends' recent progress and achievements. Suggestions of messages and actions that friends can take to show their support could be appended to these updates e.g. *"X completed the challenge today. Send a congratulatory message"* or *"Comment on your favorite photo with 'I like ...'"*. Alternatively, buttons such as 'like', and 'favorite', can be extended such that when a user clicks on the button, instead of just incrementing the number of clicks, a comment box also appears with a prompt for the user to specify their feelings e.g. *"I like ...."* or *"Well done on...."*. Participants who are struggling to adhere to the challenges or to complete the challenges should also be aided in requesting support for instance by prompting them to share their struggles, or by guiding them to relevant information resources.

3) Provide an In-application Public Sharing Space for Tips, Conversations and Emotional Support

Informational support was highlighted as an important form of social support in the focus group. Providing an in-application public sharing space where users from different groups can exchange tips, information on location of resources e.g. exercise facilities, recipes and exercise plans etc. can allow easier access to valuable information. Many fitness applications provide web-based forums, but in-application forum features are still not as widely supported. Information seeking effectiveness can lead to higher levels of perceived empathy [40], and therefore this strategy may also help address the challenge of low levels of emotional support within groups. Allowing individuals and groups to share their challenge photos to such a public space can further address this challenge, as individuals can gain both informational and emotional feedback from non-group members.

4) Provide Opportunities for Vicarious Learning from the Best Performing Groups and Individuals

Vicarious/observational learning [41] can promote behavior change and participants in our study showed interest in its inclusion in group fitness applications. Top performing groups and individuals can support others by either sharing their photos to the public domain for a day, sharing short stories on their fitness journeys, answering a subset of user questions or mentoring/coaching an individual. Rewards such as badges and small gifts donated by users and intrinsic rewards of contributing to something meaningful can be utilized to encourage participation.

5) Allow Individual Competition and Awards to Recognize Individual Achievements

Many participants felt competitions motivated them to perform more challenges. To support competitive users who may be in non-competitive groups i.e. a group where the majority of members are motivated by their internal goals and not competition, a leaderboard of individual performance could be provided in addition to a group leaderboard. Furthermore, users could be allowed to personally reach out to users in other groups to challenge each other to mini-competitions.

B. LIMITATIONS AND FUTURE WORK

One limitation of our study was the low number of participants, which limits our ability to generalize our findings to the wider population. We also relied on participants self-reporting their activity levels which may have resulted in over-reporting.

Further work on the effect of group applications over an extended period of time is needed. Determining correlates and determinants of individual and group performance levels is also needed to provide more design recommendations.

VIII. CONCLUSION

In this paper, we presented results from a focus group on the social support and application design users desire in group fitness applications. Users identified information and emotional support as most important, and desired an application that provided common daily challenges to small groups of users. We developed MyFitnessTeam based on these requirements and evaluated its effect through a 6-week field study (n=23). We found that adherence to physical activity and healthy eating increased significantly. Men had significantly higher levels of adherence to females, and participants of varying baseline fitness levels had similar levels of adherence during MyFitnessTeam use. Groups consisting of real-life friends exchanged more informational support, but both groups of friends and groups of strangers had low levels of emotional support due to lack of knowledge on when and how to extend support. We presented 5 design recommendations on how to engineer in-group collaboration and interactions.

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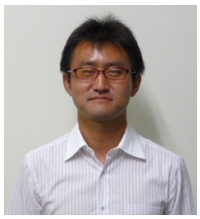

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