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ORIGINAL PAPER

Barriers to Physical Activity: A Study of Self-Revelation in an Online Community

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Abstract The importance of regular physical activity to overall health has been well established, yet adults in the United States are leading increasingly sedentary lives. Research suggests that lowering perceived barriers to exercise is an effective strategy for encouraging physical activity. This article describes the top barriers that emerged from a qualitative analysis of message board traffic from a three-month healthy lifestyle intervention that promoted physical activity and healthy eating. The findings further elaborate known barriers to physical activity—two of which are not reported as key barriers in prior research—and illustrate the value of a grounded approach to studying health and fitness behaviors. Based on our analysis, we identify design considerations for technologies that encourage and support physical activity. Understanding the needs of a population is a critical step in the design process, and this paper offers unique insights for those working in this growing domain.

Keywords Barriers to physical activity · Fitness · Health · Message boards · Web-based discussion forums · Virtual community

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Introduction

On New Year's Day, Laurie decided that her top resolution for the year would be to work out five times a week. She had been exercising irregularly in prior months and not making progress toward her weight loss goal. Laurie began her workweek with the plan to get a 30-minute workout each day after work and before picking her daughters up from school. On Monday afternoon, a one-hour work meeting lasted two hours, preventing Laurie from getting to the gym as planned. She told herself that she would exercise after her husband got home from work, but her daughter needed help with a science project so Monday passed with no workout. Her mother needed to be taken to an appointment on Tuesday afternoon so Laurie looked forward to hitting the gym on Wednesday for a 60-minute workout to compensate. Wednesday morning, Laurie's youngest daughter woke up with the flu and after a full day caring for her child, she felt too exhausted to exercise when her husband came home from work. Finally, on Friday, Laurie's day went as planned and she completed 30 minutes of cardiovascular exercise. Saturday and Sunday passed with no exercise as she sat watching her daughters in a swim meet. When Laurie drove to work on Monday morning she reflected on her new exercise goal and decided to stop planning her exercise because it was too frustrating to continue to fail.

Laurie's story is very common. Among adults in the U.S. who begin an exercise program, approximately 50% drop out during the first three to six months [1]. Individuals may be motivated to change exercise habits but fall short when confronted with barriers presented by everyday life,

ultimately discontinuing the activity completely. Research supports this pattern, finding that an individual's perceived barriers to physical activity are an important determinant of activity level [2, 3]. Large-scale surveys have shown that people have many barriers to being physically active such as *lack of time*, *lack of motivation*, and *lack of energy* [4–7]. Several investigations have reported that helping people overcome their perceived barriers has more influence on encouraging people to be physically active than does enhancing perceived benefits of exercise (e.g., [1, 8, 9]). In fact, knowledge of health benefits is not correlated with activity levels [2]. Barriers may affect those who are trying to make a change as well as cause a break for those with an established routine.

Our study was part of a requirements gathering effort to inform the design of technologies to encourage and support people who are beginning or maintaining a physical activity routine. We studied message board traffic during a three-month healthy lifestyle intervention that promoted physical activity and healthy eating. The aim of our research was to understand the naturally occurring barriers that people discuss as they make an effort to change their day-to-day fitness activities. We employed two different grounded approaches [10] during our data analysis to uncover and elaborate barriers to being physically active. We found that the popularity of the mentioned barriers differs from that in prior research.

Understanding the needs of a population is a critical step in the design process, and this paper offers unique insights for those working in this domain, an area of growing popularity (e.g., [11–19]). Our findings expose opportunities for technologies to help individuals overcome or mitigate barriers, as well as help designers and evaluators of the technologies understand potential issues that may arise during long-term use of the technologies which may adversely affect the technologies' effectiveness. This work can also be used to inform the way that discussion forums are used to support health interventions like the one we studied.

In what follows, we provide an overview of the common barriers covered in prior research. The method for analyzing the message board traffic is described next, followed by the findings related to the barriers the message board posters' experienced. Finally, implications for designing technologies that support and encourage physical activity are presented.

Barriers to physical activity

Unexpected emergencies, chaotic schedules, fluxes in work and family responsibilities, and other challenges can prevent an individual—even a fitness fanatic—from maintaining a regular exercise routine. In addition to these "personal barriers," other factors including environmental constraints such as the limited availability of safe trails and parks have been found to influence an adult's choice to begin and continue a physically active lifestyle. These factors or "determinants" of physical activity have been studied extensively in an effort to better design interventions that promote physical activity. This study focuses on personal barriers to physical activity because it has emerged as one of the most consistent and strong correlates of physical activity behavior [3].

Table 1 provides a summary of the top barriers reported in existing literature obtained from survey-based studies and intervention studies [4–7, 9, 20–28].[1] In 11 of the 13 studies reviewed, the principal reason given for not being physically active was a *lack of time* for exercise [5–7, 9, 20–22, 24, 25, 27]. *Care giving responsibility*—including caring for children, elderly parents, or other family members—was also a prevalent barrier in studies that focused on women [4, 6, 7, 25]. *Lack of motivation* [5, 21, 22, 24] and *lack of energy* [6, 7, 20] were also frequently ranked as principle barriers.[2]

The method used to understand the top barriers in these studies often included surveys dispensed during phone or face-to-face interviews that were based on instruments such as the Exercise Benefits/Barriers Scale (EBBS) and Behavioral Risk Factor Surveillance Survey (BRFSS).[3] The questions used to prompt subjects about their barriers were therefore very structured. Similarly, in the two intervention studies that we reviewed, the EBBS was administered pre- and post-intervention to determine barriers, but not during the intervention when barriers naturally occur [9, 27]. Another tool that has emerged from this research is the Barriers to Being Active quiz [29]. Similar to the EBBS and BRFSS, it can help intervention developers understand their target population and thus where to focus efforts.

This barrier-related literature informed the development of the codebook that we used to analyze the collected data. The approach used to studying personal barriers in this study is novel because while informed by knowledge of existing barriers, the analysis of naturally occurring message board discussions uncovered barriers expressed by people during an active attempt to increase physical activity level without prompts from preexisting models and survey instruments.

[1] 4 and 19 report on the same study

[2] Barriers from the various studies may overlap in some cases due to an inconsistency in their naming (e.g., *care-giving duties* is often related to a *lack of time*; *lack of energy* may be synonymous with *too tired*).

[3] http://www.cdc.gov/brfss {link verified 13 January 2011}

Table 1 Principle barriers to physical activity. *Italicized references* indicate the top barrier for the study

Principle barrier	Study
Lack of time	[*5–7*, 9, 20–22, **24***, 25, **27***, 28*
Care-giving duties	[4, 6, ***7***, 25]
Lack of motivation	[5, 21, 22, 24]
Lack of energy	[6, 7, 20]
Physical exertion	[9, 25]
Exercise is tiring	[*23*, 27]
Exercise is fatiguing	[23, 27]
Exercise is hard work	[23, ***27****]
Too tired	[6, 21]
Injury or poor health	[***24****]
Health concerns	[22]
Lack of interest	[26]
Lack of enjoyment	[26]
Social interaction	[25]
Lack of social support	[22]
Get physical activity on the job	[21]
Not the sporty type	[28]

* In [24], *lack of time* was the top reported barrier overall, but *injury or poor health* was the top barrier for those aged 60–75. In [7], *lack of time* was the top barrier for urban women and *care-giving duties* for rural women. In [27] *Exercise is hard work* was the top barrier pre-intervention, and *lack of time* post-intervention

Method

One goal of this work was to explore opportunities where technology could encourage and support individuals' efforts to be physically active. The aim was to understand barriers that naturally occur as individuals attempt to change their behaviors to lead healthier lifestyles. Much of the prior work relies on retrospective surveys of people randomly selected from a specific segment of the general population. While that well-established approach may yield statistically significant and generalizable results, it may miss barriers that are not part of formalized prompts or which respondents simply do not recall.

In contrast, the method employed in this study focused on the open-ended, natural discussions that occur in online communities such as that of Usenet and other web based forums. Briefly, our method was to (1) identify and archive message board traffic, (2) develop a set of codes to apply to the messages, (3) systematically code the content of the messages, and then (4) analyze the resulting coded messages and select full discussion threads. To judge the popularity of a barrier discussion topic, we used the lengths of discussion threads as a function of the number of unique posts where personal barriers were expressed.

We archived the web forum messages from *GetFit!*, an annual three-month healthy-lifestyle intervention created and promoted by BeFit[4]—a U.S. magazine that covers women's fitness, nutrition, health, beauty, and style topics. BeFit has roughly 5 million readers, almost 75% of whom are college educated with a median age in their late 30's and household income of around $72,000 USD. Each month during *GetFit!*, BeFit publishes articles about incorporating physical activity (cardio, strength, and flexibility training) and proper nutrition practices into daily life.

During the *GetFit!* intervention studied, BeFit offered web forums to support intervention participants. The forums were arranged topically and included an "Ask the Expert" forum where designated experts[5] responded to posts in addition to other forum participants. No registration or membership was required to read or post messages. We collected 13,262 posts (from 3223 threads) over a 15-week period, which spanned the duration of *GetFit!* and contained all messages from the "Ask the Expert" forum. Threads contained from 1 to 74 messages each (mean: 4.1, median: 3). Ten experts and 2649 registered posters (i.e., unique poster IDs) contributed posts. There were an additional 945 contributions by the undifferentiated "guest" poster name.

Next is a description of how the codebook was developed, how coding was conducted, and some general demographics collected by reading and analyzing the 13,262 messages.

Data coding

We developed an initial set of codes based on a review of the related literature described above and two social-psychological theories—*Presentation of Self in Everyday Life* [30], which addresses the pervasiveness of social interaction and how social interactions impact behavior, and the *Theory of Cognitive Dissonance* [31], which addresses the distinction between attitudes and actual behaviors and the justifications used to explain inconsistencies between them. Given the initial set of codes, a sample of messages was read to identify code omissions. When a message included a topic related to, but not accounted for by a code, we either clarified or expanded the code, or added a new code to cover the topic. The codebook was validated

[4] Pseudonyms are used for the magazine and health intervention names to protect the identities of message board posters, expert contributors, and the magazine.

[5] Experts, who were arranged by BeFit, included two psychologists, an obstetrician/gynecologist, a registered dietitian, two personal trainers (one was a former professional athlete and the other was also a track and field coach), two gym owners, a personal finance columnist, and a spa chef.

through pairwise pre- and post- discussion Kappa values among four coders. Prior to any discussion, Kappa values ranged from 'slight agreement' to 'fair agreement' while post-discussion, all coders were in 'almost perfect agreement' using the "Interpretation of Kappa" values in [32, 33].

Two of the four coders systematically coded the data using the validated codebook. This method for analyzing message data has been used by others, for example, by Arguello et al. to identify the qualities of a post that led to a successful thread [34], by Preece et al. to investigate the empathetic qualities of posts on a message board support group for individuals with knee injuries [35], and by Farnham et al. in HutchWorld, to investigate the impact of social support on the quality of life of cancer patients and their caregivers [36].

Observed *getFit!* demographics

We do not have complete demographics for the forum as we had no direct interaction with the posters. However, the content of many posts included demographic information, from which we were able to collect the following: age range of 13 to 62 years old, weight range from 70 to 267 lb, height range of 4′10" to 6′4", and body mass index[6] (BMI) range of 13.1 to 41.1 kg/m2. Though BeFit magazine targets women in the U.S., at least a few males (self-identified) and international posters (identified by use of culturally specific terminology such as references to "stones" as a unit of measure for weight) posted to the forum.

Although our analysis of the *GetFit!* message traffic covers a broad range of topics related to physical activity and nutrition, our focus here is on results related to barriers to physical activity. We have selected this topic because lowering perceived barriers has been shown to be more effective at encouraging people to be physically active than has educating people about the benefits of physical activity [1, 8, 9], therefore focusing on reducing barriers presents opportunities for those developing technologies to encourage and support physical activity.

Analysis

We used two different analytical lenses to uncover the importance of different barriers from the participants' point of view as expressed in the "Ask the Expert" forum. A *content analysis lens* [10] helped determine importance through the frequency of barrier codes assigned to individual quotations or statements made by posters irrespective of the thread in which they appear. A second *conversational lens* considers whole threads where barriers are discussed. We note that our conversational lens is not a style of conversation analysis [10]. Rather, in our conversational lens approach the thread length is used to indicate the popularity of the barriers discussed within the context of the conversation as it evolved. The individual threads can be explored for a more grounded view of the way participants discussed and interacted around these popular barriers. In this case, the ten longest threads that contained barrier-related codes were identified. Ten was chosen as the cut off because after the tenth longest thread, the remaining thread lengths leveled off to the average value of around four posts per thread.

The two perspectives in this study enhance our understanding of barriers to physical activity in different ways. In the context analysis approach, we gain an appreciation for the magnitude or significance of a given barrier category. To complement and substantiate these findings we leverage the context of the barrier-related conversations in the longest threads—assuming length is related to popularity. The conversational approach also reveals how different thread themes influenced interactions on the *GetFit!* forum, including supportive reactions to particular barriers as well as which themes sustain interest over time.

Naturally occurring barriers

The complementary analyses of the *GetFit!* "Ask the Expert" forum identified personal barriers to physical activity similar to those identified in prior work. However, the naturally occurring barriers appear in different order as a function of each analytical lens. The differences in order are described in the following sections.

There were 1,426 quotations about barriers to physical activity that were coded and organized into three major categories:

(1) *Seeking Advice*: There were 394 (28%) quotations where posters sought advice about a particular barrier. Advice seeking was often posted as a question.

> "I feel like I have so much willpower Monday and Tuesday…Wednesday comes around and I can feel myself get a little more slack…Thursday even more…Friday Saturday Sunday…BLAH!!!!!!!!!

[6] BMI, which has been shown to strongly correlate with body fatness, is calculated based on an individual's height and weight. It is used to classify people as being underweight (BMI<18.5 kg/m^2), normal weight (18.5 to 24.9), overweight (25.0 to 29.9), or obese (BMI≥30.0).

Anyone got any tips to stay focused more than 2–3 days?" <Poster 1 or "P1">

(2) *Offering Advice*: In 638 quotations (45%), posters offered advice about a barrier. Advice giving was not always in response to a request, but was sometimes provided as a "for your information" type of statement.

"Make sure you're eating the right foods…Lay off sugar and simple carbs. Eat more vegetables and fruits. Try taking a multi vitamin everyday (the vitamin B in it will give you energy), and drink lots of water! Dehydration often causes fatigue, and hinders muscle production and performance. Also, make sure you're getting 7–8 h of sleep a night!" <P2>

(3) *Mention*: In 394 quotations (28%) posters simply mentioned a barrier without specifically asking for advice.

"I get the BLAH's to [sic] during the week. I actually will do great for a week and then horrible the next week and I am really trying to stay focused on my workouts and eating habits. I don't really know how to overcome the BLAHS … I just wanted to tell you that you are not alone." <P3>

The codes in these three categories were used in different ways for each analytical lens applied. In the content analysis, the quotations coded as "seeking advice" were analyzed in an effort to isolate the most common concerns of individuals trying to change physical activity routines. In the conversational analysis, all three types of barrier codes were considered in an effort to identify the most popular barrier-related discourse. The ten experts assigned to this forum contributed a total of 622 (4.7%) of the 13,262 posts with an average of 62.2 posts per expert (minimum 14, maximum 232). The average number of posts by a non-expert was 4.4 (minimum 1, maximum 949).

Results: Content analysis lens

This analysis focuses on quotations where advice was requested about a barrier. These quotations offer a rich source of insight into the natural struggle that posters experienced as they attempted to be physically active. Table 2 provides the frequency of mention for all of the physical activity-related barriers in our dataset where posters sought advice. The top four barriers, *injury or illness*, *lack of willpower*, *lack of time*, and *actual or anticipated body change* are discussed next; they account for 75% of the quotations in which posters *sought advice* about overcoming a barrier. For each, we provide excerpts from the posts that characterize the barrier and propose design considerations for technologies that seek to encourage and support physical activity.

Table 2 Barriers to physical activity from the forum posts where advice was requested, listed in order of frequency

Barrier	# of unique quotes
Illness or injury	188 (48%)
Lack of willpower	34 (9%)
Lack of time	33 (8%)
Actual or anticipated change in body	30 (8%)
Lack of resources	27 (7%)
Lack of energy	15 (4%)
Other barriers—generic	12 (3%)
Lack of progress	11 (3%)
Weather related barriers	10 (3%)
Psychological barriers	6 (2%)
Social Influence	6 (2%)
Too boring	5 (2%)
Change in physical environment	4 (1%)
Occupation	4 (1%)
Fear of injury	3 (1%)
Temporary change in environment	3 (1%)
Physical barriers	2 (0.5%)
Lack of enjoyment/fun	1 (0.25%)

Illness or injury

Illness or injury was the most frequently mentioned barrier comprising 188 (48%) unique quotations in which advice was sought. Discussions included asking and offering advice about how to start or continue physical activity routines when confronted with an illness or injury. A range of illnesses and injuries were discussed including broken bones, recovery from surgical procedures, as well as common illnesses such as colds and flu. Chronic problems were also reported and ranged from permanent back and knee injuries to diseases such as fibromyalgia and arthritis. However, the top complaint was *muscle pain* from exercise (e.g., sore muscles, shin splints), with *common illnesses* and *general knee pain* tied for second. Interestingly, this barrier is often not mentioned as a principle barrier in the literature, and when it is, minor illnesses and injuries such as sore muscles and common colds are not described.

1) Overdoing it

Muscle pain, sometimes caused by overdoing it, was a common barrier for which posters sought advice. The following quotation illustrates how a new workout may negatively influence an individual.

> "On Monday night I did the strength workout for month 1 down to the letter…when I stood and walked after doing the squats my hamstrings were very tight. When I woke up on Tuesday, I was incredibly sore, and it was almost painful to walk downhill or downstairs…and I could feel my hamstrings with every step. So, I skipped my plan cardio (walking/running) b/c I couldn't bear the thought of moving my legs that much. Today they are the same, possibly even worse. I hadn't worked out at all for months before I started [GetFit!]…is it normal to be this sore?" < P4>

P4 is frustrated by muscle soreness from a new workout regimen and wonders if she has done something wrong, uncertain if the soreness is "normal" or an injury, when perhaps it is simply a case of attempting a program that was too ambitious for her starting activity level or not knowing what to expect from a new strength-training routine. While muscle soreness related to a new workout regimen is a common and usually temporary condition, it can be discouraging and may be difficult to distinguish from a potentially serious injury, especially for someone new to exercise.

2) Getting back on track

Common illnesses, such as a cold or flu, can also interfere with routines. Getting back on track with physical activity during or after an illness was another common theme from our analysis. The following quotation illustrates an individual's experience with an illness that interrupted her progress in the *GetFit!* intervention.

> "I had made a lot of progress in the first 4 weeks and was really feeling great. However, this week, week five, both my baby and I were sick. The day I was sick I barely had the energy to take care of my baby's and my needs. On the two days my baby was sick I could not leave the house and spent much of my time holding her so I wasn't able to get my workouts in. Now it seems I've lost my momentum. I went out walking this morning for only 22 min. Any suggestions on how to get back into the swing of things. I don't want to fall backwards on my progress." <P5>

This quotation exposes the rich complexity of barriers and daily life. Both the poster and her baby were ill, illustrating how care-giving duties can also present a barrier. She is disappointed at the set back and concerned about losing the momentum she gained in the first month of the program. Everyone is eventually affected by a cold or flu, not only parents with young children. In fact, adults average two-to-four colds per year [37].

3) Design Considerations for Illness or Injury

When designing technology to encourage and support physical activity, it is important to address the barriers that may arise from *illness or injury*, even when the illnesses or injuries may seem minor. This was by far the most commonly discussed barrier on the forum, indicating that it can be a serious issue for people who are actively pursuing a healthy lifestyle change. Design considerations to help people overcome this type of barrier include: (1) Anticipate muscle pain from starting or adding to an exercise regimen and build in mechanisms to assist people in getting around the discomfort. This includes keeping people interested in exercise while taking it easy during recovery, and helping them understand what to expect and when they should rest or work through the soreness/pain. (2) Provide suggestions for safe alternative exercises. In many cases, people with illnesses or injuries wanted to be physically active, they just did not know what was appropriate to do given their current condition. (3) Expect temporary disengagements with physical activity due to illness or injury, and use persuasive techniques [38] to help people get back to focusing on their fitness.

Lack of willpower

Many people have trouble starting or restarting a physical activity routine, despite knowing that they should and even wanting to do so. Thirty-four quotations (9%) sought advice about how to find the willpower to become or continue to be physically active.

1) Can't seem to get started

The following quote is a representative example of someone who wants to but just can't seem to get started exercising.

> "I'm having a problem motivating myself to diet and exercise. I can wake up in the morning and tell myself "today is going to be a healthy day. I'm going to eat right and work out after classes." But by the time noon rolls around all I want to do is eat a bag of chips and call it a day. It's coming to the point where I'm almost trying to convince myself that 200 lbs. at 20 years of age is OK. I mean, after all, my friends say that I look good and my boyfriend isn't complaining and can't understand why I would want to diet. But I know I'm not on a healthy track. What can

I do? I have tried so many things and now I'm frustrated!" <P6>

P6 wants to live a healthy lifestyle, starting her day with good intentions. However, she lacks willpower to follow through as the day goes on, falling back to unhealthy habits. Further, her friends and boyfriend actually support her unhealthy lifestyle. Social support is another correlate of physical activity that has a consistently positive association, particularly in women [3]. Similar to findings by Christakis and Fowler that suggest that *"obesity appears to spread through social ties"* [39], this quotation highlights how social influences can exacerbate barriers to physical activity—in this case, a lack of willpower.

2) Falling off the wagon

A break from a particular behavior due to a lapse in willpower is sometimes called "falling off the wagon." Experiencing a lapse in willpower to continue physical activity by people who had already found the willpower to get started was a common concern on the forum as the following quotation reveals.

"I really fell off the wagon this past week and it's a really hard recovery process. I still worked out, but only half as much and I ate really bad and didn't record a darn thing (probably out of shame). I'm confused as to why, when I lost 4 lbs already. I was really tired this week, but that's no excuse. And I am having a hard exercise motivation time. What can I tell myself to help me stop with the slacking, because the things I'm thinking right now, like you've come so far, and how can you do this to yourself when you were doing so well and not having a hard time doing it? I'm scared that I'll backslide again or continue this pattern and I could really use some pearls of wisdom." <P7>

This quotation illustrates a conflict between attitude (the desire to lead a healthy life) and behavior (a decrease in activity). Occasional lapses are normal and do not need to lead to a "backslide," however, 50% of people who start a new exercise regimen stop it within the first three to six months [1]. P7 is concerned about losing the ground that she gained in prior weeks and is harshly criticizing herself in the process.

3) Design Considerations for Lack of Willpower

Willpower was often elusive for posters; sometimes they had it and other times, they did not. It can prevent people from getting started as well as disrupt healthy routines that are being established. We offer the following considerations for technology that encourages and supports physical activity. (1) There are critical decision making moments throughout the day when willpower may be low and where technology could have influence. (2) At times of low willpower, encourage at least some physical activity, even if it is not as comprehensive as the prescribed routine—some physical activity is usually healthier than no physical activity. (3) Recognize that social influence can affect willpower positively *and* negatively, potentially impacting the effectiveness of the technology. (4) As with the illness and injury barrier, expect disengagements with physical activity that will inevitably occur, and find ways to help the individual get back on track rather than develop a pattern of inactivity.

Lack of time

Lack of time is the most frequently reported barrier to physical activity across gender, race, culture and socioeconomic status in prior research [4–7]. In our data, it was only the third most common barrier for which GetFit! forum posters sought advice with 33 (8%) unique quotations. Common time constraints included work responsibilities (13 quotes), school commitments (10 quotes), caring for children (5 quotes) and housework (3 quotes). In many cases, physically active people do not have more time than those who are inactive, but rather find ways to make time for activity.

1) Making time

The following quotation is an example of how people get trapped in hectic lives and put off fitness goals instead of "making" the time to exercise.

"I signed up for [GetFit!] toward the end of the first week. That weekend I had planned to get the things I needed to do workouts but other things came up and I wasn't able to. Then in week two, I had no time due to long work hours, church commitments and my two-hour commute. I was getting home late, going to sleep even later and was very tired in the morning. I feel guilty about not being able to squeeze any workouts in. I plan to make up the missed time at the end but I still don't feel good about last week. I also noticed the my [sic] lack of time had me eating on the run and late in the evening. I've gotten a few DVD's to help with workouts in the house and I'm not sure if I'll get any outdoor workouts in this week. I'm also determined to do better with my eating this week. Is squeezing in workouts (as opposed to having sufficient time) going to help me? Is it o.k. for me to make up missed time at the end or should I approach the problem a different way? I have a few commitments that are going to take up a lot of my time until mid-{month}." <P8>

This litany of responsibilities and commitments reflects personal choices about how time is spent. In such situations, a 'perceived' time barrier must be overcome. P8 needs help fitting physical activity into her busy daily life.

The next quotation exemplifies the challenge imposed by a new daily schedule brought about by a change in stage of life.

> "I am an avid exerciser…always been involved with sports in school, and now being in college, I workout [sic] at a local gym regularly. Lately I have been so busy and overwhelmed with my classes and schedule that I have went [sic] a whole week, sometimes a week and a half w/out working out! since I am so used to working out at least 4 days a week, I feel like a complete blob! Some people may say that I'm being ridiculous but when your [sic] used to something and for some reason or the other circumstances change, you are bound to feel awkward. Is this huge break of no exercise going to effect [sic] my weight maintenance? Is there a place to start to get back on track?" <P9>

For P9, her new school schedule is competing with her established workout routine. What used to work for her no longer does, and she does not know what to do. Transition periods such as starting college, changing jobs, and moving homes require reconstructing workout schedules and habits. Stressful life events can create pressure to complete ordinary tasks, restricting time for physical activity [2].

2) Design Considerations for Lack of Time

We offer the following considerations for technologies that encourage and support physical activity to help people overcome a lack of time barrier. (1) People often need help finding opportunities for physical activity in what they perceive as being already over-packed daily schedules. Even 10-minute increments of activity can provide health benefits [40]. (2) Workout routines may need to be restructured following life transitions and during stressful events. Technology could be leveraged to detect these periods and offer support. (3) Account for fluxes in schedules, for example, unusually long work hours related to impending paper deadlines. In our work, we have found that helping people reflect on their recent physical activity can often help them reprioritize what is going on in their lives so that they find time to be active when they otherwise would not have [12, 13].

Actual or anticipated body change

Thirty unique quotations (8%) were characterized by concern over actual or anticipated changes in body shape or size brought on by physical activity (and in some cases, the resulting weight loss). The types of posts in this category have not been previously addressed by studies that report on barriers to physical activity. Half of the participants who sought advice about this barrier were concerned with increasing the size of their lower body (15 quotations). Of those 15 quotations, seven posters experienced an actual change in their thighs, calves and/or buttocks and eight were afraid of such changes.

1) Bulking up

The following quotation expresses a fear of an anticipated, undesirable change in body size due to physical activity—bulking up on the bottom.

> "I used to do the elliptical everyday but one of my friends said if I wanted to loose [sic] weight off my butt and thighs the most productive machine to use would be the stepper, but then one of my other friends said she bulked up from using the stepper… and believe me my butt needs no more bulking—even if it is muscle." <P10>

In this case, P10 is concerned about using the stair stepper because of a preexisting body image concern that she believes will be exacerbated. Her fears have been substantiated by a friend's experience with the equipment. Another poster experienced an actual, undesirable change in her muscle mass complaining that, *"some of my pants don't fit my legs anymore!"* <P11>.

For some, increased muscle mass from strength training can be an undesirable outcome—bulking up on top—of this healthy behavior.

> "My arms are very defined and toned. A few weeks ago, I once again increased the weights I use for my arms—except now I'm noticing my arms are looking bigger. I really don't want my arms bigger, I'm very happy with how they look right now. The problem is, if I drop down in the amount of wt. I'm lifting its no longer challenging for me. So, how can I maintain but yet still challenge myself?" <P12>

P12 has experienced an actual body change after trying a more challenging strength-training workout. Her desire to challenge herself physically is competing with her notion of her ideal body image. She is motivated and actively engaged in a healthy behavior that may be deterred by the need to project a particular image. Dworkin describes the dilemma in her sociological perspective on the ideologies of women's fitness: "Despite the message that women should 'just do it,' ideals of emphasized femininity lead many women in the weight room to 'just hold back'" [41, p. 346].

2) Losing weight in the wrong places

Targeting weight loss to specific areas of the body is not possible and thus can contribute to losing weight in the wrong places where the loss is not necessarily desired.

> "Since I've started working out I've gone from 175 lbs to 132 lbs which makes me extremely happy but I have also gone from a C cup to an A cup. Any suggestions on how to continue to lose weight without ending up with a compeltely [sic] flat chest?" <P13>

The poster is "extremely happy" with her 43 lbs weight loss which may greatly contribute to her health, but she is struggling with a competing concern to maintain a particular body image. It is not clear if the change in breast size will definitely deter future efforts to continue physical activity but it was enough of a concern that she asked for advice about how to continue to lose weight without losing more of her breasts.

3) Design Considerations for Actual or Anticipated Body Change

The concerns over body changes resulting from exercise were a very real fear or experience for many *GetFit!* forum posters. Its rank as the fourth most frequently occurring barrier in our analysis is important considering that it has not been identified in the related barriers literature. Though it may be difficult for technology to address the larger issue at hand—that is, cultural definitions of body image—we have identified some considerations for technical approaches to this barrier. (1) Help people focus on their fitness accomplishments and how physical activity is benefiting their long-term health. (2) Identify concerns about body change and encourage alternative exercises where appropriate. (3) Let people know what to expect in the way of likely body changes and debunk common myths (e.g., the "Fact or Fiction" video feature of Bedsider.org [42]). In addition, we note that the actual or anticipated body change barrier may impact the effectiveness of an otherwise well-designed technology to encourage and support physical activity.

Results: Conversational lens

In order to further characterize the barriers to physical activity that naturally evolved for the *GetFit!* participants, an additional perspective of the message board traffic was taken. A thread-based analysis was conducted that relied on the 10 longest threads from the "Ask the Expert" forum containing one or more barrier codes related to physical activity. Ten was set as the cutoff point because after the tenth longest thread, the thread lengths leveled off to the average length value of four posts per thread. The use of our codes was solely to identify possible full threads that focused on personal barriers to physical activity. The interaction in the discussion thread was analyzed as a whole in order to flesh out relevant barrier-related themes and social roles.

Re-emergence of top barriers

Table 3 presents the results of the analysis showing the barrier-related themes in the 10 longest threads. We found that four of the threads did not have a barrier-related theme despite having several codes for specific barriers. In these cases, the barrier was simply *mentioned* in the context of the discussion but did not represent the theme. The other six threads, however, could be classified as one of the top four barrier categories found in the content analysis described above—*lack of willpower*, *illness or injury*, and *actual or anticipated body change*—confirming the importance of these barriers for the *GetFit!* participants. Additional perspective about each barrier was attained through an examination of the issue within the context of the conversation.

1) Lack of willpower

In addition to being the second most frequently cited barrier in the content analysis, *lack of willpower* was one of the most popular discussion themes surfacing in three of the longest threads (739, 2626, and 2633). Thread 739 began with a request for help on how to handle weight gain in college when there are so many competing demands. Fourteen of the 18 respondents to this thread provided advice grounded in personal experience; five of the 18 explained that they were currently experiencing similar issues with willpower. The advice given was generally good and nearly all interlaced dietary recommendations with suggestions for getting more physical activity. Suggestions to become motivated to exercise in a college environment centered on creating accountability and included registering for a course requiring physical activity (e.g., weight lifting, dance, etc.); working out in the morning before class or make going to the gym a "class time" (in other words, schedule your workout); and joining a club or intramural team.

Thread 2626 had a similar tone, beginning with a plea from an 18-year-old college student for help finding ways to exercise while in college. This conversation, however, was focused on the impact of depression on the *lack of willpower* to exercise.

> "In high school I was heavier but my senior year I began working out and lost about 60 lb. I believe I have [re-gained] 20 lb, but I have not weighed myself. I can see the muscle that I worked so hard for disappearing and it

Table 3 Most popular discussion board threads in descending order by number of posts

Barrier theme by thread	# Posts	Unique user IDs	# Days	Subject of starting post
Thread 1432—*Mentioned*: Lack of Willpower	23	23	3	Everyone's goals… 21 of 23 posters shared weight loss goals.
Thread 739—*Advice sought:* Lack of Willpower	21	19	3	How to lose when in college. 14 posters offered advice on losing weight in college; 5 were experiencing same problem.
Thread 2592—*Advice sought*: Illness or Injury	21	10	19	Fingers feel swollen after 45+ min. walking 2 posters shared same problem. Expert posted recommendations. 8 posts re: low calorie diets.
Thread 1886—*Mentioned*: Lack of Willpower	18	14	4	Your Attitude. 7 posters shared exercise motivation tips.
Thread 2412—*Mentioned:* Illness or Injury	18	15	1	What is everyone's schedule like? All posters shared workout schedule.
Thread 2316—*Advice sought:* Actual or Anticipated Body Change	17	9	2	Slight Belly Bulge. 6 posters ready to "throw in the towel" due to frustration with this unchanging body concern.
Thread 2626—*Advice sought:* Lack of Willpower	15	8	4	Depressed college student. 7 shared re: weight gain in college and how to overcome "I'll start tomorrow attitude."
Thread 1712—*Advice sought*: Illness or Injury	14	8	14	Hurting knees. 5 posters shared experience with same issue.
Thread 2633—*Advice sought*: Lack of Willpower	14	13	2	Fun ways to exercise? All shared fun ways to exercise as motivation.
Thread 2848—*Mentioned*: Lack of Energy	13	5	6	Heart rates and weight loss. Discussion about heart rate and fat burning.

> makes me more depressed … and then I eat. I have the 'I'll start tomorrow' attitude, but tomorrow never comes…how can I be motivated to do something when I am so sad? Right now, I am not involved in anything and I don't know how to get out and move… I am always making excuses to put it off…if anyone can help me I would really appreciate it." <P14>

Six of the seven respondents in this thread had similar college experiences and shared the ways that they overcame obstacles to physical activity. The majority of posts in this thread revolved around ways to tackle depression as a means to improve health overall and specifically improving motivation to exercise.

In thread 2633, the discussion began with a request for ideas about *fun* ways to exercise as a means to both motivate and sustain physical activity. This thread generated a lot of excitement with 14 posts from 13 different people and was quite playful, with suggestions that caused one to remember times in childhood when exercise was simply play. There were suggestions to use trampolines, hula hoops, skipping rope to music, dance-dance-revolution, roller-skating, and getting a dog. This thread was full of optimism as people shared the ways in which they overcame this barrier to physical activity.

2) Additional Design Considerations for Lack of Willpower

Additional design considerations for this barrier include the importance of establishing (1) *accountability* for routine exercise. While this was proposed as a helpful tactic in college, through the scheduling of exercise classes—it can apply to any individual beginning an exercise routine. It may therefore be beneficial to build technology in a way that provides the scaffolding for accountability—either with another person or the individual herself. (2) *Underlying health issues* such as depression should also be considered when designing to enhance willpower, supporting an individual's self-reflection and encouraging group support. (3) *Perceiving exercise as fun* also influences willpower. There have been many research projects in this domain that have leveraged fun and games to help motivate and sustain physical activity [12, 14, 16, 17, 19].

3) Illness or Injury

Two other threads (2592 and 1712) revolved around the barrier to physical activity caused by *illness or injury.* Thread 2592 began with a poster seeking advice about the cause of "swollen fingers" brought on by physical activity. Three of the 9 respondents in this thread also reported having the same problem and they shared their method of avoiding swollen fingers. There were two additional posts that proposed potential causes for the swelling and offered recommendations to prevent the problem—one from a *GetFit!* expert. The balance of the conversation in this thread dealt with nutrition, another example of how closely one's diet and exercise is intertwined. In some cases, the dietary recommendations

were inappropriate including suggestions that a very low calorie diet (<1,000 calories) was necessary for weight loss and that electrolyte replacement was *required* after 45 min of exercise without regard for intensity. The expert did not re-engage in the thread to correct the misinformation. This is an example of the inconsistency of expert participation on the "Ask the Expert" forum.

In thread 1712, several of the posters raised a concern that knee pain was limiting their ability to exercise. The theme of this thread was easy to identify as it was entirely focused on ways to deal with general knee pain. Six of the eight posters who participated in this threaded conversation experienced similar pain and were seeking advice for alternative exercises. There were no recognized *GetFit!* expert responses to the advice sought in this thread.

The threads in the *illness or injury* theme spanned the longest period of time, between two and three weeks. No other threads of the ten longest that we identified lasted more than six days. The smaller number of unique user IDs carrying these conversations also demonstrates that there was a connection made between at least a few of the posters, enough to fuel the conversation for a two to three week period of time. This is an example of the supportive interchange found in the *illness and injury* threads.

> "Hey <P15>, you truly think things through and don't stay down! ☺ …Thanks so much for sharing your story. You wouldn't believe how it motivates me to keep going. PS: tomorrow is my weigh and measure day at my circuit training club, hoping for some progress too although I'm trying not to attach a specific number to it." <P16>
>
> "<P16>, thanks for the nice words. Glad I can be motivational for you. How did your circuit training weight-in/measurement go?" <P15>

While not specifically dealing with the injury that began their conversation, these two posters forged a relationship through a common bond—one of the recognized benefits of health-related forums [35, 36].

4) Additional Design Considerations for Illness or Injury

Illness or injury remains a top concern when looking at the discussions on the *GetFit!* forum through the "conversational lens" approach to the data and additional design considerations evolved from the analysis. (1) Regular expert contribution is expected in an "Ask the Expert" forum and mechanisms should be in place to ensure participation. Our analysis showed the ten experts assigned to this forum contributed an average of 62 posts (4.7% of traffic). This amount of interaction was not perceived as adequate by many of the *GetFit!* posters as many complained about the absence of expert commentary in discussion threads we reviewed, posting comments such as *"Where are the experts?"* (2) Strive to create a personal connection with the user to promote continued engagement with the technology. Sharing a common *illness or injury* seemed to have created a level of bonding and intimacy not found in the other threads we analyzed. The conversations in this category lasted a significantly longer period of time and involved multiple messages between posters. The messages were personal and encouraging which kept the participants engaged. Thread 2412 did not have a barrier-focused theme but 15 posters included their exercise routines as part of that thread and one discussed how a shoulder injury had interrupted planned strength training. This analysis has reinforced the design considerations previously described such as providing suggestions for safe alternative exercise and leveraging persuasive techniques to resume physical activity after experiencing an *illness or injury.*

5) Actual or anticipated body change

The theme in thread 2316 revolved around an *actual or anticipated body change*. The initiating poster complains of having a hard time getting rid of a "slight belly bulge." The subsequent conversation reflected an obsessive quality regarding the fear of having a small bulge in the midsection, regardless of the amount of dieting and exercise incorporated into one's routine. This thread produced a flurry of suggestions—"ab buster" workouts, magazines, diets, etc.—that would help solve the problem. When reading the thread as a whole, it was clear that for many, the focus on this target area impacted motivation to continue a fitness routine. The fear of having a "slight belly bulge" had become more important than attaining the general health benefits of exercise and in effect had reduced the drive for exercising in any capacity.

6) Additional Design Considerations for Actual or Anticipated Body Change

This analysis supports the findings related to the *actual or anticipated body change* barrier from the content analysis. In this case, the barrier is brought about by an unrealistic expectation for "spot reducing" from particular exercises or diets. Whether the concern of a "slight belly bulge" is warranted is not the issue because the concern is real for these individuals and it is interfering with the desire to continue healthy eating and exercise habits. In this regard, the design considerations for this barrier should include (1) setting realistic expectations from exercise and (2) re-focus the individual on other positive health outcomes.

Social roles in barrier related threads

When studying conversations that take place in online forums, we see that people take on different types of social roles that parallel face-to-face conversations. Roles are important in groups because they circumscribe expectations about how someone will behave. The interaction in the barrier-related threads is similar to the types of interactions that we see in other online forums, news groups, and bulletin boards.

Golder and Donath define a taxonomy of social roles in online forums [43] by synthesizing findings from prior work and their own studies. Their schema includes the roles of *celebrity*, *newbie*, *lurker*, *flamer*, *troll* and *ranter*. In research more closely aligned with our study, Maloney-Krichmar and Preece looked at the emergent roles in an online health forum created for people with knee injuries [44]. They applied a group membership schema developed by Benne and Sheats [45] to understand the importance of roles in online group interaction. Benne and Sheats' schema describes 27 roles that are part of 3 broad categories—*task*, *socio-emotional*, and *individualistic*. Task oriented roles are specific to completion of the group's task.

Some of these roles include individuals who *give* or *seek information* (data and facts) about the task or group; *give* or *seek opinions* (belief or values) about a group issue; or act as an *orienter* (refocuses the conversation). Socio-emotional roles focus on the ways in which one relates to others in the group and include functions such as *encourager*, *standard setter*, and *follower*. Individualistic roles highlight individual behaviors in the context of the group and include *aggressor*, *dominator*, and *recognition seeker*.

We build on Maloney-Krichmar and Preece by using their schema as a part of our conversational lens to better understand the roles that emerged on the *GetFit!* forum. We did not expect to see all of the roles in our analysis because we are focusing on one specific forum. However, we did find 11 of the 27 roles in our conversation-oriented analysis. Similar to Maloney-Krichmar and Preece, we found that most of the posts fit into the category of task roles. Thirty-seven percent of the posts fell into the category of *information giver* and 28% fulfilled the role of *opinion giver*. This finding is sensible given that the purpose of the forum is to get expert advice about challenges related to healthy lifestyles. In addition to finding prior known roles, we also identified roles that are specializations of the schema. Our analysis identified: the "*me too*" information seeker; the *acceptance coach*; and the *success storyteller*.

1) "Me too" information seeker

In the excerpt from thread 2316 shown in Fig. 1, <P17> is describing her frustration with a slight belly bulge despite being within her ideal body weight range. This initial post triggered a long thread of what we defined as "*me too*" posts. The "*me too*" role is a specialization of the *information seeking* role where individuals are specifically joining in the conversation in search of a way to address a specific barrier. The "*me too*" posts do not have an empathetic tone but rather seem to be posted as a means to achieve sufficient critical mass to generate a response from the designated forum expert. <P18>'s reply characterizes the "*me too*" type of post as she discusses her own similar problem which in effect strengthens the importance of <P17>'s request for help. Longer threads seem to have more "*me too*" posts which may be an indicator that the thread topics were the ones that were very important or interesting to an array of the forum posters.

2) Acceptance coach

The other role revealed in thread 2316 is the *acceptance coach*, a specialization of the *encourager* role. The *acceptance coach* is a person who encourages personal acceptance when the quest for health leads to the drive for an idealistic physical state (e.g., the lack of a belly bulge, which interferes with appreciation of the general health benefits of physical activity). This role is that small "voice of reason" person who will point out when a friend is going too far with self-criticism. For example, <P18> feels like she *"should just throw in the towel,"* giving up on exercise and all of its benefits simply because the slight belly bulge will not go away. <P20> discusses her *"dreaded little bulge"* instead of taking pride in a healthy level of physical activity and forgiving herself for weekend breaks. <P19> offers a reality check for her online friends pointing out how a lack of progress in the battle of the belly bulge should not detract from the overall health benefits of exercise. The *acceptance coach* plays an important role for those attempting to change lifestyle habits by providing positive coaching about ways to handle barriers—in this scenario, reframing an unrealistic anticipated body change.

3) Success storyteller

The excerpt from thread 1432 shown in Fig. 1 contains a portion of the longest barrier-related thread, beginning with <P21>'s request to *"hear everyone's goals"* for participating in *GetFit!* This request resulted in a long series of posts that contained statements of personal goals; but more importantly they acted as an outlet for the sharing of personal success stories. The role of *success storyteller*, a specialization of *opinion giver*, provides motivation to overcome a lack of willpower to exercise. This form of sharing appears to motivate the reader through modeling, for example <P24> indicates that she is impressed by the achievements of the others and this is a *"good motivator"*

Excerpt from Thread 2316 – *Slight belly bulge*

From: <P17>
Post number: 1
Hey guys, I have been doing <GetFit!> for 2-3 weeks...I want to get rid of the slight belly bulge and the love handles. I'm not sure why I lost the 4 lbs in the first week (I'm sure it was just water) but now I am stuck. What I can do to really make a difference and get rid of the extra weight I am carrying in my trunk area. Please help!! Any tips would be welcome!

From: <P18>
Post number: 2
Oh goodness! I also have the same problem and weigh the same...Are we just stuck?? This is soo depressing and frustrating seeing that if anyone ate or worked out like myself (at any age) they'd be destined to lose but with all the workouts, weight trainings etc nothing is budging...I sometimes think I should just throw in the towel but where would I be then?? Any ideas anyone!!

...[posts elided]...

From: <P19>
Post number: 10
Ya know, sometimes I wonder if we all just pick ourselves to death when it comes to "slight belly bulge" I'm in the same boat with all of you....I also have thought about giving up, but why? Just because a little "flaw' like belly bulge is getting me down?! NO WAY! Since I've been exercising consistently, eating cleaner, toning my body...I feel AWESOME! My mood is better, outlook more positive, just generally happier! So I say SCREW the belly fat!! ...I'm going to keep up my healthy habits and if it magically disappears great, if not...I'm O.K.! Who's with me?!

...[posts elided]...

From: <P20>
Post number: 13
Man do I feel better knowing I am not the only one. I do hard core spin 4 to 5 times a week. Body pump (aerobic type weights) 2 to 3 times and I was doing step at least four times a week...On the weekends I tend to go astray a little...Hence I still have the dreaded little bulge... HEEELLLLLLPPPPPP

Excerpt from Thread 1482 – *Everyone's goals*

From: <P21>
Post number: 1
Hey everyone I know this an "ask the expert" forum, but I often check this forum daily, if not several times a day. Everyone has given me great advice and has kept me motivated...so I thought it would be neat to hear everyone's goals...

...[posts elided]...

From: <P22>
Post number: 12
Hi! My goals are to lose about 5 more pounds. I've already lost 6 pounds in the past 3 months. I am 5'2 and 126. I'm already happy with the weight I lost but I would like to lose just a few more pounds. But most importantly I want to just tone up...I'm approaching these goals with the way I already lost the 6 pounds...I do have my days where I splurge...(I think everyone needs one of these days) ... No matter what happens I'm just happy with myself and that I'm doing something good for myself (being a healthy person).

From: <P23>
Post number: 13
HI all...My goal is to lose 40 pounds. I am in the second week of <GetFit!>and I feel great! I am so much more tolerable to be around at work. Wow! What a change in my affect now that I have been working out and it has only been 2 weeks! This is a great forum! Thanks for all of the support! Good luck to everyone!!!!!!!!!

...[posts elided]...

From: <P24>
Post number: 18
Let me just start by saying I think everyone is doing a great job! This is really going to be a good motivator for me...I have just started the challenge this week, starting with exercise. I'm back at the gym with a goal to lose about 20-25 lbs...I'm not trying to do too much too soon, adding exercise this week and next week will start with food changes. I know myself and if I try to change everything at once I will be at <fast food restaurant> by the end of the week! Good luck to everyone and keep up the good work!

Fig. 1 Excerpts from select threads that demonstrate social roles

for her. Similarly, <P23> seems motivated by the support she feels after reading through the posts. The stories shared not only motivate the reader through modeling behavior but also motivate the storyteller as they recant their recent or past achievements, building self-efficacy. In the response from <P22>, it is clear that sharing goal-related information is secondary to sharing information that relates to her current progress. <P22> acts as her own acceptance coach when she says *"No matter what happens i'm just happy with myself and that i'm doing something*

good for myself (being a healthy person)"—a statement that may have motivational value from the very act of writing it. This form of expression was popular—nearly one third of the posts in the longest threads were classified as success story-telling.

Discussion

The conversations that took place inside this virtual community illustrate the struggle that people encounter when trying to start or continue an exercise routine. The richness of the quotations convey the emotions—frustration, despair, desperation, amusement—that posters experienced as they encountered barriers, offering insight into how technology may be suited to support physical activity. Discretionary-use technologies that are intended to encourage and support physical activity need to be used over long periods of time to be effective. Therefore it is important to understand the barriers that people are likely to face in order to help them overcome those barriers and lead healthy lives.

There are two primary contributions from this work. First, from the results of our qualitative analysis, we have produced a set of design considerations for those developing technologies to encourage and support physical activity. Second, the method that we used to investigate barriers that naturally occurred for forum participants has offered an alternative perspective to the problems faced as people attempt to make healthy lifestyle changes. The duel focus from both the "content analysis lens" and "conversational lens" substantiate our findings as they rendered the same top barriers based on frequency of mention and popularity. Although the barriers to physical activity identified in this work are complementary to the prior work presented in the literature, our analysis has shed light on two categories that have not been previously reported as principle barriers to physical activity.

Under-represented barriers

Illness and injury was by far the most common barrier for which people sought advice on the *GetFit!* forum, with muscle pain, common illnesses, and general knee pain being the top complaints. This barrier was also the central theme in two of the longest threads as measured by the quantity of posts and duration of time. Although the survey instruments used in most of the studies from the barriers literature included questions posing ill health and injury as potential barriers, the impact of those barriers when compared with our findings is under-represented.

Injury has been documented as the number one cause for *relapsing* from vigorous activity [2] (though not from moderate activity, as we observed on the forum). Similarly in Eyler et al.'s qualitative study of minority women 40 years of age or older, participants cited health concerns due to fatigue, injury, and specific conditions such as arthritis as significant barriers [22]. While Eyler et al.'s finding may differ from the findings of the survey-based studies due to the specific population of the participants, it may also be associated with the qualitative data collection method employed (i.e., focus groups). Finally, Finch, Owen, and Price found injury or disability to be among the barriers to physical activity in their survey study of 2,298 people living in Australia (it was the top barrier for subjects aged 60–75) [24]. The researchers suggest that this barrier be further explored, and our findings represent such an exploration, illustrating how seemingly minor illnesses and injuries can represent important barriers to older as well as younger adults.

Anticipated or actual body change does not appear to be represented in the barriers literature, although some research suggests that an individual's self-presentation concerns may impact her willingness to exercise [46]. In an overview of factors affecting levels of physical activity, Seefeldt et al. note that "self-presentation is a neglected but important determinant in the exercise behavior of adults" [47]. In our findings, this barrier had nearly the same number of quotations as lack of time—the number one barrier reported in most of the prior work we reviewed. In addition, this barrier seems to be a popular concern as it generated one of the longest conversation threads pertaining to barriers—one of only three barriers represented as a thread theme in our analysis. Thus, our approach to understanding this population has uncovered two important issues that may have gone un- or at least under-considered in a general review of the barriers literature.

Other factors in a fitness forum

While our primary results are around the nature of barriers and how those barriers are expressed either in isolation or through conversation, several other issues were apparent from our analysis. One particularly striking observation from both perspectives of our analysis was the lack of posts from the experts assigned to engage in the forum. In fact, there were no posts from an expert in any of the longest barrier-related threads. There were even instances where posters explicitly asked, *"Where is the expert?"* It is understandable that people using a forum for expert advice would become frustrated by a lack of contributions from these designated individuals. Although the posters seemed to come up with solutions as a community, it would be preferable to have expert interaction when people are seeking help to deal with barriers. We have no knowledge of what tools the experts were provided to decide what

conversations they would join, but our analysis has revealed that the designated *GetFit!* experts did not participate in some relevant threads.

Few would argue that experiencing an illness or injury is a *real barrier* to physical activity. However, lack of willpower and anticipated or actual body change might be considered *excuses* for avoiding exercise. The rich conversations that unfolded in the threads expose the subtleties of what posters were actually experiencing. These psychological or emotional barriers are just as real to those who experience them. Understanding when someone is expressing a barrier, either in a forum or through other behaviors, could be used to intervene at opportune times with support that may help.

Finally, the influence of others was evident in our analysis. In 2007, Christakis and Fowler presented the results of a detailed analysis of a large social network of 12,067 people who had been closely followed as part of the Framingham Heart study for 32 years, from 1971 to 2003 [39]. They found that the risk for obesity increased when there were members of the person's social network who were obese. If a friend became obese the individual's chance of becoming obese rose to 57% and if a sibling or spouse became obese the risk increased to roughly 40% [39]. Clearly, the value of a social network is a double-edged sword and virtual social networks may be no different. We found evidence in our analysis where not only were members of an individual's social network not supporting his/her efforts to be healthy, but actually discouraging the healthy behavior.

In our thread analysis we found, as have others [43, 44] the similarity between online social roles and those in face-to-face interactions. Our findings revealed several specialized roles that are important in this type of forum. An intervention or technology should account for the motivational value of the *success storyteller*; the value of the *acceptance coach* for certain barriers; and the needs of "*me too*" information seekers.

Study limitations

The message board posters chose to participate in the *GetFit!* intervention as well as on the *GetFit!* forum. This population is a group of self-selected individuals who are unlikely to be representative of the general population. Their needs may be different from individuals who do not have Internet access or chose not to participate in online forums. However, they represent people who were actively attempting to change their behavior to live a healthier lifestyle and were seeking advice from experts and others who were going through a similar experience.

We also note that our analysis focuses specifically on barriers. People naturally talk about many topics on open-ended forums and the *GetFit!* forum was no exception. As mentioned earlier, we coded for a wide range of topics related to physical activity and nutrition. Even though physical activity-related barriers accounted for 394 of the total number of unique items coded, the fact that two of the top four barriers have little representation in the literature makes our focus on barriers novel and valuable.

We note that our findings may be different from the prior literature that used survey-based methods because they come from a fundamentally different perspective—the free-form opinions of people who were in the midst of participating in a healthy lifestyle intervention. As such, our method did not attempt to elicit all posters' experiences with all possible barriers. Instead, our analysis focused on the barriers about which posters chose to solicit advice from the online community as well as barriers that generated the most interest. The approach that we employed captured the naturally occurring barriers about which people chose to seek advice online as they attempted to follow a healthy lifestyle intervention, and as such, complements the studies from the barriers-related literature.

Design considerations

The opportunities for design that emerged from our analysis are based on the commonly reported barriers on the *GetFit!* forum. The rationale for constructing design considerations that address barriers is grounded in literature that suggests that helping people overcome perceived barriers is one of the most important elements of effectively encouraging physical activity [3]. It was not our intent to identify technological solutions for each barrier as much as to characterize the prevalent barriers in an effort to inform future work. Some of our findings are not immediately implementable design suggestions but rather offer insight into why otherwise good designs may fail to motivate the target behavior.

We propose six general categories of opportunities for technology to help people overcome or mitigate the top barriers identified in our study.

(1) Set realistic expectations, not just goals

People need to know what to expect from the activity or they may abandon their workout routines for fear of injury, unrealistic expectations, or an undesirable body change. For example, *injury* barriers may be reduced if people know what type of soreness or discomfort is normal versus what should be cause for concern. When should they take a break from working out, try a different activity, or work through the discomfort? What can they do to help their recovery? When is it time to see a doctor? *Actual or anticipated body change* barriers may be reduced by being clear about the benefits that the physical activity offers and what types of changes in their bodies

they should expect from performing the physical activity. Underlying health issues, such as depression, must also be considered when setting expectations. *Willpower* to start or maintain physical activity can be affected by certain medical conditions and goals must be set appropriately to prevent discouragement.

(2) Provide alternatives

Technology provides a unique ability to immediately offer a vast array of alternative exercises, including live expert opinions. *Illness & injury* barriers may be reduced if safe and effective exercise alternatives are offered. Providing disease-specific alternative exercise recommendations may motivate an individual incapacitated with a debilitating disease. Suggestions for alternative workout regimens may lower the obstacles presented by life transitions, helping individuals deal with *lack of willpower* or a perceived *lack of time*. Creating fun alternative exercise suggestions may also impact motivation to sustain physical activity, lowering the *lack of willpower* barrier. Offering substitute cardio and strength training routines may mitigate fears of undesirable *body changes*.

(3) Encourage a little now, for a lot later

People are unlikely to consistently perform the recommended physical activity routine all of the time due to a variety of reasons, for example, illness, injury, lack of willpower, time, an actual or anticipated body change, a temporary change in priorities, stress, and so on. Technology can be used to identify these lapses as well as encourage people to continue to do at least some form of physical activity. For example, in our work with UbiFit, we provided people with the option to set a primary as well as a secondary goal [48]. The secondary goal is intended to help people stay active during difficult times, such as a work deadline or mild illness. Of course, the technology should also encourage people to get back on track as soon as is reasonable. The goal should be to prevent a pattern of low or inactivity from developing [49].

(4) Accommodate lapses in routine

It will not always be possible or even appropriate to encourage people to do at least some form of activity during lapses; therefore the technology should be designed to keep people thinking about physical activity goals even during periods of inactivity. Providing feedback that is not guilt-producing but rather an encouraging reminder of past accomplishments or how minor lapses can have minor impact in the big picture may help people overcome setbacks resulting from illness, injury, stressful life events or periods of low motivation. Additionally, it might be helpful to include alternative incentives for being physically active, perhaps by making physical activity entertaining, such as Fitster's "Race Across Michigan" [50] or the approach being used by Nintendo's Wii Fit. However, care should be taken when using non-health related incentives to motivate health, and as with opportunity #3 above, the technology should encourage people to get back on track as soon as is reasonable. Technology can be used to reduce the burden of re-entry into routine exercise by breaking down the larger goal into smaller steps and offering cues for problem solving—for example, bolstering self-efficacy and self-control [51]. Again, the goal is to prevent a pattern of low or inactivity from developing [49], not to make people feel guilty about taking a reasonable break.

(5) Provide expert feedback

One particularly striking observation from both perspectives of our analysis was the lack of posts from the experts assigned to engage in the forum. In fact, we only found one post from an expert in the longest barrier-related threads. The expert post came in response to a request for advice about an *illness or injury* barrier; however, in this same thread, there was an extensive discussion about very-low calorie diets that received no attention from the experts. There were instances in several other discussion threads where posters explicitly asked, "Where is the expert?" It is understandable that people using a forum about expert advice would become frustrated by a lack of contributions from these designated individuals. Although the posters seemed to come up with solutions as a community, the advice of experts would have been useful for posters who were seeking help to deal with barriers. There was no information about what tools the experts were provided to facilitate intervention, but this analysis has revealed that the designated *GetFit!* experts did not participate in some relevant threads. Thus, one design implication would be to offer some mechanism for experts to identify and focus their efforts on prominent threads or perhaps focus on threads where bad advice was being offered.

(6) Create a personal connection

Research has shown that health-based discussion forums can promote a connectedness and support that is helpful for people suffering with chronic disease and injuries [35, 36]. This was reflected in our findings as conversations where personal connections were made lasted the longest time period, maintaining posters' interest. Continued engagement is a design issue that may be addressed by finding ways to engage people at a personal level. Behavioral theory supports this design consideration as self-efficacy can be bolstered by using a tailored approach in delivering personalized health messages for more effective interventions [51].

Conclusion

In this article, we have explored the most prevalent barriers to physical activity that emerged from the online forum during a three-month healthy lifestyle intervention. The conversations and self-revelation that took place in the virtual community of the *GetFit!* forum has illustrated the struggle that people encounter in their efforts to live a healthy lifestyle. Helping individuals overcome or mitigate barriers has emerged as one of the most consistent and strong correlates of physical activity behavior [3], and our findings have outlined several opportunities where technologies that are intended to encourage and support physical activity can help.

This research has also uncovered some of the nuances of and interplay between the barriers, and can be used to help designers and evaluators understand potential issues that may arise during long-term use of their technology, which may adversely impact the effectiveness of an otherwise well-designed technology. We identified two significant barriers that are not reported as principle barriers in prior research. We have also unpacked important subtleties in how people experience barriers based on an analysis of the conversations that occurred naturally as people discussed what was important to them.

The complementary method of using both a content analysis and conversational thread-based analysis gives designers a richer understanding of barriers and that those barriers are more than just excuses for avoiding exercise. Discretionary-use technologies that are intended to encourage and support physical activity need to be used over long periods of time to be effective. Therefore it is important to understand the barriers that people are likely to face in order to help them overcome those barriers and lead healthy lives.

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