Toward Technologies that Support Family Reflections on Health

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ABSTRACT
Previous research has explored how technology can motivate healthy living in social groups such as friends and coworkers. However, little research has focused on the implications of collecting, sharing, and reflecting upon health information within families. To explore this domain, we conducted a study that consisted of a week-long journaling activity followed by semi-structured interviews and formative design activities with 15 families (66 people). We identified four areas in which these practices are unique in a family context. Based on these findings we propose preliminary considerations for technologies that effectively support family reflections on health data.

Categories and Subject Descriptors
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous. J.3. Life and medical sciences: Health.

General Terms
Design, Human Factors.

Keywords
Family, health, nutrition, exercise, lifestyle, information sharing.

1. INTRODUCTION
Recent advances in technology allow us to collect, present, and share health data in new and exciting ways [2,5,15]. Wearable monitoring devices allow us to continuously measure physiological or behavioral data as we go about our everyday activities. Innovative processing techniques allow us to make sense of that data, and online personal health record (PHR) systems (e.g. [9,16,18]) provide the basic infrastructure for easily and flexibly storing, accessing, aggregating, and sharing health information.

Researchers in Computer Supported Cooperative Work (CSCW) and related fields have leveraged this increased availability of personal health data to explore how technology can be used to encourage healthy lifestyles in social contexts. While much of this work has focused on groups of friends [4,23] or extended networks (e.g. for elder care) [6,17], there has been much less effort devoted to understanding how technology can be used to support health discussions within the core family unit (i.e. parents and children). We believe that understanding this unit is important because of the demonstrated value of family-based early education about healthy living [22], and because the frequency and nature of intra-family interactions provide unique opportunities for introspection and behavior assessment.

In our work, we specifically examine families' interests in and attitudes toward collecting and sharing behavioral and physiological health information within the family. In addition, we explore the implications of designing technologies that facilitate these activities to support family awareness and discussions about health. In this paper, we describe our formative study, which consisted of a week-long journaling activity followed by semi-structured interviews and design activities with 15 families (66 people). We contribute to social health research within CSCW and related disciplines by discussing our results, highlighting four areas in which reflection on health information is unique in the family context:

1) Families' overlapping routines afford particular opportunities for health data collection and reflection.
2) When sharing health information, families work to balance the competing values of openness, caring and modeling with the value of protection.
3) Comparisons and competition based upon health information require particular sensitivity in the context of the family.
4) Health information affords non-health related benefits for families.

In this paper, we elaborate on and provide support for these themes, and discuss their implications for designing collaborative

Figure 1. Design activity conducted in a family interview.

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technologies that support discussions between parents and children about increasingly accessible health information.

2. RELATED WORK

In this section we motivate our work by presenting relevant research on the relationship between parental behavior and child health activities, technological support for tracking health behavior, social health systems, and the implications of technological health monitoring.

2.1 The Role of Family in Child Health

Numerous health researchers have acknowledged the importance of focusing on the family unit, particularly when trying to improve the health of children. For example, research has shown that children in families who eat meals together are more likely to eat fruits and vegetables, consume less fried foods and soft drinks, and have a greater intake of important nutrients [8,19]. Furthermore, research suggests that parents who eat healthfully and exercise are more likely to have children who engage in these healthy behaviors [10,21,25]. These results show the important role that parents play in terms of modeling behavior.

In addition to influencing children through their own behaviors, parents play a direct role in shaping child behavior through their health-related attitudes and the foods that they serve [20]. Further research suggests that social factors including praising healthy behaviors, increasing interaction between family members, and providing emotional support within the family contribute to healthier eating and exercise practices in children [21,22,24]. The demonstrated importance of modeling, praise, and family interaction provide strong motivation for our research on how sharing information about health behaviors amongst family members might facilitate discussions about how to live healthier lifestyles.

2.2 Technological Support for Tracking Health Behavior

Our work is also motivated by advances in sensing technologies, which allow for increased monitoring of behavioral and physiological health information. Such systems provide a basis through which people can reflect on their health-related choices and identify opportunities for improvement. For example, one commercially available sensing device is the BodyBugg (Apex Fitness Inc.), an armband that incorporates a variety of sensors to estimate the user's caloric expenditure. In addition, a number of researchers have explored other ways of tracking or inferring physical activity. While some researchers have leveraged pedometers to track step counts [4,23], others have used custom-built sensing devices together with cell phone software to infer user activity (e.g. walking versus using an elliptical trainer) and to communicate that back to the user for review [5].

While much research on personal health-related sensing has focused on physical activity, work has also been done to detect eating behaviors as well. For example, Chang et al. [3] developed a dining room table that senses the movement of food from the serving container to the individual consuming it. The combination of weight and RFID sensors allows the system to track the type and quantity of food consumed. Other researchers have developed sensor-augmented kitchen knives and cutting boards [13] and on-body sensors [1] for inferring what people are cooking and eating.

All of these systems show the trend toward automatic detection and collection of data about health-related behaviors. We argue that this trend points to the potential of designing technologies that help families leverage this information, given the role that family plays in healthy living. Furthermore, as researchers begin to explore the design space, care must be taken to examine families' attitudes towards such technological support, and the ways in which health information collection is distinctive in the family context.

2.3 Characteristics of Social Health Systems

While there has been little focus on technological support for family management of and reflection upon health information, the previously described advances in sensor-driven activity tracking have facilitated a number of health applications for other social groups. These systems have typically focused on sharing information about one's physical activity within social groups such as friends and coworkers. These applications often have two characteristics in common: they support competition, and they enable electronic communication about shared health information.

In such social health systems, competition is often an explicit design goal or a consequence of how the system is used. In the *Houston* system [4], individuals use their mobile phones to share their step counts with friends. In a field study of this system, all participants but one were positively motivated by the social influence that Houston supported, and particularly by the desire to "beat" their friends. Similarly, the *Shakra* mobile phone system [15] supports people in sharing and comparing their activity levels with friends and coworkers. In a field study of this system the authors found that users enjoyed competing amongst one another, even when their activity level was much lower than others. With the *Fish'n'Steps* system [14], coworkers competed based upon their pedometer-tracked step counts. Most participants in this study liked the competition because it challenged them and also provided a benchmark against which they compared their own progress, though some participants felt that competition went against the spirit of the system. In another project, researchers developed a system for middle school girls to share their step counts with one another [23]. They found that participants viewed the simple sharing of step counts as a competition and that while some girls found this aspect fun others saw potential drawbacks. For example, one of their participants felt that extended competition would be unhealthy for a friendship. In summary, previous work has found that competition is mostly seen as a positive source of and motivation in social health systems, though some concerns did arise.

Another characteristic of many social health systems is that they support communication about shared health behaviors. For example, with the Houston system [4], users can attach comments to the step count information they share, and participants in a field study of this system enjoyed receiving encouragement and praise from their friends. Other researchers found similar promise in providing messaging support, but saw less successful adoption of this feature. In the Fish'n'Steps system [14], a user's activity level is mapped to the size and facial expression of a virtual fish character. In a field study of this system, participants were grouped anonymously (i.e., they did not know who their group members were) and were able to see other group members' fish characters. Because they did not know who group members were, however, participants felt uncomfortable using the system's communication mechanism. Toscos et al. [23] also supported messaging as part of their step count sharing application for adolescent girls, hypothesizing that this would help to motivate physical activity. However, their study showed that girls did not

know what to say to encourage one another, and thus few of the messages were motivational. Thus, while numerous researchers have seen promise in providing ways for people to communicate about their activity levels with their social networks, there have been some challenges in doing this effectively.

Work on social health systems that has focused on the family has looked at caring for elders [6,17], caring for individuals with disabilities [7], and tracking child developmental progress and medical data [11,12]. Our work differs from this research in that we examine the implications of collecting and sharing diet and exercise related information amongst parents and children to support reflection and dialog, independent of disabilities and medical conditions.

2.4 Implications of Health Monitoring

Our research is most closely related to that of Beaudin et al. [2], who examined individuals' reactions to the idea of extended health monitoring. Their goal was to derive implications for the design of personal health monitoring systems for individuals with and without serious health problems, and their work highlights a few findings related to sharing this information in the context of the family. Some of their participants were concerned about forcing familial involvement by sharing health information, and also suggested that family members might not want to share health information because it could lead to conflict. Our work extends this research and provides, through in-depth family interviews and design exercises, an account of the challenges and benefits of collecting and sharing health information amongst parents and children.

3. FIELD STUDY

We conducted a formative, mixed-method study to examine families' interest in receiving technological support for the collection and sharing of health information. In addition, we examined the particular ways in which supporting these activities is unique in the context of the family. Finally, we explored the potential and implications of using behavioral and physiological information to support family discussions about health. In the following sections we describe our participants, methods, and analysis in more detail.

3.1 Participants

Fifteen two-parent families (66 participants in total) from the Greater Seattle, Washington area participated in this study. At least one parent worked in all 15 families; in 9 families, both parents worked. Families had a mix of income levels, ranging from $40-60k to $120k+ annually. Families also varied in educational background; in 7 families both parents held at least a college degree, and in 5 others, at least one parent did. We did not screen for the existence of particular health conditions within families (e.g. diabetes), because during this exploratory study we wanted to gather feedback from families who had particular health problems as well as families that were interested in health and wellness more generally. By being inclusive in this way, we had the opportunity to potentially explore a range of issues related to collecting and sharing health information in the family.

When recruiting, we specifically required that each family had at least one child in the 8-12 age range. At this age, children were able to perform the activities required for our study, and would be able to benefit from systems that help teach healthy diet and exercise habits. We also believed that they would provide good feedback and insight into our understanding of family dynamics. Regardless of age, we invited all children in the household to participate in the interviews. Each family received a software gratuity, as well as entries into a raffle for additional gratuities.

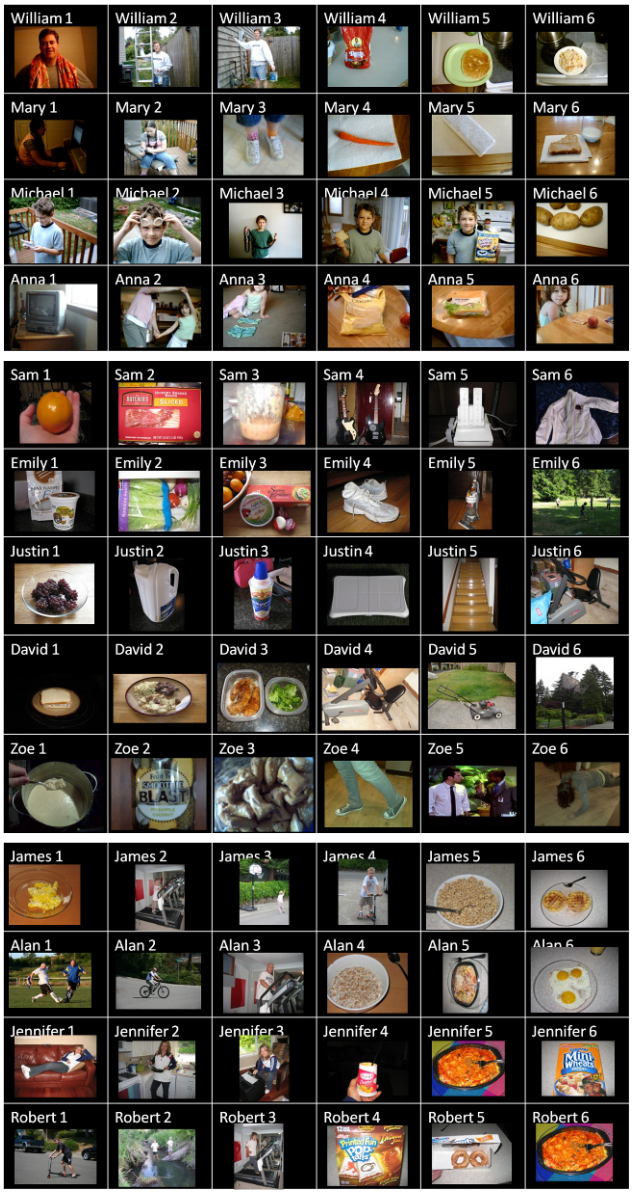

Figure 2: Three photo collages (one for each of three families) assembled from photographs submitted by participants. Subsets of the collages were used during interviews to elicit discussion around family members' diet and exercise practices in the preceding week. Names have been anonymized.

3.2 Methodology

We visited the families in each of their homes twice during this study. The first visit was an introductory visit to explain the study and to get participants started with a journaling activity that would provide grounding for the follow-up visit. In the second visit, scheduled about a week later, we conducted semi-structured interviews and performed design exercises to explore the dynamics of health journaling and discussions about health that occurred within families.

3.2.1 Introductory Visit: Journaling

We conducted an introductory visit to each family's home to explain the goals of the study and to explain the tasks for the days leading up to the second visit. We asked each family member (including children who were old enough to do so) to keep a written food and exercise journal in the time between our introductory visit to their home and our interview. We encouraged them to record as much detail as possible in these log books, including the time and date of each meal, snack or activity, as well as what food was consumed or what type of exercise they did (if any). In addition, we asked each family member to take three pictures of foods that they ate over the week, and three pictures reflecting exercise done as well. These logs partially mimic current technological trends toward increasingly automated collection of personal health data.

We hoped that actually having to record their diet and exercise habits over the course of a week would allow participants to speak more concretely about their feelings about health data collection, sharing, and reflection. In addition, these logs and photographs provided a frame of reference for talking about diet and exercise information during the follow-up interviews.

3.2.2 Follow-up Visit: Design Exercise and Interview

After a week of journaling, we conducted follow-up interviews. Our goal in these interviews was to understand some of the nuances of collecting, sharing, and viewing health information amongst parents and children. In particular, our goal was to derive design implications for systems that utilize family members' behavioral and physiological information to help promote reflection and dialog about current and potential eating and exercise behaviors. We did one interview with each family, with two parents and at least one of the children present. The interviews typically lasted one and a half to two hours.

The interviews consisted of four parts: log book reflection, evaluation and discussion of the photographs taken, a design activity, and semi-structured interview questions. First, we asked parents and children to look at each others' log books and tell us their reactions to the entries (e.g. entries that surprised them, missing entries, and entries that were particularly interesting). This activity helped bring to light some of the challenges and benefits of sharing health information within the family.

Second, for families who provided photographs prior to their interviews (14 of the 15 families) we displayed a subset of the photographs and asked each participant to assign a healthiness score to each picture (Figure 2). Scores were based on a scale of 1 to 5, 1 being extremely unhealthy and 5 extremely healthy. We then asked the families to discuss why each person chose the scores they did. Both the log and photo activities allowed us to stimulate and observe family health discussions based on their actual diet and exercise habits. This observation allowed us to examine the characteristics of these discussions and look for commonalities across families.

The third component of our interviews was a design activity, conducted with all participating family members gathered together (Figure 1). In this activity, we asked participants to imagine that information about their nutrition and exercise could be collected automatically. We then asked them to take one piece of paper for each person in the family whose data history would be of interest, and to tell us why they chose those particular people. For each family member chosen, we asked participants to denote which of the following types of information they would like to see and why: (1) detailed nutrition information, (2) detailed exercise information, (3) body statistics (i.e. physiological data like BMI), (4) health overview (an abstraction of specific health information, showing how healthy the individual is overall), (5) the person's notes about their health, (6) family messages to that person about the health information that they shared, and (7) a comparison of how healthy family members are relative to one another (e.g. in terms of amount of exercise done, eating habits, etc.). In addition, for each person that they chose, they were asked to select which of that person's log book entries and diet/exercise photos they would like to be able to see. This exercise helped our participants to speak more concretely about whose information they were interested in seeing, what information they wanted to have access to and why, and how they felt about sharing information about themselves. Figure 3 demonstrates several design sketches created and annotated during this design activity.

Finally, in addition to asking questions around the logging activity, photos, and design artifacts created, we asked families questions regarding (1) how much they felt they currently know about one another's diet and exercise habits, (2) prior family discussions about health, and (3) ways in which parents were succeeding and struggling with teaching children about healthy eating and exercise.

3.3 Analysis

Our notes and transcripts reflected our participants' answers to our direct questions, as well as their family discussion of their log books, photos, and artifacts they created during the design activity. We examined our interview notes to get an initial sense of reoccurring themes and then inductively coded the interview transcripts by developing labels to describe the phenomena we saw in the data. After deriving this set of codes, we iteratively clustered related codes into higher-level groupings, representing the major themes that came out of our data.

4. RESULTS

In this section we present trends we observed in our interviews and design activities to inform the design of future technologies supporting family reflection on health data. These findings represent an initial exploration of this space, and motivate the design implications that we present in later in this paper.

Our results show that families were often interested in gathering and seeing health information about one another and that there was potential benefit in doing so, though concerns arose regarding how this should be facilitated. In the following sections, we discuss four main themes that emerged: (1) opportunities afforded when family members cross paths, (2) balancing competing values, (3) the challenge of competition and comparisons, and (4) the benefits of fitness data beyond health improvement.

4.1 Opportunities Afforded When Family Members Cross Paths

The overlapping routines that families often have (e.g. shared meals, group outings, and inhabiting the same space) afford unique opportunities for health data collection and reflection. In particular, our results highlight the unique opportunity that family discussions provide for the *collaborative completion* of and *collaborative reflection* on individually collected data. This increased information can support deeper reflection than a family member could make using only her own personal health data.

Figure 3: Examples of materials created in our design activity.

Furthermore, the regularity of family gatherings provides a unique vehicle for such collaboration.

4.1.1 Collaborative Completion of Data

Commonly cited challenges of personal fitness logging are remembering to log and remembering what to log. However, as our families were all keeping diet and exercise logs, they were able to rely upon one another to complete their logs as they saw one another throughout the week. In the absence of technological cues to log (e.g. cell phone alerts), families were able to remind and encourage one another to fill out their log entries. Furthermore, both children and parents reminded one another to record their meals and exercise.

In addition to acting as a collaborative reminding system, families also functioned as a distributed memory since many of the meals they shared overlapped. For example, mothers often had to complete the logbooks for children who were too young to complete it themselves or who did not complete it for other reasons (e.g. because they forgot). These mothers were able to rely upon the fact that their children often ate the same foods too quickly fill out the logs. Furthermore, because the mothers were often in charge of preparing meals, they had a unique knowledge of what was being consumed and were thus a valuable resource for completing the logs. In addition, because family members often ate the same thing (most commonly at dinner or breakfast), kids who had forgotten a meal were able to complete their own logs by either asking other family members what was consumed or looking in their logbooks to see what they had written.

4.1.2 Collaborative Reflection on Data

Families are also well positioned to provide context for analyzing individually-collected data, as participants often had a good sense of the quirks and habits of their family members. For example, when reflecting upon how well they knew their family's habits, one family noted the dad's chocolate habit and another family a daughter's constant snacking. Many families anticipated the entries they saw in others' log books, either because they were around them when the behavior happened or because they were familiar with that person's diet and exercise practices.

As families were reviewing the log books and photos different people provided unique perspectives on the documented meals or activities. The individual comments raised by each person, in combination with the written or visual record of the food or exercise behavior, collectively provided a vivid picture of those behaviors. In particular, family members were able to clarify, enrich, and correct one another's understanding of what was represented in the log books and pictures. For example, as Family 9 began looking at a breakfast picture, the dad asked the mom whether the muffin in the picture was multi-grain, and whether the chocolate milk had added sugar. In Family 8 the mother explained that she had used a photograph of an abdominal exercise as a kind of shorthand for the fact that she had done a more extensive exercise routine. Finally, one of Family 10's pictures showed the mother holding a large box. The father described how the picture actually represents how she was doing a lot of "lifting, bending, moving from point a to point b." This process of clarification helped families more adequately assess the healthiness of one another's meals and activities.

Families also provided contextual information about what was going on when the meals were consumed and when the exercise activities were done. For example, the mother in Family 1 pointed out that in one humorous picture of her son eating he was actually singing a song that he had learned at church. Reflecting upon this amused the family as they remembered how funny it was when he was singing. In this way, the data (the photograph) was infused with life as the family commentary evoked enjoyable memories. This interaction around the data thus gave it an added layer of richness. The mother in Family 3 also provided contextual information as she explained that her daughter's McDonald's entry was a special treat since she had just gone to an orthodontist appointment. Thus, family members were able to provide further context for the activities represented in their own records and the records of others. This context helped families to delight in and reminisce about things that they had done previously, to justify behaviors, and also to explain the nature of those behaviors (e.g. how intensive the exercise was).

4.1.3 Family Gatherings as Occasions for Reflection

When we asked our participants to recount recent family conversations about health, the most commonly described conversations were those that happened around meal and snack times. While families mentioned a variety of other types of health conversations (e.g. parents encouraging children to get more exercise), mealtime conversations stood out as an important class of conversations. During these discussions, parents questioned children's decision making, suggesting for example that kids

choose healthier snacks. For example, the mother and son in Family 3 told us about one such discussion:

> Son: "[I said,] 'Mom, I'm going to have a piece of candy.' [And then my mom said,] 'Are you sure you NEED to have that candy? Maybe you should eat something healthier?'"
>
> Mom: "I gave you choices."
>
> Son: "Yeah [and you suggested that] instead of candy, maybe [I should eat] a banana."

In Family 6, the parents frequently encourage their children to "put something green on their plates" at dinnertime as a way to get them to eat more nutritious vegetables. Clearly meal and snack time is an opportunity for parents to notice their children's habits and make suggestions for improvement or change. The repeated social interaction of family members facilitates these impromptu conversations. Of course, families do differ in how much time they spend together, something that may affect the frequency of such conversations.

In discussing possible ways that technology might support family health discussions, participants highlighted the value of face-to-face communication at these family gatherings, and many felt that it was better to have family health conversations in person than electronically. This finding is an interesting contrast to previous systems for sharing health information amongst friends and coworkers that have shown the promise of including electronic communication as a feature (e.g. [4,14,23]). The mother in Family 8 described her concern to us in the following way:

> "I feel like I get really good feedback from my kids when we prepare meals… I just really value communication, face to face, with all of them: the kids and [my husband]. It's really, really important to me and I would much rather get my information from sitting down and talking with them face to face–even if it's not formally digging into what's going on with them–than to go and read about it. I've found that when someone types something down or emails for example, there's a lot of interpretation that has to go into there, it's very subjective."

This quote exemplifies how parents were concerned about how sensitively people can speak about health-related matters in computer-mediated conversation. Being able to tactfully and positively comment about a family member's diet & exercise activities was important to many of our families. For example, the father in Family 6 noted:

> "It's sensitive when you're talking about health stuff, how you address it with your loved ones… [It's] a sensitive thing in terms of how you communicate with those you love, your concerns about their health... I don't know if [my wife] would listen to me anymore if I emailed [her and said] 'Exercise, dear!'"

In addition, the son in Family 3 was concerned with how his family would respond if they could see a detailed record of his eating habits:

> "I really wouldn't want people to see that I was advertising that I ate 7 pieces of pizza and 2 bowls of ice cream. I wouldn't want people to write stuff like, 'Wow how come you ate that?!'"

Other families expressed particular concern about siblings being overly critical of one another. Previous research has cited the importance of providing positive feedback to encourage healthy behaviors in children [22]. Our results confirm this finding, particularly in the context of sharing health information.

The findings presented here highlight the importance of family gatherings as a unique opportunity for constructive and collaborative reflection on personal health data, suggesting that system designers should examine ways of supporting rather than replacing this collaboration. We believe this to be true even when it is technologically feasible to allow for more comprehensive automated logging and communication mechanisms.

4.2 Balancing Competing Values

During our design exercises and interviews, we sought family member's ideas about the extent to which technology could and should help them gather and reflect upon their eating and exercise practices. In these discussions, families made it clear that any application that is developed must take care to balance the values of openness, caring and modeling with the value of protection.

4.2.1 Openness, Caring, and Modeling

Our results highlight how the values of *openness*, *caring*, and *modeling* are tied to sharing and viewing health information in families. It is important to understand the potential interplay between health-oriented technologies and these values because appreciating them may lead to system designs that are embraced more fully.

First, participants discussed how making information about oneself available to the family was important partially because it was a reflection of the value of *openness*. For some of the families who felt comfortable sharing their health information with one another, one reason why they felt compelled to do so was that they thought it was important that they be transparent with one another. Not sharing health information could be seen as a violation of that core value. While the mother in Family 4 felt conflicted about sharing health information within the family – at first she said that it should be kept private – she decided that doing so might be akin to keeping secrets within the family, something she did not approve of. Similarly, the mother in Family 5 said that health information should be shared within the family because no one should be trying to hide anything. The dad in Family 15 was also an advocate of family openness, though for him this was in large part because he thought too much secrecy could lead to eating disorders. Finally, in Family 6 both parents said that they valued being open and making one's habits visible to other family members. When we asked them how they felt about their children seeing information such as what was recorded in their diet and exercise logs, the dad noted how openness was important, even at the cost of comfort:

> "I'm ok with it but yet it's not that it's completely comfortable. It's just that I'm ok with it because it's transparent and reality and that's a value. It's not that I feel good about the fact that I eat at 11'oclock at night and that's something that they're aware of, but I know that the transparency is an important family value".

In addition to *openness*, another abstract value that participants frequently tied to the sharing and viewing of health data was *caring*. The mom in Family 3 said that she would want to see data about everyone in the family, because she wants to "take care" of them. For this mom and other parents in our study, having the role

of "mother" strongly implied that they *should* see their family's health data. This was a feeling of moral duty, where it was not simply that parents *wanted* to view their family's information, but that they *ought to do so*. For example, the father in Family 1 said that he would be interested in seeing the information because it is his job to do so as a father. Similarly the mother in Family 3 said that, as the mother, she felt she "had to" look at information about her family's nutrition and exercise. Thus, having access to information about the family's health was one way for parents to exhibit caring for the family. In Family 5, the mother said, only somewhat jokingly that "no one cared" about her, because no one had said that they would want to see her health data.

Another value that we observed to be closely tied to health attitudes and behaviors was parents' desire to "set a good example" for children. It is through the process of *modeling* that parents can care for their children by helping them learn what to do, and what not to do. The mother in Family 1 said that she did not mind her children seeing information about her eating and exercise habits because it was a good way for her to model appropriate behaviors to them. The father in Family 3 and the mother in Family 9 thought that her children seeing information about their health behaviors would be a good thing because it could show them what not to do. The father in Family 10 also felt it might be good for his children to see his bad habits:

> "The fact is that I don't care what they see 'cause I want them to be as informed about my health [as possible], so that they can see if my health is poor, why. And then they can go, 'I don't want to be like that', and then make good decisions and then have a healthier lifestyle."

In Family 6, the mother noted that having her children be able to see her health information would help her to see the effects of her actions. She and her daughter had the following discussion during their interview:

> Mom: "I know that we're examples for them… They know I have diabetes so if they see me eating something I shouldn't be, that's a bad example… So I would want to know what they're picking up from me and to know how I'm affecting them as far as how they think about food and exercise."
>
> Daughter: "Don't we already do that though? Tell you [what we think]?"
>
> Mom: "You do, you'll say 'Mom you shouldn't be eating that'… But honestly we have to think about that because what I'm doing is a modeling for you and I want to model good things. So having your feedback, actually knowing what you see and what you think about it would be motivating to me."

Parental modeling is important when educating children about health [8,19], and many families saw sharing health information within the family as one way of facilitating this.

4.2.2 The Need for Protection

While families saw value in sharing health information because it exemplifies openness and caring and facilitates modeling, a conflicting value was that of protection. In particular, parents were concerned about protecting kids from the harm that having access to health information might lead to.

For example, many parents said that they were concerned about how much information kids saw because they did not want them to worry. The dad in Family 3, while on the one hand saying that it would be good for his children to see information about his health because it facilitated modeling, was also concerned that this information would cause them to worry. He said that it is his job as a parent to worry about his children, not vice versa. The mother in Family 8 pointed out that kids may worry unnecessarily if they are not equipped to understand the information they are seeing:

> "There's a lot of variables in each person's health. Like I wouldn't want them to see [that] mom's cholesterol is X and get concerned about it."

In addition, some families were concerned about children seeing their own health information because they thought it might lead to problems such as paranoia and eating disorders. The mother in Family 5 noted that her daughter having too much information about her health could be potentially problematic:

> "And that's the other worry, is too much information going to push her to obsess, or is it going to help her make the good choices that she needs to make? So, how do you balance that?"

Similarly, the parents in Family 15 were concerned that their children having access to too much health information would cause them to be neurotic. In addition to kids having negative reactions to their own health information, two other families raised the concern of siblings tormenting one another about their health data. For example, Family 3 described the potential sibling interaction around dietary information like this:

> Mom: "I don't think he needs to monitor his sister and vice versa."
>
> Son: "Because [we would say things like], 'I can't believe you ate like four pies yesterday, you're a pig!'"

Thus, there are a number of reasons why families were concerned about children having access to health information about themselves and about others in their family. The concerns described here reflect the parents' desire to protect their children from the potentially negative consequences of seeing this information. We would expect that parents would want to shield their children from harm, but what is interesting to note here is the ways in which this desire to protect conflicts with the desire to be open, to care, and to model that we discussed previously. The mom in Family 6 described this tension to us:

> "I guess my first thought is that I wouldn't want them to worry, that if it showed stuff that could then cause them worry I don't think it would be necessary for them. But… if I'm not exercising I don't want to hide that… I just wouldn't want to give them anything [that would lead to them] worrying about my health."

4.3 Competition & Comparisons

In addition to balancing family values such as the ones described above, participants discussed the subtlety required when using health information as the source of competitions and comparisons. Competition and interpersonal comparison have frequently been used to support behavior change in previous social health systems for friends and coworkers [14,15]. However, a significant challenge that our participants discussed was the way in which comparing the health behaviors and measures of different family members could lead to *negative* comparisons and competitiveness. Interestingly, when we raised the topic of family comparisons,

many families immediately equated comparison with competition. Furthermore, even some families who described themselves as generally competitive or liking competition were averse to the idea of competing with one another based on health behaviors and measures.

The critical issue for families seemed to be that they viewed explicit comparisons of health information as a form of negative competition. While parents thought it appropriate to make their *own* comparisons based on individually presented information about their children, seeing an explicit comparison was often undesirable. For example, parents felt comfortable making comparisons when articulating the unique challenges they faced in teaching different children how to eat healthfully and exercise. The mother in Family 3 described how her son is much more of a challenge than her daughter:

> "Because it is a struggle with my son. He could eat almost every waking hour so it's a constant struggle to come up with healthy alternatives. Lunches are awful, to pack it every day it drains me. Whereas my daughter is easier – she just normally goes and chooses healthier stuff. It's harder for him, he has to work on it."

As a result of having these unique challenges for each child, parents were interested in seeing specific types of health information for each child. For example, the parents in Family 6 wanted to see exercise information for one daughter who they consider to have weight issues, and nutrition information for their other daughter who snacks constantly. The decision to see specific types of information for each child can result from comparing children and deciding their relative strengths and weaknesses.

However, while interested in seeing information about an individual, most parents reacted negatively to the idea of making explicit comparisons of how well family members were doing relative to one another, for example in the form of a chart. The dad in Family 2 told us that while seeing individual information about people is fine, having a comparison chart risks causing that person to be singled out, or "low-lighted". The mom in Family 8 also preferred individual information to comparisons:

> "I just try to avoid comparisons... I would like to look at each person individually and maybe map *that* over a time period. But I think it could be, as the mom, it could be a little dangerous to start comparing–especially when talking about the kids. I think that is something that we typically try avoid in other areas... I would want to look at each child in an individual way and look at what maybe they can do, but NOT compared to their sibling."

These concerns around comparison and competition are interesting to consider in light of the increasingly popular "exergaming" applications such as the Nintendo Wii Fit. The difference between these gaming applications and other types of systems that might compare family member's health behavior and physiological data patterns is that the latter type of information seems to be more delicate. That is, this type of information may require more sensitivity in how it is handled because it hits a little closer to home. For example, the dad in Family 4 felt health-centric competition around personal data could be problematic:

> "I'm afraid that would lead to fist fights…Yeah, it hits kind of close to home. I just think it might get at self esteem issues… Often I support friendly competition, in fact that's a fun way to get things done. But the reality is everybody inherits slightly different genetics, it's not all the same. So it's like a competition where there may always be somebody who loses no matter how hard they work."

This quote also highlights the concern that making such comparisons could lead to people feeling discouraged or embarrassed. Whereas in exergaming applications families can play and compete based on discrete interactions with the system, comparing lifestyle data (such as eating and exercise habits over time, or physiological data like BMI or weight) may be more off-putting.

4.4 Benefits Beyond Health Improvement

Our results also highlight the aspects of health information that people attended to beyond the data itself. First, looking at their children's food and exercise logs allowed some parents to reflect upon their child's development. For example, the mother in Family 2 noted how neat her daughter's logbook was and complimented her use of cursive handwriting. In Family 4, the mother was pleased that her daughter was able to maintain the logbook herself, because the last time they needed to record her eating habits (when her daughter first was diagnosed with diabetes), mom was responsible for keeping the log. Two mothers noted the independence reflected in their children's meal entries, for example in Family 10 the children had prepared their own meals. Thus, these families reacted to the broader implications of the recorded information, appreciating how the data spoke to non health-related facets of their lives.

During our interviews, families also spoke specifically about the pleasurable aspects of exercise activities and foods eaten. For example, when asked to evaluate the healthiness of their family's activity photos, some parents and children talked not simply about the quality of the exercise (e.g. how strenuous it was) but about the fact that the exercise was fun. In Family 2, the dad rated his children's exercise highly because they were "having a good time and [didn't] know that they're exercising." The kids in families 5, 8, and 9 also pointed out which activities they found to be fun, and rated those exercises highly because they were enjoyable.

As people reflected upon the family's log books and pictures, they also pointed out which foods they thought tasted good. Family 14 talked about how the potato soup that dad cooked, while not very healthy, was delicious. One of the children in Family 9 pointed out that while there was probably too much sugar in the crepes photo, it was "sooo good!" In Family 8, a logbook entry spawned conversation about cookies that the mom bought and how much the family enjoyed them. Thus, seeing a record of what they had eaten caused many families to reminisce about the tastiness of foods and the enjoyment found in different activities. These findings are a reminder of the importance of appreciating the affective dimensions of health. When reviewing health information, families were not engaged simply by, for example, the informative power of seeing the data. They also reflected upon the pleasurable aspects of the food and exercise-related experiences that the data represented.

5. DISCUSSION

Our work was motivated in part by a recent trend toward technology for logging personal health data, as well as a parallel trend toward online systems for storing health data (e.g. [9,16,18]). These advancements make it technologically possible to gather large amounts of health data, and CSCW researchers are particularly well suited to investigate the social feasibility and

consequences of systems that leverage this data. While these trends suggest that there is opportunity for using technology to enhance the dialog around health within the family setting, we conducted this field study to see if this was indeed true and if so, identify design implications for applications in this space. Our results suggest that there is certainly room for providing technological support for family reflection upon health information. Our results furthermore reflect the unique nature of the family unit as opposed to individuals or other social groups that previous health technologies have been designed for (e.g. friends and coworkers). Indeed, our work contributes to the domain of health research within CSCW and related fields as existing research on social information sharing systems have focused primarily on groups such as friends and coworkers [4,14,15].

Building upon our study results, we now discuss design guidelines for systems that support families in sharing, reflecting upon, and discussing their health information. We present these guidelines as a starting point, fully appreciating the caveat that any new technology concept must be examined in the field to fully understand how that system augments life. Indeed, we hope that our study findings will act as an initial step in conceiving of health technology that accounts for the particular needs, desires, and nuances of family life. Furthermore, future work should examine the ways in which the guidelines we identify here are shown to be important when families interact with a functioning technology. While our recommendations may not apply to all families, they highlight a number of considerations informed by our in-depth study of 15 families, which provides a starting point for understanding how to design for different family dynamics.

Leverage Family Gatherings. Our first design recommendation is to consider that family gatherings (e.g. meals or even car rides) provide a unique opportunity for reflection on personal health data, as they occur regularly and allow family members to supplement each others' health records with shared knowledge. For example, our results highlight the "insider knowledge" that family members often have about one another, as they are aware of one another's quirks (e.g. having a love for chocolate) and habits (e.g. what they typically eat for breakfast). Playful applications could be created which challenge this knowledge. For example, games that test how well a family member can guess what another person has had to eat during the day could be a fun starting point for family reflection upon the healthfulness of their food choices.

Furthermore, our results highlight how family conversations about health often coincide with meals, for example, as parents encourage kids to serve themselves vegetables at dinner or to select a healthy snack from the kitchen. Technologies may benefit from designing specifically around this, for example by integrating applications that help spur conversation about health directly into dining areas. As designers contemplate a location for introducing new technologies, areas of the home associated with meals may be a particularly useful starting point. Systems that display a history of snack choices, for example, could further augment discussions about making healthy selections.

Support Families in Negotiating Competing Values. Our results show that parents felt compelled to share health information because doing so was an expression of the important values of caring, openness, and modeling. At the same time, these parents also hesitated to share health information because they wanted to ensure that children were protected from negative consequences of having access to this information (e.g. misinterpretation, fear, and eating disorders). Thus, technology designers must explore how to design systems that support families in balancing these competing desires (to share and to withhold information) while appreciating the values that underlie the desires. Systems should reflect the ways in which shared (or unshared) health data is assessed not only in terms of content, but also in terms of the implications of the act of sharing itself (e.g. feeling a moral duty to look at others' information, and equating sharing with the family values of openness and caring).

Recall that some of our families felt it would be improper for them to withhold information because that would conflict with their value of openness. At the same time, sharing information might lead to misinterpretation. One design decision could be to only allow information about an individual to be accessible by another family member when both people simultaneously access the system. This would allow the person whose information is being shared to clarify that information. Indeed, we saw this process of clarification happen naturally in our interviews, suggesting that this behavior may carry over if a new technology is introduced.

Consider Cooperation Over Competition. Previous systems that have used social mechanisms for motivating health behavior change have frequently used competition as a primary motivator, but our results indicate that families may require fundamentally different motivators. Our families felt that competition based upon information about eating and exercise habits over time is potentially dangerous because it may actually cause negative reactions. Some families, for example, did not advocate explicit comparisons of health information between siblings as they could lead to discouragement or embarrassment. Thus, a more fruitful approach to system design for some families may be to create *cooperative* applications as opposed to *competitive* applications. For example, visualizations of health information could be created such that they emphasize how healthfully the family is living as a unit, rather than how each person is doing compared to others.

Consider the Intrinsic Value of Reflecting on Health Information. Our results showed that when reviewing their written and photographic fitness logs, families reacted to more than just the health information captured in the logs. Indeed, they responded to the broader meaning of this data, including the way that it pointed to a child's development and growing independence. When reflecting on the logs, families also noted the pleasurable aspects of the recorded foods and activities. These findings highlight the importance of health information beyond helping people to understand the health-related implications of the family's behaviors. Thus, health information sharing applications for families should support reflection that encompasses topics in addition to health. For example, systems that capture information about eating and exercise practices might record not only what was eaten but also how a person felt while eating it. Capturing both the behavior as well as the emotional aspects of that behavior could help family members have a richer reflective experience later on. Designing in this manner means appreciating the fullness of reflecting upon health-related experiences: that this type of reflection is not solely about the health-related importance of the data but also things like the affective aspects of this information (e.g. pleasure).

6. CONCLUSION

Motivated by recent advances in technology for collecting personal health data, we explored the implications of sharing and discussing such data in a family context through journaling activities, semi-structured interviews, and design activities. Our results indicate that the increasing availability of personal health data offers unique opportunities for supporting reflection upon health in a family context, and that this context has distinctive properties that merit careful consideration when designing supporting technologies. While we solicited the participation and feedback of both parents and children in our study, our results speak most strongly to the attitudes of the parents. Future work should look more specifically at the perspective of children and the subsequent implications for technology design.

Previous research on socially-oriented health information sharing systems has focused primarily upon groups such as friends and coworkers. Our work contributes to CSCW and related fields by providing an in-depth examination of health information sharing in the family context. Furthermore, the design implications we present serve as a starting point for future work in this area.

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