

Milk Matters: Milk Donor Motivation

Use of Technology to Motivate Milk Donation

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ABSTRACT

This literature review discusses the importance of human breast milk, especially for sick, premature, or ill infants. Milk sharing and milk donation are thoroughly reviewed, as they provide ways for infants whose mothers are unable to breast feed to obtain human breast milk. Specifically, the motivation for mothers to donate breast milk, and the reasons why mothers might choose to engage in milk sharing practices as opposed to donating to a human milk bank, are reviewed in detail.

This literature review proceeds to discuss the use of technology, and in particular mobile applications, in milk sharing and milk donation. Since minimal literature exists on the use of technology to motivate human milk donation, the use of technology to motivate blood donation is assessed. Lastly, the use of gamification to motivate behaviour is reviewed.

It is concluded that technology, and specifically mobile applications, has the potential to motivate mothers to donate human breast milk. Furthermore, techniques such as gamification can be used to increase mothers' motivation to donate.

Keywords

human breast milk, milk donor, infant, milk bank, milk sharing, mobile health care application, breastfeeding, blood donation application, gamification

1. INTRODUCTION

Human breast milk is widely accepted to be the most healthy and beneficial food for infants [15, 9]. It provides the infant with many critical nutrients, and helps to strengthen the child's immune system as a result of its immunological properties [2, 15, 9]. Human breast milk is also a form of nutrition that all infants are able to tolerate, unlike formula [15]. Due to human breast milk's many positive effects on the health of infants [17], it is regarded as both a vital medical resource and the ideal food for infants [15, 13].

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In reality, however, many mothers are unable to either partly or wholly supply their children with their own breast milk for various reasons including: lactation issues, certain medications which the mother may be taking, maternal illness, and adoption [15]. In response to this issue, there are numerous ways in which mothers are able to obtain human breast milk including: wet-nursing, peer-to-peer milk sharing, and human milk banks [15, 13]. Each of these sources of breast milk has its own benefits and drawbacks, which will be reviewed briefly. The literature discusses the motivation of breast milk donors extensively. This literature review will focus on the motivation of human milk bank donors.

The primary purpose of this literature review is to support our research on the use of technology, and in particular mobile applications, to motivate the donation of breast milk to human milk banks. Unfortunately, to the best of our knowledge, the literature contains very little on using mobile applications to motivate human milk donation. As such, this literature review will discuss the broader topic of using technology and mobile media to motivate donation (often in other specific circumstances). The use of gamification to influence users and motivate donation will also be considered. Insofar as is possible, the literature discussed regarding the use of technology will be confined to the context of health care, in order to maintain the relevance of this literature review. Similarly, research conducted in developing countries will be favoured.

2. IMPORTANCE OF HUMAN BREAST MILK

Breast milk has many positive medical effects on infants [17]. Its immunological properties make it an irreplaceable resource, as it plays a critical role in the strengthening of a child's immune system [2, 15, 9]. Human milk is a vital source of nutrients for infants that cannot be emulated in formula. Furthermore, formula can lead to health complications and issues in many infants, such as infants whose bodies are intolerant to the substances that comprise formula [15].

Breast milk has been shown to lead to positive health outcomes for infants [15, 14]; this has been especially pertinent with premature, underweight or ill infants [17], whose immune systems have not been strengthened. As such, human breast milk (mainly from human milk banks) has been used extensively, and to significant effect, in Neonatal Intensive Care Units (NICUs) [15, 9, 5]. Human breast milk is considered to be, and is used as, a critical medical resource. Its indisputable benefits and positive effects on the health of infants [17] have resulted in the World Health Organisation,

amongst many others, declaring human breast milk to be the preferred food for infants [15, 13].

3. OBTAINING HUMAN BREAST MILK

Ideally, mothers should be able to provide their children with their own milk, or, as it is known in the literature, mother's own milk (MOM) [15, 13]. This ensures that the child has consistent access to the best food source possible, and alleviates the demand for donated milk. As mentioned, some mothers are unable to provide their children with MOM [15, 9]. Situations where this might be the case include: mothers who are on medication or are ill, mothers who experience lactation issues, and mothers who have adopted children [15]. In these situations, there are various media through which mothers, or parents, are able to obtain human breast milk for their children. Specifically, mothers can make use of milk sharing, or milk that has been donated to human milk banks by other mothers with excess milk supply [15, 13].

3.1 Milk Sharing

Milk sharing refers to the (usually non-commercial) direct sharing of human breast milk between a donor mother and a recipient mother's infant [15, 13]. In milk sharing, the donor mother knows which child, or children, her breast milk is feeding. Whilst the donor mother may be a family member, close friend, or acquaintance, it is also common for donors and recipients to be strangers [15, 5].

3.1.1 Types of Milk Sharing

Milk sharing can take many forms; for instance, wet nursing has been commonplace in society for centuries [15]. More recently, peer-to-peer milk sharing has become a prominent way for mothers to obtain donor milk for their children. Peer-to-peer milk sharing involves a donor mother expressing milk for a recipient mother's infant. Peer-to-peer milk sharing does not require that donors and recipients be personally acquainted before or during the milk sharing interaction [6, 15, 5]. Peer-to-peer milk sharing often makes use of technology, such as social media, to connect mothers who are willing to donate breast milk with those who are seeking it [6, 15, 14, 13, 5].

3.1.2 Concerns and Health Risks

Milk sharing has many associated concerns, mainly related to the quality and safety of the shared breast milk [5, 2, 1]. In reality, some mothers fail to adequately screen their donors or pasteurize donated milk. These are both major issues because factors, such as illness or medication, might render the donor mother unsuitable. Consequently, the donated milk may be unhealthy or even dangerous to the infant. Furthermore, should the recipient of the donated milk fail to pasteurize it, harmful pathogens and contaminants will not be killed. On the other end of the spectrum, over pasteurization of human breast milk diminishes its nutritional and immunological properties [2, 1]. Yet another risk to the health of an infant is that donated breast milk may be unsafely shared [13]; for instance, unclean or unsterilized equipment may be used to express and store the donated breast milk.

The issue of negligence on the part of both donor and recipient mothers is compounded by the complexity of screening mothers and pasteurizing milk. Ultimately, even if a

mother has erroneously attempted to ensure the safety of donated milk, there is no guarantee that the milk will indeed be safe for an infant. For instance, many mothers use flash heat pasteurisation (FHP) to eradicate harmful pathogens and contaminants. FHP involves heating a container of milk in a water bath up to 72 degrees celcius, the temperature at which one can be certain that contaminants and pathogens have been killed. An issue with FHP, as described by Chaudhri et al [2, 1], is that many guides for the execution of FHP stipulate that the milk ought to be removed from the water bath once the water has reached a "rolling boil", which is a very vague threshold. To combat this issue, systems, such as those created by Chaudhri et al (comprising mobile applications connected to thermometers), have been developed to aid in the FHP process and ensure it is performed adequately [2, 1].

3.2 Human Milk Banking

Mothers who are unable to provide their child with MOM may be eligible to receive breast milk from a human milk bank [15, 9]. Human milk banks are typically non-profit organisations that receive breast milk from mothers with an excess supply, pasteurize the breast milk, and distribute it to medically needy infants [6, 5]. Breast milk is most commonly given as a donation. However, some organisations will pay mothers for their excess milk, which raises issues that are discussed by Gribble [6].

The demand for milk donated to human milk banks is often high. This issue is compounded by the frequent under supply of human milk [13, 5]. As a result, milk donated to human milk banks is usually only available via prescription from a health professional, and reserved for infants with a medical need: ill, underweight and premature infants, such as those in NICUs [15, 5].

3.3 Donor Motivation

Significant research has been conducted around what motivates women to donate breast milk. For instance, Thomaz et al discuss the experience of mothers donating breast milk [20], and Katke and Saraogi investigated the socio-economic factors which influence milk donation to human milk banks in India [9]. Fortunately, the literature is mostly in agreement regarding the factors which influence milk donation. Similarly, the reasons which motivate donation to milk banks are generally consistent with those that motivate private, direct donation in the form of milk sharing. There are, however, factors which influence women to partake in milk sharing as opposed to donating milk to human milk banks (and vice versa). These factors, which are outlined by Perrin et al [15, 14] and Gribble [5] amongst others, will be discussed briefly.

3.3.1 Milk Sharing vs Human Milk Banks

Many mothers are reluctant to donate to human milk banks. As described by Perrin et al, mothers looking to donate milk expressed concern that milk donated to human milk banks is not free for recipients [14, 5]. These mothers had a philosophical objection to the fact that their freely donated milk would not, in turn, be given to a needy recipient for free [5]. Many mothers, such as those objecting to the human milk banks charging for donated milk, appear to be ignorant of the costs involved with: recruiting and screening donors, pasteurizing milk, distributing milk, and perform-

ing other human milk bank functions. Furthermore, there are misconceptions amongst mothers that milk banks profit by charging recipients for human milk, and many mothers are unaware of the fact that recipient mothers do not necessarily directly bear those costs. Yet another misconception amongst potential donors is that they consider milk provided by human milk banks to be merely a source of food for children, as opposed to a valuable medical resource that is vital health outcomes of vulnerable infants [14].

Another major deterrent for mothers considering donating to human milk banks is that (in most cases) donors do not know which recipients will benefit from their breast milk [5]. Many mothers consider their breast milk to be a valuable resource [6, 14] and would like to know that it benefits a sufficiently needy and deserving infant [5]. Milk sharing is thus often a more appealing prospect as the donor is able to choose who benefits from their breast milk, and witness the specific impact their contribution is having [6, 5]. In some cultures, such as amongst Muslim mothers, human milk banking (without appropriate considerations) is actually unacceptable. It is believed that milk sharing forms a bond between the donor mother and the recipient (known as milk kinship). [6, 13, 5]. It is thus imperative that Muslim mothers know the source of the donated milk they receive [5].

The last issues to be discussed regarding many mothers' preference to engage in milk sharing, as opposed to donating to human milk banks, is practical in nature. Firstly, some mothers were unable to donate to a human milk bank because there were no human milk banks in their geographical area. Secondly, many mothers were not recognised as eligible donors due to the strict screening processes and criteria imposed by human milk banks. Lastly, a considerable deterrent for mothers was the extra work associated with donating to a human milk bank [14, 5]; it was simply quicker and easier for mothers to engage in milk sharing and thereby avoid the rigorous, demanding milk screening and donation processes required by human milk banks.

3.3.2 General Motivation to Donate Breast Milk

As mentioned, the motivation to donate breast milk is mostly the same for mothers partaking in milk sharing and mothers donating to a human milk bank [6]. The motivation to donate breast milk has been researched extensively. For instance, Gribble [6, 5] and Thomaz et al [20] discuss the motivation of breast milk donors.

Many donors are motivated in an altruistic sense by the desire to help somebody [6, 14]. Others felt that they had a social responsibility to donate excess breast milk. The knowledge of a particular infant's need for human breast milk is also a large motivating factor, as is the case in a large number of milk sharing interactions. In the case of human milk banks' donors, donations are motivated by the knowledge of milk banks and the need they have for human breast milk. Other mothers are motivated by the hope that somebody else would do the same for them if their children were in need of human breast milk [6].

Generally speaking, mothers consider their breast milk to be a valuable resource, as they are aware of its health benefits and ability to sustain life. Many mothers, who have an excess supply of breast milk, thus do not want to waste what they consider to be a precious resource [6, 14]. Furthermore, mothers who express milk for their children (or

other peoples' children) invest time and energy into doing so, which adds to the perceived value of their milk [14]. This provides motivation for those mothers to donate their excess milk to a needy recipient. The literature tends to separate mothers who express milk specifically to donate and mothers who express milk for other purposes into distinct conceptual groups: mothers in the latter group are often motivated to become donors as a result of their desire not to waste their excess milk. Lastly, the role of health professionals in convincing mothers to donate breast milk has been described as vital [6].

4. USE OF TECHNOLOGY

This section will focus on the use of technology, and in particular mobile applications and other media, to track and motivate donation of human breast milk. Unfortunately, to the best of our knowledge, there is no (or little) existing literature specifically relating to the use of technology to track and motivate donation of breast milk. There is, however, literature on the use of technology to facilitate and encourage blood donation. Parallels can be drawn between blood and human milk donation, as they both involve humans giving of their own bodily fluids to other humans in need.

Thomaz et al [20] suggest that blood donors and human milk donors, and their motivations for donating, are similar; they make use of this similarity and refer to the motivation of blood donors in their research [20]. The processes of blood and milk donation both require a concerted effort on the part of the donors, who also give of their time and energy in order to partake in the donation process. Both blood and human milk are vital medical resources that are essential to the survival and health outcomes of humans in need. On the other hand, there are serious health risks associated with blood and milk donation. As such, both blood and milk donors and donations have to be carefully managed, handled and screened.

Considering the similarity between blood and human milk donation, it is justifiable to cite the use of technology to motivate and track blood donation in the context of this literature review. This will be discussed after a brief review of the existing use of technology in milk sharing and donation.

4.1 Use of Technology in Human Milk Sharing and Donation

As mentioned, there is little (to no) literature on the use of mobile technology to motivate donation to human milk banks. Technology has, however, been used in other areas of milk sharing and milk donation, such as the previously described flash heat pasteurization method by Chaudhri et al [2, 1]. There are also various apps related to breast feeding that can be downloaded, such as apps which educate mothers about breast feeding or allow them to track their breast feeding practices. Minimal relevant literature has been found describing the success or effectiveness of these applications.

4.2 Use of Technology to Motivate Blood Donation

Unlike the use of technology to motivate donation to human milk banks, the literature describes (to varying extents) the use of technology to motivate blood donation. The aforementioned similarities between donation to a human milk bank and blood donation render studies of the use of

technology to motivate blood donation relevant. Papers by Jenipha et al [8], Divyarani et al [3] and Ishema [7] outline similar mobile applications for use in the context of blood donation, which aim to motivate users to donate. Another paper, which is assumed to be unpublished, by Sundarde et al also describes a blood donation mobile application [19]. Unfortunately, little is known about the effectiveness or success of these applications.

The applications proposed by Jenipha et al and Divyarani et al both focus on creating a database of blood donors and allowing users to interact with the database of blood donors in a variety of ways (e.g. by viewing donors of a given blood type that are in their area, or broadcasting a need for blood) [8, 3]. Whilst these applications are thus not directly relevant, as they provide functionality that could be described more as peer-to-peer, the design principles and considerations may still be of use.

The blood donation application proposed by Sundarde et al focuses on scheduling appointments to donate blood [19], whereas the application proposed by Ishema focuses on allowing organisations to share news and notifications with donors [7]. Both applications make use of gamification mechanics and allow users to locate nearby blood donation facilities [7]. The features included in these two applications are similar to those included in most other blood donation applications that can be downloaded [21]. It must be noted that the feature which allows donors to schedule appointments may not be relevant, as mothers do not need to schedule an appointment every time they donate breast milk. Many of the other design features and functionality, which will be discussed in the following sections, are relevant.

4.2.1 *Readiness of Donors for Mobile Applications*

At present, organisations attempt to motivate people to donate blood via numerous media, which include: e-mails, telephone calls, text messages, websites, mobile applications, and social media [21, 18, 21]. A study by Yuan et al found that e-mails, and other digital media, are already effective and favoured amongst donors. Specifically, e-mail was identified as the preferred medium of contact by most donors. The study found that approximately two thirds of the sample population would likely make use of a blood donation centred mobile application. Similarly, approximately two thirds of respondents considered themselves to be, at least, technologically capable, and comfortable and willing to engage with new technology. Applications and other mobile media thus have the potential to motivate donation, and improve both donor recruitment and retention by making the donation process more engaging, rewarding, easy, and convenient [21]. Donor retention is particularly important, considering some studies have found that donor recruitment is much more expensive, and thus less cost effective, than donor retention [4].

4.2.2 *Features, Design Considerations and Concerns*

Foth et al separates the features of blood donation applications into 3 categories: personal services, social media, and data visualisations [4]. The features which donors favoured most in a blood donation mobile application were appointment scheduling (an example of personal services) and receiving news and updates from blood donation organisations [21, 4]. Suggested content for news and notifi-

cations included information pertaining to local drives and blood shortage alerts. Social media aspects were favoured by some donors, but to a lesser extent overall [21]. Examples of social media aspects include the sharing of donation experiences, and recommending that friends donate [21, 4].

Other features commonly included in blood donation applications include personal donation tracking and history (which could incorporate data visualisations), and the ability to locate (nearby) blood donation facilities [21, 4]. Some blood donation applications also contained educational components, such as videos [4]. A feature that was not included in the applications surveyed was an automated screening process for potential donors [21]. Foth et al, however, noted that some mobile applications allow users to check their eligibility to donate blood [4] (which is not a formal screening process).

The features included in blood donation mobile applications are mainly intended to streamline the donation process, and make the experience of donating blood more engaging and social. It was hypothesized that personal service features, such as donation tracking and notifications, might be insufficient to motivate donation. Instead, social media and visualisation features, such as charts depicting local/national blood levels, might be needed to persuade users to donate [4].

The main concerns of donors were essentially related to being spammed by blood donation organisations via the app, and the security, privacy, and intended use of personally identifiable information in the application [21]. In response to the first concern, many respondents thought it would be preferable if the user could decide which news and notifications he/she wished to receive. It is important to note that only a small percentage of the respondents cited technology (not being able to use the app due to technological inability or a lack of an appropriate device) as a concern [21].

4.2.3 *Likely Users*

Yuan et al found that some demographics did not contribute towards the likeliness of a donor to use the application, and others did. The sex of the donor (irrelevant for milk donation) and ethnicity did not have an effect on the likelihood of a person to use the application [21]. On the other hand, the education, age, and previous number of donations did contribute to the likelihood of a person to use the application. Specifically, potential donors under the age of 45 were more likely to use the application [21]. This finding favours milk donation, where donors are less likely to be over the age of 45. It was also found that people who have donated more in the past are more likely to use the application. Education had a limited and insignificant effect on a person's likelihood of using a blood donation application [21].

4.2.4 *Best Practices*

The study by Foth et al attempts to identify mobile application design best practices to enhance the recruitment and retention of (young) donors, and optimise their engagement with the application. Co-design was used to inform which features ought to be included in the aforementioned 3 categories, and how users would interact with them. Foth et al focused on using human computer interaction (HCI) to induce behaviour change in users. An important consideration in the study was that different people respond in

different ways to motivational and persuasive (HCI) techniques and technologies. As such, (HCI) techniques to motivate behaviour would not work (in the same way) for each and every user. Foth et al suggested that a customised, or customisable, user experience could counteract this issue. Specifically, it was noted that the application needs to cater for various user archetypes, as well as different types of donors. The main (relevant) types of donors identified were "silent" donors, people who donate and do not share that information with many others, and "sharers", people who share information about their donation activities (often via social media) [4].

4.2.5 Limitations

Since the research conducted by Yuan et al and Foth et al has been used extensively (as we were unable to find other useful sources on the topic), the limitations of the studies must be mentioned. The research by Yuan et al was conducted on past and present donors in urban and suburban areas in the United States of America. As such, people who have not ever donated, and people who live in rural areas, were not included in the study [21]. The study by Foth et al was not performed on a significant large number of participants [4]. Despite their shortcomings, both studies are informative, and the literature does not, to the best of our knowledge, contain any/many alternatives.

4.3 Gamification

Gamification is the use of traditional game mechanics and features to influence or motivate a person to behave in a certain way [11, 16, 10]. Typical gamification mechanics include: badges, challenges, leaderboards, levels, points, quests, social engagement loops, and onboarding. A distinction needs to be made between gamification mechanics that compare users and allow them to compete amongst each other, such as leaderboards, and those that do not, as they motivate users in different ways [16].

In order to be successful, gamification elements need to provide the user with enjoyment and purpose, and they need to be voluntary and positive. [12]. The user's actions also need to directly affect the game's outcome [11]. Merely adding certain gamification elements, such as points, to an application might not have the desired (long term) effect on users [11, 16, 10].

4.3.1 Use in Mobile Health

Gamification has been used in many mobile health (mHealth) applications [12, 10] to incentivise people to manage their health [12], and adopt behaviour that results in positive health outcomes (for themselves or other people). Lister et al found that approximately half of the applications included in their study made at least some use of gamification [10]. Despite the extensive use of gamification elements in mHealth applications, there is minimal research on the effectiveness of gamification in a health context [10].

McCallum noted that it is appropriate to use gamification in a health context, because the health, and health objectives, of a person is reflected in (the state and actions of) the game [11]. The blood donation mobile application proposed by Sundarde et al makes use of gamification mechanics [19]. Gamification mechanics are also used in the research by Foth et al, as a part of their suggested application design to increase blood donor retention [4].

4.3.2 Concerns

Gamification may provide users with an extrinsic motivation to perform an activity or behave in a certain way, which may undermine that user's intrinsic motivation [11, 16]. As a result, if used improperly, gamification might only affect a user's behaviour within the context of the game or application [11]. Furthermore, a user's intrinsic motivation to behave in a certain way could also be diminished [11, 16]. Gamification mechanisms thus need to be aligned with, and derived from, the user's intrinsic motivations to behave in a certain way [16]. Another concern is that gamification may decrease a user's perception of the significance of an activity [11].

Lister et al found that, despite the prominence and popularity of gamification mechanics in mHealth applications, best practices, behavioural theory, and industry standards are often not fully considered or applied. Another criticism is that many mHealth applications merely use gamification in order to promote and encourage use of the application itself, as opposed to long term behavioural change [10].

5. CONCLUSIONS

This literature review has thoroughly assessed the importance of human breast milk, especially for premature, underweight, or sick infants. The nutritional and immunological properties of human breast milk make it a vital medical resource, which results in the best possible health outcomes for infants. Human breast milk is the most healthy and ideal source of food for infants; it is thus essential that infants whose mothers are unable to produce sufficient breast milk have access to donated breast milk.

As such, milk sharing and milk donation practices were thoroughly reviewed. Specific attention was paid to the factors which motivate mothers to donate breast milk to human milk banks. Similarly, the reasons why some mothers are deterred from donating to a human milk bank, or prefer to engage in milk sharing practices, were reviewed in detail.

This literature review proceeded to assess the use of technology, and in particular mobile applications, in the context of milk sharing and milk donation. Little was found in the literature on the use of technology to motivate human milk donation. However, parallels were drawn to the use of technology to motivate blood donation, which was reviewed in order to provide insight into the possible uses of technology to motivate human milk donation. Lastly, the use of gamification to motivate behaviour, specifically in mobile health applications, was discussed.

The literature indicates that technology, and specifically mobile applications, has the potential to motivate mothers to donate human breast milk. Furthermore, techniques such as gamification can be used to increase mothers' motivation to donate.

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