Mobile health app engagement and counselling uptake in fertility patients: a preliminary study

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Abstract

Infertility affects up to one in six Canadian couples and is a challenging experience, associated with increased stress, depression, and decreased quality of life (Cousineau & Domar, 2007; Fisher & Hammarberg 2012; Greil et al., 2010), and some patients may benefit from accessing counselling services. However, the large difference between patients' interest in counselling services and actual uptake (Laflont & Edelmann, 1994; Wischmann et al., 2009;) suggests that some patients may experience barriers to accessing mental health care. Common barriers outlined in the mental health help-seeking literature include a lack of information, especially about recognizing symptoms of mental illness and how to access care (Boivin et al., 1999; Dawadi et al., 2018; Mojtabai et al., 2011; Read et al., 2014), and attitudinal barriers, such as wanting to handle the problem by oneself, and stigma of mental health help-seeking (Clement et al., 2015; Gulliver et al., 2010). Accordingly, the provision of psychosocial information – information that addresses how infertility impacts several domains of a patient's life (such as the couple and broader social relationships), the psychological distress it can cause, and information about coping strategies, including counselling –may be a feasible method of encouraging counselling uptake amongst those who want it.

This thesis presents the results of a pre-post repeated measures study of Infotility, a mobile health app containing information relating to infertility and reproductive health, including psychosocial information. We recruited 166 male and female fertility patients from clinics in Montreal and Toronto. Specifically, we examined: (1) What independent variables (patient characteristics, fertility treatment-related, and psychological factors), were associated with greater engagement with the psychosocial app content; (2) Whether the independent

variables and engagement with the psychosocial content were associated with counselling uptake post-intervention amongst the entire sample of study participants, and; (3) whether the independent variables and engagement with the psychosocial content were associated with counselling uptake amongst the sub-sample of participants with an unmet need for counselling –those who wanted, but did not seek, counselling pre-intervention.

Results indicated that: (1) Having an unmet need for counselling was the only variable significantly associated with greater participant engagement with the psychosocial app content; (2) In the entire sample of participants, the receipt of mental health information from a healthcare provider and greater perceived stress were significantly associated with counselling uptake post-intervention, and; (3) Within the sub-sample of those who expressed an unmet need for counselling, receiving information from a healthcare provider was significantly associated with counselling uptake. Participants who demonstrated greater engagement with the psychosocial app content and those who earned over \$100,000 per year were also more likely to seek counselling post-intervention.

Our results suggest that information provision is a key factor in encouraging counselling uptake in fertility patients, and that healthcare providers play an important role in disseminating this information. Exploratory findings also speak to the potential of using a mobile health app to provide fertility patients with psychosocial information and encourage counselling uptake for those who want it. The primary clinical implication of this research is that to address fertility patients' informational and psychological needs, health care providers should make efforts to provide all fertility patients with psychosocial information, which could be given in-person, or through mHealth patient education materials. Future research should investigate the utility of mHealth information provision for encouraging counselling uptake in a larger sample of fertility patients.

Resume

L'infertilité affecte près d'un couple de Canadiens sur six et est associée à une hausse de stress et de dépression ainsi qu'à une baisse de qualité de vie (Cousineau et Domar, 2007; Fisher et Hammarberg 2012; Greil et al., 2010). Ces patients pourraient bénéficier de services de santé mentale. Cependant, l'écart existant entre l'intérêt exprimé par les patients pour les services de santé mentale et leur réelle utilisation (Wischmann et al., 2009;) suggère une difficulté d'accès aux soins. Les obstacles d'accessibilité incluent: le manque d'information, notamment quant à l'identification des symptômes des troubles mentaux et aux moyens d'accéder aux services de soins (Boivin et al., 1999; Dawadi et al., 2018; Read et al., 2014), et l'attitude, par exemple, la volonté de gérer soi-même le problème et la stigmatisation liée à la santé mentale (Clement et al., 2015). Ainsi, fournir des informations psychosociales pourrait inciter l'utilisation de services de santé mentale. Les informations psychosociales traitent de l'impact de l'infertilité sur divers aspects de la vie des patients (ex : sur le couple et le cercle social), de la détresse psychologique liée à l'infertilité et des stratégies d'adaptation, y compris la consultation en santé mentale.

Cette thèse présente une étude pré-post de mesures répétée évaluant Infotilité, une application de santé mobile contenant des informations relatives à l'infertilité, dont des informations psychosociales. Au total, 166 patients masculins et féminins ont été recrutés en cliniques de fertilité à Montréal et à Toronto. Nous avons examiné: 1) quelles variables indépendantes (caractéristiques des patients et facteurs liés au traitement) étaient associées à une utilisation plus élevée du contenu psychosocial de l'application, et; si les variables indépendantes et l'utilisation du contenu psychosocial étaient associés à l'utilisation de services de consultation après l'intervention 2) chez l'ensemble de l'échantillon de participants et 3) chez un sous-échantillon de participants exprimant un besoin non satisfait de consultation, c'est-à-dire ceux qui voulaient, mais n'ont pas cherché, à consulter avant l'intervention.

Les résultats indiquent que: 1) La seule variable significativement associée à une utilisation plus élevée du contenu psychosocial était le besoin non satisfait de consultation. 2) Chez l'ensemble des participants, recevoir des informations sur la santé mentale de la part d'un professionnel de la santé et percevoir un stress élevé étaient significativement associés à l'utilisation de services de consultation après l'intervention. 3) Chez les personnes ayant eu un besoin non satisfait de consultation, recevoir des informations de la part d'un professionnel de la santé était significativement associé à l'utilisation de services de consultation. Les participants ayant davantage utilisé le contenu psychosocial et ceux gagnant plus de 100 000\$ par an étaient aussi plus susceptibles de chercher à consulter après l'intervention.

Les résultats suggèrent que l'information est un facteur clé pour encourager le recours aux services de consultation en santé mentale chez les patients en clinique de fertilité. De plus, les professionnels de la santé jouent un rôle crucial dans la transmission de ces informations. Des résultats exploratoires témoignent aussi du potentiel d'une application de santé mobile pour transmettre des informations psychosociales et pour encourager le recours aux services de consultation en santé mentale. Cette étude implique qu'afin de répondre aux besoins d'information et de santé mentale des patients en fertilité, les professionnels de la santé devraient leur offrir des informations psychosociales, qu'elles soient communiquées en personne ou par le biais de la santé mobile. De futures recherches devraient examiner l'utilité de l'information offerte via la santé mobile pour faciliter l'utilisation des services de santé mentale dans un échantillon plus large de patients.

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Contribution of Authors

This thesis research was supervised by Dr. Phyllis Zelkowitz and is a part of a larger project funded by the Canadian Institutes of Health Research. Our research team comprises of Dr. Phyllis Zelkowitz, who is the principal investigator, and co-investigators Dr. Peter Chan, Dr. Deborah Da Costa, Dr. Cindy-Lee Dennis, Dr. Carolyn Ells, Dr. Nancy Feeley, Dr. Hananel Holzer, Dr. Kirk Lo, Dr. Neal Mahutte, Dr. Sophia Ouhilal, Dr. Zeev Rosberger, Dr. Janet Takefman, and Dr. Togas Tulandi.

The study design and protocol were conceptualized by our research team; Dr. Zelkowitz oversaw the development of Infotility, the mHealth intervention that is evaluated in the current study. The study utilized a pre-post survey design, the questions and measures for which were selected by our research team. In addition, the members of my advisory committee, Dr. Deborah Da Costa and Dr. Ian Gold aided in the conceptualization of the research questions and the statistical approach for the current study. Participant recruitment and data collection took place at the McGill University Health Centre's Reproductive Health Centre and the Montreal Fertility Clinic in Montreal, and in Mount Sinai Fertility and the Murray Koffler Urological Wellness Centre at Mount Sinai in Toronto. I aided in recruiting participants, and administering follow-up reminders, as did Felicia Brochu, Eden Gelgoot, Paul Grunberg, Rachel Idelson, and Asa Kazerani. Online data collection, data retrieval, and participant compensation was managed by Stephanie Robins and Siobhan O'Connell. I contributed to the creation and cleaning of our final dataset, as did Felicia Brochu, Eden Gelgoot, Siobhan O'Connell and me. In particular, I conceptualized, retrieved, and managed the data for variables describing the extent to which participants engaged with the app.

As a master's student, I reviewed the literature relating to the psychosocial consequences of infertility and the utility of mHealth interventions for encouraging mental help-seeking behaviours. I conceptualized my research questions, conducted the statistical analysis, and prepared a thesis to report and interpret the results.

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Introduction

1. The experience of infertility and its psychosocial consequences

Infertility is the inability to conceive after 12 months of unprotected sexual intercourse. Estimates suggest that 11% to 16% of Canadians experience infertility in their lifetimes (Bushnik et al., 2012). Most men and women desire to reproduce, and parenthood is viewed as an expected stage of adulthood in North American society (as in most societies). Fertility patients are distressed because of their involuntary, and often unexpected, childlessness, and often report feeling as if they've lost control over their life-course (Ulrich & Weatherall, 2000). Patients have described the treatment process as an emotional rollercoaster, with cycles of hope and disappointment (Van den Broek et al., 2010). The treatment procedures themselves can be physically arduous and time-consuming, commonly requiring patients to restructure their daily routines so they can take medications and attend clinic appointments.

Fertility patients also experience distress as a result of the condition's impact on their social relationships. For example, the challenges associated with infertility may cause strain on the couple relationship (Luk & Loke 2015; Petersen et al., 2003). Regarding other social relationships, one common theme in studies of the infertility experience is feeling isolated from the fertile world, as infertile individuals may feel excluded from, or uncomfortable attending, events involving friends and family members with children. Social relationships may also be a source of distress if fertility patients perceive that individuals are unsupportive, or do not understand what they are going through (Cousineau & Domar, 2007).

1.1. The psychological consequences of infertility

For many fertility patients, the inability to have children can be a life crisis, generative of stress and depressive symptomatology (Gerrity et al., 2001). Studies have compared psychological distress in fertile and infertile individuals, with the majority of research on this topic examining outcomes separately by gender. Infertile women generally score higher on measures of distress compared to comparison groups: Women with recurrent pregnancy loss presented with more stress than fertile women, as captured by the Perceived Stress Scale-10 (Coughlan et al., 2014); Compared to population-level norms, infertile women had more anxious and depressive symptoms, as measured by Symptom Checklist-90 (Wischmann et al., 2001); In a population level survey of 11,000 women, those who were infertile scored significantly higher on the Generalized Anxiety Disorder scale compared to those who were fertile (King, 2003); One systematic review examined 9 studies comparing the emotional distress in women prior to starting IVF and population-level norms (and in one case matched controls drawn from routine-care gynecology patients). Fertility patients presented with similar levels of depressive symptomatology as comparison groups, but findings on anxiety were mixed. Four studies reported no difference between fertility patients and the norm groups, while five studies reported increased anxiety amongst the fertility patients. The same review also examined 18 studies assessing emotional distress in female in vitro fertilization (IVF) patients longitudinally, finding that unsuccessful treatment was associated with increased distress and negative emotions (Verhaak et al., 2006).

Although most fertility patients do not develop a major psychological issue, such as a depressive disorder because of their condition (Fisher & Hammarberg, 2012), patients have

recounted experiencing depressive symptoms such as periods of extreme sadness and grief, often in the context of failed cycles of treatment (Williams 1997). Compared to women in the general population, women IVF demonstrated greater short-term social and emotional problems on the Sickness Impact Profile, a measure of the impact of a health issue on daily functioning, compared to women in the general population. However, the study also found no significant differences between the two groups regarding more long-term self-reported psychological complaints (Fekkes et al., 2003). Some research has found an association between increased infertility related distress and depressive symptoms (Peterson et al., 2013). One study compared the psychological burden experienced by fertility patients and patients with other health conditions, finding that fertility patients had anxiety and depression scores that were similar to those of patients with cancer, hypertension, and cardiovascular disease (Domar et al., 1993; Miner et al., 2019).

There are fewer studies measuring psychological distress in fertile and infertile men, and this literature generally reports mixed findings: Compared to men in the general population, men between the ages of 21 and 30 planning IVF treatment demonstrated greater emotional and social problems, as measured on the Sickness Impact Profile. There were no significant differences in these scores between older men planning IVF and the general population, and no significant differences in scores for the psychological complaints (Fekkes et al., 2003). However, another study reported that infertile men do not differ from population norms on the presentation of stress and anxiety, as captured by the Symptom Checklist 90 (Wischmann et al., 2001). A review (with no meta-analysis) of 73 studies related to the psychosocial aspects of male infertility concluded that infertility diagnosis and treatment are associated with increased infertility-specific anxiety in men. The study also concluded that rates of clinically significant mental health problems among infertile men are no different than what is present in the general population (Fisher & Hammerberg, 2012).

Comparative studies of infertility-related distress in men and women generally indicate that women score higher on measures of stress, anxiety and depression compared to men (Greil et al., 2010; Fisher & Hammarberg, 2012). However, several authors have argued that these findings may reflect gender differences in responses to distress generally, as opposed to a gendered response to infertility specifically (Edelmann & Connolly, 2000; Culley et al., 2013; Fisher & Hammarberg, 2012; Wischmann & Thorn, 2013). In other words, a difference in the degree of measured distress should not be interpreted to mean that men do not suffer because of infertility. In fact, extant research of men's experience of infertility indicates that men have a strong desire to have children and are distressed because of their condition (Fisher & Hammarberg, 2012; Peronance et al., 2007; Wischmann & Thorn, 2013).

1.3. Fertility patients may benefit from counselling services

Because of the challenging nature of infertility and its treatment, some patients may benefit from seeking counselling services. There exist different types of counselling services, and Petersen et al. (2012) distinguishes between infertility-specific counselling and psychotherapy counselling. Infertility-specific counselling includes support counselling, such as support for grief after a miscarriage, short-term crisis counselling, such as support after a crisis event such as a failed cycle of IVF, and implications and decision-making counselling, which aims to ensure that that patients are adequately informed about the treatment process. Implications and decision-making counselling can be disseminated by members of the patients' fertility care team, such as their physician. Psychotherapy addresses psychological issues such as anxiety and depression, and can address the couple relationship, for example, marriage counselling.

Apart from implications and decision-making counselling, infertility-specific counselling and psychotherapy are typically administered by mental health professionals, such as a psychologist or a counsellor. The present study uses counselling as an umbrella term to refer to any support service offered by a mental health professional.

A few studies have reviewed the efficacy of psychological interventions for fertility patients' mental health, generally reporting positive to mixed findings. De Liz et al., (2005) conducted a meta-analysis of 10 studies examining the impact of group, couple, and individual psychotherapy on anxiety and depression. Both controlled and uncontrolled studies were included in the analysis. Results indicated a significant and strong effect-size for the reduction of anxiety, and a non-significant smaller effect size for depression.

Another meta-analysis by Frederiksen et al. (2015) evaluated 39 studies of psychosocial interventions. Eligible interventions were broadly defined as anything with a psychosocial aim that did not primarily have a physical focus (such as massage therapy) or include prescribing medication. Again, both controlled and uncontrolled studies were included in the analysis. After accounting for publication bias, the meta-analysis found a small, non-significant effect of the psychosocial interventions on infertility-related distress, depression, and marital function. A small, but statistically significant effect size was found for state anxiety. Interventions utilizing cognitive behavioural therapy demonstrated the largest effect size, followed by mindfulness-based interventions, and all other interventions. However, there was no significant difference in

effect sizes between the intervention types. Overall, the authors reported a significant medium effect size of the interventions on the combined psychological outcomes.

Two studies have reported mixed to negative findings: Boivin (2003) conducted a systematic review (with no meta-analysis) of 25 studies evaluating the impact of psychological and educational programs on well-being. Interventions were categorized as psychological if their primary aim related to "emotional expression and support, and/or discussion of thoughts and feelings," (Boivin 2003). Educational programs aimed to provide knowledge or skills training. Overall, Boivin concluded that the educational interventions were more effective at reducing negative affect (anxiety, depressive symptomatology, and psychiatric morbidity) compared to the psychological interventions.

Finally, a meta-analysis by Hammerli et al., (2009) assessed 21 controlled studies of psychological interventions (defined as a face-to-face intervention based on a psychological theory, and whose primary aim is to improve psychological functioning). The interventions were associated with small and non-significant effect sizes for on mental distress, infertility-specific stress, and interpersonal functioning.

These mixed findings may in part reflect the wide variety of interventions considered in the review studies, which ranged from cognitive behavioural therapy to guided relaxation. In addition, the reviews were not able to examine responses to the psychosocial intervention by participants' initial level of distress. Doing so may have shed more light on the efficacy of the interventions, as some research in patients with other medical conditions, such as cancer, indicates that participants with higher levels of distress may benefit more from mental health interventions (Tamagawa et al., 2012). To summarize, the literature regarding the efficacy of psychological interventions is inconclusive, and better controlled studies are needed in order to ascertain their impact on fertility patients with various levels of distress. However, some studies suggest that there is potential for interventions rooted in cognitive behavioural therapy (Fredericksen et al., 2015) and individual, couple, or group psychotherapy (de Liz & Strauss, 2005) to be useful for patients.

1.4. Fertility patients experience barriers to accessing mental health care services

Although some fertility patients may benefit from counselling, only a small fraction of those who express interest in counselling make use of it. For example, Wischmann et al. (2009) found that 62% of fertility patients sampled demonstrated interest in attending counselling services, but only 34% reported doing so. Likewise, a study by Laflont & Edelmann, (1994) reported that 71% of participants perceived individual counselling sessions as helpful, but only 26% reported receiving some form of psychological help during IVF treatment.

These numbers may reflect that some patients ultimately decide that their mental health concerns do not require psychological services – unsurprisingly, greater psychological distress is associated with both the desire for counselling and uptake in both men and women (Boivin 1999; Pook et al., 2001; Wischmann 2009). However, the discrepancy between interest in counselling and its uptake also suggests that some patients who want counselling experience barriers to accessing it.

One survey study by Boivin et al. (1999) asked 143 fertility patients (84 women and 49 men) about the sources of support they used, and examined barriers to seeking counselling in the sub-sample of female respondents. A factor analysis of female participant responses

grouped barriers into three categories: patients' comfort level with seeking counselling (too shy or scared to use counselling; felt that "only mad people need a counsellor"; or felt awkward about going to counselling); patients' available coping resources (do not feel the need for counselling, can cope with distress, and have sufficient support from friends and family); and, practical concerns (the cost of sessions; did not know who to contact; and had difficulty scheduling sessions). One barrier, that counselling would not help, was related to all three categories in the factor analysis. The study also categorized the female respondents into two groups: those demonstrating higher levels of distress and those with lower levels of distress.

Significantly more participants who were highly distressed stated that they were likely to use counselling services, compared to those who were less distressed (although the study did not report the number of highly distressed participants who had sought counselling). Those with higher distress were significantly more likely to rate practical concerns as reasons for not seeking counselling, as opposed to their comfort with counselling or available coping resources. Conversely, participants who were less distressed indicated that they had not sought counselling because they felt that they had sufficient resources for coping.

Wischmann et al. (2009) surveyed the psychological and sociodemographic characteristics of 535 male and 633 female fertility patients who indicated that they were open to seeking counselling. The authors then offered participants access to a counselling intervention and compared the characteristics of those who utilized counselling and those who did not. Again, psychological distress was strongly associated with counselling uptake (depressive symptomatology and suffering from childlessness for women, and dissatisfaction with marriage/partnership and sexuality for men). Those who used counselling were also more likely to be university educated compared to those who did not (Wischmann et al., 2009). Although this study did not examine barriers to counselling seeking, these findings indirectly speak to facilitators. The authors hypothesized the higher level of education in the counselling uptake group suggests greater acceptance of psychotherapy amongst those with a university education.

A qualitative study of 32 couples undergoing fertility treatment examined the types of support fertility patients wanted and used (Read et al., 2014). Most couples desired some type of psychosocial support (ranging from psychological counselling to peer support), but only half the sample sought it. A prominent theme for not seeking counselling was a lack of information about accessing it. Read et al., (2014) wrote that "Some couples were able to overcome this barrier and seek support on their own, but others were stymied by a lack of "know-how" to find help on their own." Other reasons included negative attitudes towards emotional support and feeling that they did not need a psychologist.

Other studies lend indirect support to practical concerns as a barrier for mental health help seeking. In one survey, fertility patients indicated that they would have utilized counselling sooner had they been made aware of available services at an early stage in their fertility treatment. Again, the number of participants who would like counselling versus those who sought counselling are not clear (Warbrick & Corner, 1993). Another study reviewed the support services offered by fertility clinics in the UK and found that one third of clinics charged for counselling. The study authors hypothesized that the cost of counselling could serve as barrier for uptake (Hernon et al., 1995). Negative attitudes towards counselling and believing that one does not require counselling (attitudinal barriers) are also associated with a lack of uptake, but the extent to which these factors hinder those who are highly distressed from seeking counselling is unclear. One population-based survey in the United States (N=5962) suggests that attitudinal barriers impact help seeking amongst those who are highly distressed. Mojtabai et al., (2011) reported that a lack of perceived need was the primary reason respondents did not use mental health services. However, for those with a perceived need, attitudinal factors, such as wanting to handle the problem on one's own, perceived ineffectiveness, and stigma remained the most commonly reported barriers. This pattern held when stratifying respondents with perceived need by the severity of their mental health symptoms. Other studies, which do not group respondents by perceived need and severity of mental health symptoms, nevertheless also highlight the impact of attitudinal barriers on mental health help seeking (Andrade et al. 2014; Clement et al., 2015; Gulliver et al., 2010).

To summarize the extant research, the discrepancy between interest in counselling services versus uptake suggests that some fertility patients have an unmet need for counselling services. Practical concerns about accessing treatment, such as a lack of information about what services are available, how to access these services, and the cost of treatment seem to be prominent barriers to seeking counselling amongst those who are highly distressed. Attitudinal barriers may also deter distressed fertility patients from seeking counselling.

The extant fertility research presents with some limitations. First, there are relatively few studies examining barriers to mental health help seeking in fertility patients. Second, most studies examined relatively homogenous groups. For example, the studies by Boivin et al.

(1999) and Wischmann et al. (2009) mostly sampled white fertility patients and/or patients who were born in the study country. The exception is Read et al. (2014), where 67% of the sample were immigrants to Canada, although the study did not explicitly examine any differences in barriers to mental health help-seeking between immigrant and non-immigrant fertility patients-Studies of help seeking in the general population indicate that being a man, or a member of a marginalized community is associated with greater barriers to uptake. For example, immigrants are more likely than non-immigrants to experience language, knowledge, and financial barriers when seeking mental health care (Giacco et al., 2014).

In addition, most studies addressing this topic were conducted between 10 to 30 years ago. Patient and healthcare provider (HCP) attitudes regarding the utility of psychological support for fertility patients, and the availability of services, have changed in the past decades (Boivin & Gameiro, 2015). As such, newer studies are required to better capture the help seeking landscape for fertility patients.

2. The provision of information may increase the use of counselling services in fertility patients

Given the prominence of informational and attitudinal barriers to counselling seeking for fertility patients, the provision of information about how infertility can impact a patients' life, the psychological distress it can cause, and information about coping and mental health services (psychosocial information) could be a feasible method of increasing counselling uptake for those who want it.

2.1. Theoretical Rationale

Theoretical models speak to the utility of information provision to encourage help seeking behaviour. The health belief model (HBM) conceptualizes help seeking as a process involving five key patient beliefs that increase or decrease the likelihood of the patient engaging in health-promoting behavior (Stretcher & Rosenstock, 1997). These are: (1) Perceived susceptibility: the extent to which an individual believes that they could suffer from the health problem in question; (2) Perceived severity: the harm associated with the health concern; (3) Perceived benefits: the belief that an intervention or preventative action could reduce their symptoms; (4) Perceived barriers: the barriers against taking the intervention or preventative action. These can include practical barriers (not knowing how to access counselling services, the cost of services and the long waiting times to access them), and attitudinal barriers, such as stigma; (5) Cues to action: Events that remind an individual of the threat of illness. This includes the experience of symptoms, or external cues, such as a health care provider initiating a conversation about health behaviours pertinent to the illness in question (Henshaw & Freedman-Doan, 2009).

Accordingly, information that acknowledges how infertility affects several domains of a patients' life (such as the impact on the couple and their broader social relationships), the psychological distress associated with infertility, and information about coping strategies and mental health resources (collectively referred to as psychosocial information) could help reduce the informational and attitudinal barriers to counselling uptake. The information could serve as a cue to action, helping patients recognize the symptoms of mental distress (perceived severity) and the benefits of engaging in mental health help seeking (perceived benefits). Psychosocial information could also reduce attitudinal barriers to help seeking by normalizing the occurrence of psychological distress, or strain on the couple relationship. Directly telling patients how to access counselling services may also help them overcome a key informational barrier.

2.2. Empirical evidence that information provision is associated with help-seeking behaviour

To the author's knowledge only one study of fertility patients has examined whether the receipt of information was associated with counselling uptake. A survey of 659 fertility patients found that only 20% reported receiving information about accessing mental healthcare services from their HCP. This proportion did not vary by participant characteristics, such as gender, perceived stress, or depressive symptomatology; moreover, the majority of participants who did not receive this information indicated that they would have liked it (Dawadi et al., 2018). The study also reported that people who received information about accessing mental health services from their HCP were about 3 times more likely to seek counselling compared to those who did not receive the information.

There is a small body of research on the association between psychosocial information and mental health help-seeking in other population groups. When evaluating this body of research, it is important to distinguish between studies with help-seeking attitudes and intentions as their primary outcome versus those with help-seeking behaviour as an outcome. Studies of help-seeking attitudes and intentions generally report that informational interventions are effective at improving attitudes and intentions regarding mental health services (Kauer et al., 2014). There are fewer studies examining help-seeking behaviour, and the limited evidence presents with mixed results:

A systematic review by Kauer et al., (2014) included three studies examining informational interventions and help-seeking behaviour: one reported no intervention effect (Costin et al., 2009), and the remaining studies had mixed to positive findings (Collin et al., 2011; Gulliver et al., 2012b). Another systematic review by Gulliver et al., (2012a) assessed two additional studies, both of which found no association between exposure to an informational intervention and help-seeking behaviour (Christensen et al., 2006; Sharp et al., 2006).

These results may reflect the limitations of the field as a whole. Firstly, the quality of the studies are variable (Gulliver et al., 2012a; Kauer et al., 2014). Secondly, most studies assessed mental health help-seeking behaviours in youth aged 14-25 years. Research indicates that help-seeking attitudes, intentions, and behaviours can vary by age (Mackenzie et al., 2006). Because infertility is more common in women over 35 (Bushnik et al., 2012), more research is warranted to examine help-seeking behaviour in an older population. Finally, five of the six studies reviewed above were conducted in Australia, which has different regulations compared to Canada regarding the provision and cost of mental health care services. This applies to fertility patients and members of the general population (Blyth et al., 2012). Accordingly, Canadian studies of interventions to improve mental health help-seeking behaviour would be more applicable to the North American context.

The individual studies also present with limitations: To the author's knowledge, Gulliver et al. (2012b) were the only study authors to examine whether participants had accessed the intervention. Measuring participants' level of engagement with the intervention could shed more light on its efficacy. In addition, the interventions were all under 3 weeks long (with the exception of Christensen et al.,2006), and most of the follow-up surveys were conducted directly after the intervention took place (excepting Christensen et al. (2006), who captured responses at post-intervention, and at six months follow up, and Gulliver et al. (2012b) who captured participant responses at post-intervention, and at three months follow-up). Accordingly, the studies may not have had enough time to capture behaviour change. Finally, only Collin et al., (2011) one examined their data by participants' level of distress. Evaluating behaviour change by participants' initial level of distress, or desire to seek mental health services may help provide a clearer picture of the efficacy of the interventions.

To conclude, there is a paucity of studies assessing the ability of informational interventions to encourage mental health help-seeking behavior in fertility patients, and the small body of literature that examines this question in the general population is of variable quality. However, there may be potential for the provision of psychosocial information to improve counselling uptake in fertility patients.

2.3. Methods of distributing psychosocial information for fertility patients, and the utility of mobile health applications

Fertility patients' HCPs may be a key source of mental health information provision (Dawadi et al., 2018), but research indicates that fertility patients may not be receiving as much psychosocial information as they would like in clinical settings (Dancet et al., 2010; Dawadi et al., 2018; Read et al., 2014; van Empel et al., 2009). There are several reasons why HCPs may not proactively speak to their patients about the psychosocial aspects of fertility treatment. They may expect that patients will talk about the emotionally challenging aspects of fertility treatment or inquire about mental health services if they feel that they need it (Machin et al., 2007). HCPs may also not feel that it is within their purview to provide patients with psychosocial information. In addition, patients may not initiate such a conversation because of stigma associated with mental health help seeking (Machin et al., 2007).

As such, it may be practical to examine the utility of alternative methods of distributing psychosocial information to fertility patients, such as the provision of patient information

materials via a mobile health (mHealth) application (app). mHealth refers to any provision of health-related information and services using a smartphone or mobile device (Free et al., 2013). mHealth is easily accessible, as most Canadians own a smartphone, and rates of ownership are consistent across socioeconomic lines (Fox et al., 2014; Poushter 2016). In addition, members of the general population are already familiar with mHealth apps: In 2013, the United States Food and Drug Administration estimated that 50% of smartphone users had at least one mHealth app downloaded on their phones (The Food and Drug Administration, 2015

There is a paucity of research examining what groups are more likely to use mHealth (and it is important to note that user groups may vary depending on the target audience of an mHealth app). Research into the use of online health information more generally suggests that women and those with a higher level of education are more likely to use it (Kontos et al., 2014; Smail-Crevier et al., 2019). However, given its accessible nature, a fertility mHealth app may have the potential to benefit patient populations such as men and immigrants, who typically experience barriers to accessing fertility health and mental health information.

Furthermore, a mHealth app developed in conjunction with a university or hospital affiliated research group can provide patients with content that is accurate and easy to understand. Online sources of fertility information are readily available on the internet but are often written at a reading level that is much higher than recommended for a general audience (Kahlor & Mackert, 2009; Robins et al., 2016). Moreover, patients report that they prefer using resources recommended to them by their HCP, as opposed to independently evaluating the quality of every website they encounter online (D'Auria, 2010).

The unique modality of mHealth apps may also improve user experience with psychosocial information. By virtue of their touch screen interface, smart phones have the ability to present content in engaging and innovative ways. Content can be presented in a variety of media other than text, such as infographics, diagrams, audio, and video. Finally, researchers can also track the level of patients' engagement with the mHealth app, which may help shed more light on the impact of the psychosocial information on the patient behaviours.

3. Research Questions

The current research aimed to contribute much needed knowledge about the ability of information provision to facilitate counselling seeking in fertility patients. Fertility patients were given access to a mobile health app (Infotility) for 8 weeks. The app aimed to address fertility patients' informational and psychological support needs. We evaluated participants' use of Infotility, and assessed their mental health help-seeking behaviours pre and post intervention.

Specifically, this research examined:

1. What patient characteristics (gender, immigration status, income, education, parity, and age), fertility treatment characteristics (amount of time in treatment, pregnancy success), and psychological characteristics (perceived stress, depressive symptomatology, receiving mental health information from a HCP, wanting to receive counselling) were associated with greater engagement with the psychosocial app content.

2. Were patient characteristics, fertility treatment characteristics, psychological characteristics, and engagement with the psychosocial app content associated with counselling uptake post-intervention?

3. Among fertility patients with an unmet need for counselling pre-intervention, was engagement with the psychosocial app content associated with counselling uptake postintervention?

Methods

1. Participants

Participants were recruited from private and hospital-based fertility and urology clinics in Montreal and Toronto. Eligible participants met the following criteria: (1) they were over 18 years of age, (2) able to answer questions in English or French, (3) owned an electronic device with access to the internet, (4) identified as a man or woman, and (5) were in a heterosexual relationship at the time of recruitment. Sexual orientation was included as a part of our inclusion criteria to limit variability in our participant sample. LGBTQ patients may have different needs, preferences, and experiences of fertility treatment, which should be addressed in future research.

Recruitment took place between October 2018 and January 2019; men and women were recruited separately, not as a couple, so that data on app use (and associated outcomes) would reflect the activity of an individual participant. Across all four clinics 969 participants were approached, 661 of whom agreed to be screened for eligibility and 505 of which were eligible. Of this group 387 consented to participate in the study, 49 refused, and 69 were missed. Reasons for refusal included that participants were not interested, were too busy, were too mentally or physically distressed, or wanted to maintain a distance from their fertility issues. Participants were missed because recruiters were interrupted by a medical appointment, there were no French recruiters available, or there was no time for follow-up.

At the time of analysis, a total of 263 participants completed the pre-survey and 259 downloaded the app. After having access to the app for eight weeks, 166 participants finished both the pre-and post surveys. Of these, 125 were women and 41 were men.



2. Procedure

2.1. Intervention: Infotility – a psychoeducational mHealth intervention for fertility patients

Infotility is a mHealth app designed to address the informational needs of both men and women undergoing fertility treatment. It contains information about treatments and test procedures, fertility health and risks to fertility, mental health and well-being, the social aspects of infertility, as well as a peer-moderated message board. The types of information on the app and the way in which the information was presented were informed by a needs assessment survey of fertility patients (Dawadi et al., 2019a). In addition to choosing app content topics that were relevant to participants' needs, we worked to ensure that all information was scientifically accurate and written in easy to understand language. All content was sourced from scholarly articles identified through a literature review of relevant topics, and then reviewed by patient stakeholders and clinical experts for accuracy and readability. For a more detailed account of the app development process, see Dawadi et al., (2019b). All app content was presented in English and French.

The app also included a message board feature, known as Connect. Users were able to write posts on the forum, read what others had written, and respond to others' posts. Users were also able to communicate with peer-supporters on the forum and via private messages. Peer-supporters were men and women who had previously undergone fertility treatment and were recruited and trained by our research team. For a detailed description of the peer-support component of Infotility and training of the peer-supporters, see Grunberg et al., (in preparation). The study employed a longitudinal pre-post repeated measures design. Participants used Infotility for eight weeks, and completed online questionnaires before and after this period.

Participants were approached by research assistants at the fertility clinics, and those interested in participating were provided with a verbal explanation of the study and screened for eligibility. Those who were eligible and agreed to participate provided written informed consent before proceeding with the study. Once informed consent had been obtained, participants were e-mailed a unique link to access the online survey by signing in with their email addresses and creating a secure password. Once the pre-survey was completed, participants were emailed a link to download the app. The first time they accessed the app, participants were prompted to create a username for themselves and to select an icon that would serve as their avatar. These steps were a part of the onboarding process and were implemented to maintain users' anonymity if they choose to post on the peer-support message board.

After the eight-week intervention period, participants were asked to complete the postsurvey via an email link. Participants received email and phone call reminders if they did not complete either the pre or post-surveys one week after consenting to the study. In addition, participants were emailed reminders to use the app at 2 and 4 weeks. Those who completed both the pre and post surveys were provided a \$25 gift card to either Starbucks or Amazon. Finally, we conducted post-intervention follow-up phone calls to capture responses for items in the post-survey that had a large proportion of missing data. The pre and post surveys were constructed using Information Management Services (IMS), located at the Lady Davis Institute of the Jewish General Hospital in Montreal, Quebec. Respondent data were stored by IMS on Canadian servers, meeting institutional requirements for data security.

<u>Ethics</u>

Ethical approval was obtained from the research ethics committees of the institutions at which recruitment took place. Participants who were screened positive for clinically significant depressive symptomatology were offered a co-intervention by way of referral to a psychologist.

3. Measures

3.1. The Pre-Survey (Time One)

A questionnaire administered prior to app use captured the following independent variables:

Gender: Participants were asked to indicate what gender they identified as. *Immigration status:* Participants were asked whether they were born in Canada, and were able to respond "yes" or "no".

Income: Respondents were asked to indicate their average annual household income. Response categories were less than \$40,000 per year, \$40,000 -\$59,000 per year, \$60,000-\$79,000 per year, \$80,000 -\$99,000 per year, \$100,000-\$119,999, \$120,000-\$139,999, \$140,000-\$159,999, and over \$160,000 per year. In the current study, income was dichotomized as above, or equal to, the median category of \$100,000 per year, and below the median category.
Education: We asked participants to indicate the highest level of education they had completed out of elementary school; high school; pre-university, technical college or a trade or vocational school; an undergraduate university degree; a graduate university degree. Education was dichotomized as having a university degree versus not having a university degree.

Time in treatment: Respondents indicated how many years and months they had been in fertility treatment. To distinguish between newer fertility patients, and those who have spent more time in treatment and are more familiar with the treatment process, or may have experienced several treatment failures, this variable was dichotomized into those who had been in treatment for less than a year, and those who had been in treatment for one year or longer.

Parity: Participants were asked how many children they had. Those with no children were categorized as having primary infertility, while those with one or more children were categorized as having secondary infertility.

Counselling (Time One): We asked whether participants had sought psychological counselling during fertility treatment. Participants were able to respond "yes" or "no".

Desire for counselling: Those who indicated that they had not sought counselling were asked if they would like to access it. Participants were able to respond "yes" or "no", and those who indicated that they had not sought counselling, but would have liked to access it were categorized as having an unmet need for counselling.

3.2. The Post Survey (Time Two)

The post survey asked additional questions about treatment outcomes and help-seeking behaviours over the course of the study.

Treatment success: Participants were asked if they had achieved a pregnancy during the intervention period and were able to respond "yes" or "no".

Miscarriage: Participants indicated whether they had a pregnancy loss during the study period. Those who reported achieving a pregnancy, but had not experienced a pregnancy loss were categorized as being pregnant at time two. Respondents who did not get pregnant, or reported a pregnancy loss were categorized as not being pregnant at time two.

Mental health information: Respondents indicated whether or not they had received mental health information from their HCP.

Desire for mental health information: Those who stated that they had not received mental health information from their HCP were asked if they would have liked it.

Participants were able to respond "yes" or "no".

Counselling (Time Two): We asked whether participants had received psychological counselling during the study. Participants were able to respond "yes" or "no".

3.3. Outcome of interest – Counselling uptake post-intervention:

Our outcome of interest is one response category within a variable capturing change in counselling behaviour pre and post intervention. Change in counselling behaviour was operationalized by examining participants' use of counselling services across time one and time two. We coded the variable into four different categories: (1) those who did not seek counselling at either time point; (2) those who reported being in counselling at both time points; (3) those who sought counselling at time one, but not at time two, and; (4) those who did not seek counselling at time one, but sought counselling at time two. This final category is our outcome of interest, and is also referred to as counselling uptake.

3.4. Psychological characteristics

Participants' psychological characteristics were captured in both the pre and post surveys:

Perceived stress: This was captured using the Perceived Stress Scale-4 (PSS-4), a validated and reliable measure of the extent to which a person appraises the occurrences in their life as stressful (Cohen et al., 1983). The PSS-4 consists of four questions scored on a 5 point Likert-type scale. Total scores are calculated by reverse-scoring responses to items 2 and 3 of the scale, and then summing across all four items. Total scores range from 0 to 16, with higher scores indicating greater stress. There are no validated cut-off scores for this measure.

Lee et al., 2012 reviewed the psychometric properties of the PSS-4 across six studies, finding that internal consistency scores for the measure ranged from a Cronbach's alpha of 0.60 to 0.82. A prior study conducted by our research team administered the PSS-4 on a sample of 647 fertility patients attending clinics in Toronto and Montreal finding a Cronbach's alpha of 0.71 (satisfactory) for the measure (Dawadi et al., 2018). According to Cohen et al. (1983), the PSS-4 has demonstrated strong criterion validity measured against the Stress and Life Events scale, the Centre for Epidemiologic Studies Depression scale, ad the Medical Outcomes Study Short Form Survey (Cohen et al., 1983; Mitcell et al., 2008). In addition, the PSS-4 can be quickly administered and is a feasible method of capturing stress in clinical settings (Cohen et al., 1983; Lee et al., 2012).

Depressive Symptomatology: This was measured using the nine-item Patient Health Questionnaire (PHQ-9), a validated screening and diagnostic tool (Kroenke et al., 2001). The PHQ-9 consists of nine questions, each scored on a four-item Likert type scale. Total scores are obtained by summing the responses to each question. Scores range from 0 to 27, with higher scores indicating greater symptomatology.

The PHQ-9 demonstrates excellent internal consistency reliability, demonstrating a Cronbach's alpha of between 0.86 and 0.89 in one study of 6000 primary care and gynecological patients (Kroenke et al., 2001). The PHQ-9 also demonstrates adequate construct validity, being significantly correlated to the mental health subscale of the 20-item short form survey, and the depression subscale of the Hospital Anxiety and Depression Scale (Cameron et al., 2008; Kroenke et al., 2001). The measure has validated cut-off scores; values ranging from 0-4 indicate none to minimal depressive symptomatology; 5-9 indicate mild symptoms; 10-14 indicate moderate symptoms; 15-19 indicate moderately severe symptoms, and; 20-27 severe symptoms. One review of the PHQ-9's psychometric properties determined that a cut-off score of 11 as a positive screen for depression demonstrated an acceptable level of sensitivity and specificity (Manea et al., 2011). The present study classified participants as having clinically significant depressive symptomatology if they scored 10 or higher on the PHQ-9, or answered affirmative to any items relating to self-harm. Both the PSS-4 and the PHQ-9 have previously been used in studies of fertility patients, and have demonstrated acceptable reliability and construct validity (Dawadi et al., 2018)

Co-intervention: Participants who scored greater than 10 on the PHQ-9, or responded affirmatively to one question in the measure that asked about self-harm, were called by a member of our research team and offered a referral to a psychologist. These participants were tracked by the research team during the study.

3.5. Engagement with the psychosocial app content

All informational pages on the app were systematically organized into first-order content categories. We then merged select first-order categories (pages relating to stress, coping, couple issues, and family and friends) to create a broader category representing pages containing psychosocial information. These pages were chosen because they spoke to the participant's mental health, but also to the domains of life that are negatively impacted by infertility and are often a source of stress for fertility patients, such as the couple relationship and broader social relationships. Table 1 lists all the app pages categorized as psychosocial content.

Page Title	First-Order Category
What you can do – mental well being	Stress
What you may be thinking	Stress
Changing negative thoughts	Stress
Why does your stress level matter?	Stress
How do we know when it's more than stress?	Stress
What you can do when you're feeling stressed	Coping
Communication tips and how to improve it	Couple's Issues
Couple time and intimacy	Couple's Issues
Couple issues	Couple's Issues
What you can do – your relationships	Couple's Issues
Languages of love and care	Couple's Issues
Sex	Couple's Issues
What about other people's baby news	Friends and Family
To share or not to share	Friends and Family
Social support issues	Friends and Family
You've decided to tell – now what?	Friends and Family
Who to tell and when	Friends and Family

Table 1: App pages within the psychosocial information category

3.6. Measuring App Engagement

Engagement data, measuring the extent to which a participant used the app, were tracked by the app during the eight-week intervention period using Google Analytics, a software that collects data about website traffic. A user was defined as a participant who downloaded the app and viewed at least one page.

We elected to capture engagement by creating an index of several variables, a choice that was informed by a review of the emergent literature about engagement with mHealth interventions or online websites. Engagement behaviour is a multi-dimensional construct that may not be adequately captured with a single measure (Taki et al., 2017; Sieverink et al., 2017). A single-measure approach might utilize a variable such as the total number of website log-ins to capture engagement. However, incorporating other metrics, such as the types of actions a user completes while logged on, the amount of time they spent on the website per session, and the extent to which they return to the site over time, may provide researchers with a more indepth construct of user engagement behaviour (Sieverink et al., 2017. This multi-dimensional approach is informed by Lehmann et al.'s (2012) classification of the different facets of engagement: popularity, the extent to which the website is used; activity, which captures *how* the website is used, and; loyalty, which captures how often users return to a website over time.

Determining which variables to include in the engagement index was an iterative process, informed by the engagement literature, the research questions we were interested in exploring, and what metrics were available for download from Google Analytics. We choose to download six variables from Google Analytics:

Page Views: The number of times a participant viewed a page on Infotility.

Unique Pageviews: The number of sessions over which a participant viewed a page. A session was defined as a continuous period of activity on the app: a session started when the user interacted with the app and ended after 60 minutes of inactivity. *Time on Page:* The amount of time a participant spent on a page, measured in seconds. *Bookmark:* Whether or not a participant bookmarked a page, measured as a dichotomous variable

Participants were also able to indicate on the app whether they found a certain page to be helpful or not. This was captured using the following metrics:

Set Helpful Yes: Whether or not a participant indicated that they found a page helpful, measured as a dichotomous variable.

Set Helpful No: Whether nor not a participant indicated that they did not find a page helpful, measured as a dichotomous variable.

All engagement variables were captured per user per app page. Accordingly, variables could be calculated for the entire app, or for a specific set of pages.

We then conducted a factor analysis using principal factor extraction to determine which variables best captured the latent variable of engagement. The first factor had an Eigenvalue of 2.94, accounting for 75% of the variation in the data. Factor 2 had an Eigenvalue of 0.70 and accounted for 28% of the variable, and factor 3 had an Eigenvalue of 0.11 and accounted for 3% of variance. The remaining factors had negative Eigenvalues. Unique page views per session had the strongest association to Factor 1, with a factor loading of 0.97, followed by page views (0.97) and time on page (0.90). The other engagement variables had considerably weaker associations with Factor 1: set helpful yes had a loading of 0.51, set helpful no had a loading of 0.07, and bookmarks had a loading of 0.38. The variables with the strongest associated with Factor 2 were set helpful yes, with a loading of 0.57, and bookmarks, with a loading of 0.43.

We elected to create an engagement index using the variables with the strongest factor loadings for Factor 1: page views, unique page views per session, and time on page. We chose not to incorporate the variables in Factor 2 because the factor had an Eigenvalue below zero. Moreover, Factor 1 explained a sufficiently large proportion of the variance in the engagement data. Because only one factor was extracted from the data, we did not proceed with factor rotations.

The present study utilizes an engagement index calculated for all the app content (Total Engagement Index), and an engagement index calculated for app pages relating to the psychosocial challenges of infertility (Psychosocial Engagement Index).

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To create the total engagement index, we first individually log-transformed each of the three engagement variables (page views, unique page views per session, and time on page) to normalize their distribution. We then standardized the transformed variables so that all values were reported in units of standard deviations. The three variables comprising the total engagement index demonstrated excellent internal consistency, with a Cronbach's alpha value of 0.97. Finally, we created an index score by summing the variables and dividing by three, the total number of engagement variables included in the index.

To create the psychosocial engagement index, we first individually linear transformed all engagement variables by adding one to all values. This was done to ensure that no values were dropped during the log-transformation process: the log of zero is undefined, and users who did not view any psychosocial pages incurred values of "0" for page views, time on page, and unique pageviews per session. The subsequent steps were the same as for the total engagement index: we log-transformed, and then standardized the variables. The three engagement variables demonstrated excellent internal consistency, with a Cronbach's alpha value of 0.98. We again summed the variables and divided by three to obtain the psychosocial engagement index values. Because the engagement indexes are reported in units of standard deviations, the mean value is 0, the standard deviation is 1.

The initial step of linear transformation was not required when calculating the total engagement index, because a user in the current study is defined as a participant who has viewed at least one page of app content. By default, there are no users with a value of "0" for total pageviews across the entire app.

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Both the total and psychosocial engagement indexes are conceptualized as a continuous scale: participants with fewer page views (or none, in the case of the psychosocial engagement index) are included in the lower end of the scale. Again, the mean for the psychosocial engagement index is 0 and the standard deviation is 1.

The psychosocial engagement index is left-skewed because non-viewers were included in the index (skewness statistic = 0.85). To ensure that parametric tests, such as t-tests, could be reliably conducted on this data, we tested whether randomly-drawn subsamples of the data approached a normal distribution, per the central limit theorem. The number of values in the randomly-drawn subsample indicates the minimum number of values required in the full dataset in order for parametric tests to be reliable. Using a bootstrapping method, we determined that a sample size of 8 was sufficient to ensure that the data tended towards a normal distribution. For example, in the context of an independent sample t-test, each group should have at least 8 values for the test to be reliable.

Finally, in addition to creating the total and psychosocial engagement indexes, we also measured how many people viewed at least one page of the psychosocial app content. This was captured by summing the total number of pageviews per user for every page in the psychosocial section.

4. Data Analysis and Statistical Approach

4.1. Statistical Approach

Independent sample t-tests, chi-square tests, and correlations were used to investigate associations between the independent variables in the study. Bivariate analysis examined the associations between the independent and outcome variables in all three research questions. Finally, for the first two research questions, multi-variate analysis (a multinomial logistic regression) was used to investigate the relationships between variables that were significant in the bivariate analysis and the outcome variables.

4.2. Research Questions

Question 1: Which factors related to engagement with the psychosocial content?

Independent sample t-tests were conducted to examine which independent variables were associated with psychosocial engagement. An ordinary least squares linear regression was then used to model the relationship between psychosocial engagement and the independent variables that were significant in the bivariate analysis.

Question 2: In the total sample of participants, what factors were associated with counselling uptake post-intervention?

Chi-square tests investigated the relationships between the independent variables and counselling uptake post-intervention. A one-to-one multinomial logistic regression was included in the bivariate analysis to investigate engagement with the psychosocial app content and counselling uptake post-intervention. Multivariate analysis using a multinomial logistic regression then modelled the relationship between the variables that were significant in the bivariate analysis counselling uptake post-intervention.

Question 3: Among participants with an unmet need for counselling, what factors were associated with counselling uptake post-intervention?

All analyses were conducted on the sub-sample of participants with an unmet need for counselling – those who did not receive counselling pre-intervention, but would have liked to. In the bivariate analysis, an independent samples t-test was used to assess the relationship

between the continuous independent variables (psychosocial app engagement, total app engagement, and perceived stress) and counselling uptake post-intervention. Chi-square tests were used to examine associations between the categorical independent variables and counselling uptake, and Fisher's exact p-value was used when comparing groups with sample sizes less than five. Given the small number of participants in the sub-sample of those with an unmet need for counselling, the current study did not proceed with further regression analysis.

Results

1. Descriptive characteristics of participants

Table 2 presents the descriptive characteristics of the sample. Of the 166 participants in the study, about three-quarters of our sample were women and one-quarter were men. Approximately two-thirds of our sample were born in Canada. In addition, a third of the participants had completed at least a bachelor's degree. Four out of five participants were experiencing primary infertility, while one in five participants experienced secondary infertility. Median household income fell between \$100,000 to \$199,999 per year.

1.2. Fertility treatment characteristics

At pre-intervention just over half of our sample indicated that they had undergone fertility treatment for less than one year, while the remainder indicated that they had been in treatment for one or more years. At post-intervention, about one in five participants reported getting pregnant with no miscarriage, while the remaining participants either did not report a pregnancy or reported both a pregnancy and a miscarriage.

1.3. Psychological characteristics:

The mean pre-intervention perceived stress score of the sample was 6.64, with values ranging from 0 to 16. Approximately one in five participants were screened as having clinically significant depressive symptomatology. The remaining participants did not demonstrate clinically significant symptomatology.

At pre-intervention, approximately one in five participants said they had sought counselling, and the remaining participants said they had not. Of this group, about half indicated that they would like to have counselling (this sub-sample hereafter referred to as those with an unmet need for counselling). The other half reported that they did not want counselling.

At post-intervention, again about one in five participants reported using counselling during the study, and the other participants stated that they had not used it. Fewer than one fifth of our sample received mental health information from their HCP; the vast majority did not receive the information. Of those who did not receive the mental health information, about half indicated that they would have liked the mental health information, and half indicated that they would not.

Similarly, amongst the sub-sample of fertility patients with an unmet need for counselling, fewer than one fifth of participants indicated that they had received mental health information from their HCP, and the vast majority said they had not.

1.4. Engagement with the app and the psychosocial content

Because the engagement indexes were reported in units of standard deviations, the mean value for both the total engagement index and the psychosocial engagement index was 0, with a standard deviation of one. The total engagement index had a range of -2.54 to 2.71 standard deviations, and the psychosocial engagement index had a range of -0.78 to 3.18 standard deviations.

Across the intervention period, amongst the entire sample of 166 participants, 74 (44.57%) viewed at least one page of the psychosocial app content, while 92 (55.42%) did not view any of the pages. The psychosocial content garnered an average of 2.8 views per user over the intervention period, with number of total views per user ranging from 0 to 71.

Amongst the sub-sample of 65 participants with an unmet need for counselling, 37

(56%) viewed at least one page of the psychosocial app content, while 28 (43%) did not view

any of the psychosocial pages. On average, this sub-sample viewed 4.51 pages of psychosocial

content, with the number of total views per user ranging from 0 to 71.

Pre-Intervention Independent Variables	Frequency (Percent)	Missing Frequency (Percent)
Patient characteristics		
Gender		
Woman	125 (75.30%)	0 (0%)
Man	41 (24.70%)	
Immigration Status		
Immigrant	58 (34.94%)	2 (1.20%)
Non-Immigrant	106 (63.86%)	
Annual Household Income		
Over 100,000/ year	101 (60.84%)	1 (0.60%)
Under 100,000/ year	64 (38.55%)	
Education		
University educated	126 (75.90%)	0 (0%)
Not university educated	40 (24.10%)	
Parity		
Primary Infertility	134 (81.21%)	
Secondary Infertility	31 (18.79%)	1 (0.60%)
Fertility Treatment Characteristics		
Time in Treatment		
Less than one year in treatment	91 (54.82%)	4 (2.41%)
One or more years in treatment	71 (42.77%)	
Psychological Characteristics		
PHQ-9 Scores (Depressive Symptomatology)		
Above PHQ-9 cut-off	35 (21.08%)	6 (3.61%)
Under PHQ-9 cut-off	125 (75.30%)	
Use of Counselling		
Sought psychological counselling during	29 (17.47%)	0 (0%)
fertility treatment		
Did not seek psychological counselling	137 (82.53%)	
during fertility treatment		
Desire for Counselling		
Unmet need for counselling: Did not seek	65 (47.45%)	1 (0.73%)
counselling but wanted it		
Did not seek counselling and did not	71 (51.82%)	
want it		
	Mean	Missing Frequency (Percent)
PSS-4 scores (Perceived Stress)	6.64 (3.26)	1 (0.60%)

Tab	le 2:	Descripti	ive chara	cteristics	of	participants
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Post-Intervention Independent Variables	Frequency (Percent)	Missing Frequency (Percent)
Fertility Treatment Characteristics		
Treatment Success		
Achieved a pregnancy	23 (13.86%)	5 (3.01%)
Did not achieve a pregnancy	138 (83.13%)	
Psychological Characteristics		
PHQ-9 Scores (Depressive Symptomatology)		
Above PHQ-9 cut-off	30 (18.07%)	17 (10.24%)
Under PHQ-9 cut-off	119 (71.69%)	
Receipt of mental health information from		
НСР		
Received information	26 (15.66%)	4 (2.41%)
Did not receive information	136 (81.93%)	
Desire for mental health information		
Did not receive, but wanted mental	68 (50.00%)	1 (0.74%)
health information		
Did not receive and did not want mental	67 (49.26%)	
health information		
Use of Counselling		
Sought psychological counselling during	30 (18.07%)	4 (2.41%)
study		
Did not seek psychological counselling	132 (79.52%)	
during study		
	Mean (SD)	Missing frequency (Percent)
PSS-4 scores (Perceived Stress)	6.25 (3.07)	8 (4.82%)

Note: PSS-4 refers to the four-item Perceived Stress Scale, and PHQ-9 refers to the nine-item Patient Health Questionnaire.

2. Outcome variables

Counselling Uptake Post-Intervention: Regarding counselling behaviour across both time

points, 121 (72.89%) did not seek counselling at either pre or post, 18 (10.84%) sought

counselling at both time points, 11 (6.63%) sought counselling at pre-intervention only, and 12

(7.23%) sought counselling at post-intervention only (counselling uptake).

3. Significant associations between independent variables

Clinically significant depressive symptomatology—that is, scoring over 10 in the PHQ-9

scale—was significantly more likely to occur in women compared to men (27.27% of women

versus 7.32% of men; X2(1) = 7.06, p=0.0008), amongst those who wanted counselling preintervention (72.73% of those who wanted counselling versus 27.27% of those who did not; X2(1)=6.65, p=0.01), and amongst those who wanted to receive mental health information from their HCP (76.67% wanted the information versus 23.33% who did not; X2(1)=11.68, p=0.001)

Higher perceived stress scores were significantly associated with being a woman (mean women = 7.05, mean men = 5.59; t(166)=-2.53, p=0.006), spending one or more years in treatment (mean over one year=7.16, mean under one year=6.10; t(159)=2.05, p=0.021), depressive symptomatology (mean clinically significant symptoms=10.00, mean not clinically significant=5.81; t(159)=-8.08, p<0.000), and wanting counselling pre-intervention (mean want counselling = 7.52, mean did not want counselling = 5.37; t(135)=-4.00, p<0.000). Interestingly, those who received mental health information from their HCP were likely to be less stressed than those who did not (mean received information = 5.7, mean did not receive = 6.90; t(159)=1.63, p=0.052). Of those who did not receive mental health information, those who wanted it had significantly greater stress than those who did not want it (mean want information=8.11, mean did not want=5.65, t(132)=-4.75, p<0.000)

None of the other independent variables were significantly associated with depressive symptomatology, perceived stress, or wanting counselling pre-intervention. Appendix A presents all non-significant results.

	Under PHQ	Over PHQ	Chi Square	Mean PSS-4	T-test
	Cut-Off	Cut-Off	Test	scores (SD)	
	Frequencies	Frequencies			
Gender		1	1		1
Woman	88 (72.73%)	33(27.27%)	X2(1) = 7.06,	7.05 (3.27)	T(163)=-2.71,
			p =0.0008		p=0.004
Man	38 (92.68%)	3 (7.32%)		5.59 (3.11)	
Time in Treatment					
Under one year in				6.10 (3.13)	T(159)=2.05,
treatment					p=0.021
One or more years in				7.16 (3.33)	
treatment					
PHQ-9 Scores (Depressive					
Symptomatology)					
Under PHQ cut-off				5.82 (2.81)	T(157)=-7.97,
					p≤0.000
Above PHQ cut-off				10.00(2.45)	
Desire for counselling					
Wanted counselling	46 (42.59%)	16 (72.73%%)	X2(1)=6.84,	7.52 (3.17)	T(133)=-4.14,
_			p=0.009		p≤0.000
Did not want counselling	63 (57.41%)	6 (27.27%%)		5.37 (2.86)	
Receipt of mental health		1			1
information from HCP					
Received information				5.77 (3.20)	T(163)=1.59,
				, , , , , , , , , , , , , , , , , , ,	p=0.052
Did not receive				6.90 (3.23)	
information					
Desire for mental health		1			1
information					
Wanted mental health	42 (41.18%)	23 (76.67%)	X2(1)=11.68,	8.12 (3.09)	T(132)=-4.74,
information			p=0.001		p≤0.000
Did not want mental	60 (58.82%)	7 (23.33%)		5.65 (2.91)	
health information	. ,	, ,		. ,	
Note: PSS-4 refers to the fo	ur-item Perceive	d Stress Scale, and	PHQ-9 refers t	o the nine-item	Patient Health
Questionnaire.		-			

Table 4: Significant associations at time one between independent variables and psychological distress

Research Question 1: Which factors relate to engagement with the psychosocial content?

4.1. Bivariate Analysis

T-tests and Pearson correlations revealed that greater engagement with the psychosocial app content was significantly associated with having clinically significant depressive symptomatology (mean clinically significant=0.41, mean not clinically significant)= - 0.10; t(158)=2.70, p=0.003), perceived stress (Person's R=0.17, p=0.033) and wanting counselling pre-intervention (mean wanted counselling = 0.31, mean did not want = -0.30, t(134)=-3.72, p=0.003). Unsurprisingly, greater total engagement with the app content was associated with greater engagement with the psychosocial content (Pearson's R=0.21, p=0.007).

Men were less engaged (mean = -0.26) with the psychosocial app content than women (mean = 0.08; t(164)=-1.94, p=0.027). Those with secondary infertility were less engaged (mean =-0.33) than those with primary infertility (mean = 0.08; t(163)=2.15, p=0.017). No other independent variables were significant in the bivariate analysis.

4.2. Regression Analysis

A multiped linear regression was calculated to further examine the relationship between the independent variables that were significant in the bivariate analysis (gender, parity, depressive symptomatology, perceived stress, and desire for counselling) and the outcome, engagement with the psychosocial app content. Engagement with the total app was omitted from this regression analysis because of the variable's high correlation with the outcome. Results indicated a significant regression model, F(5,122)=3.91, p=0.0025 that explained

13.81% of variance in participant responses. Wanting counselling pre-intervention was the only

variable significantly associated with greater psychosocial engagement (B=0.51, SE=0.25,

p=0.005).

Table 6 : Summary of a linear regression investigating engagement with the psychosocial app content					
Time One Variables	В	SE	Р	95% CI	
Gender - Female (ref: male)	0.22	0.19	0.244	[-0.15, 0.60]	
Parity - Secondary Infertility (ref: primary infertility)	-0.37	0.21	0.083	[-0.74, 0.10]	
PHQ-9 scores - Clinically significant depressive symptomatology (ref: not clinically significant)	0.45	0.25	0.078	[-0.05, 0.95]	
Desire for counselling – Wanted counselling (ref: did not want counselling)	0.51	0.18	0.005	[0.16, 0.87]	
PSS-4 Scores (continuous)	-0.04	0.03	0.257	[-0.10, 0.03]	
Constant	-0.17	0.23	0.459	[-0.69, 0.24]	
Notes: CI = confidence interval for beta values; SE = St	andard Erro	r.			

otes: CI = confidence interval for beta values; SE = Standard Error. PSS-4 refers to the four-item Perceived Stress Scale, and PHQ-9 refers to the nine-item Patient Health Questionnaire.

F(5,122)=3.91, p=0.0025, R-Squared =0.14, adjusted R-Squared=0.10

Research Question 2: What factors were associated with counselling uptake post-intervention amongst the entire sample?

5.1. Bivariate Analysis

Chi-Squared tests indicated that those who received mental health information from a

HCP were significantly more likely to seek counselling post-intervention compared to those who

did not (19.23% of those who received information versus 5.15% of those who did not receive

it, X2(3) =10.50, p=0.014). A one-to-one multinomial regression examined the relationship

between perceived stress and counselling uptake. The model was significant (X2(6) =13.95,

p=0.003). Compared to the baseline outcome of not seeking counselling at all, greater stress

was associated with a 1.29 relative risk of using counselling at pre and post-intervention

(SE=0.11, p=0.003), and a 1.27 relative risk of counselling uptake post-intervention (SE =0.13,

p=0.017).

Engagement with the entire app and engagement with the psychosocial app content were not significantly associated with counselling uptake post-intervention, nor were any of the other independent variables considered in the study.

Table 7: What independent variables are associated with counselling uptake amongst the entire
sample?

		Frequencies				
	No Counselling	Counselling at pre-only	Counselling at pre and post	Counselling at post-only (counselling uptake)	Chi Square Test	
Receipt of mental health information from HCP						
Received mental health information	16 (61.54%)	0 (0%)	5 (19.23%)	5 (19.23%)	X2(3)= 10.50, p=0.015	
Did not receive the information	105 (77.21%)	11 (8.09%)	13 (9.56%)	7 (5.15%)		

One-to-one Multinomial Logistic Regression: X2(6)=13.95, p=0.003, log likelihood =-128.41							
	NoCounselling at pre-onlyCounselling at pre and postCounselling						
PSS-4 scores	Base	RRR=1.02,	RRR=1.29,	RRR=1.27,			
	outcome	SE=0.10,	SE=0.11,	SE=0.13,			
		P=0.833	P=0.003,	P=0.017,			
		CI [0.83, 1.25]	CI [1.04, 1.55]	CI[1.04, 1.55]			

Note: Fisher's exact p is reported in cases when cell size is smaller than 5.

RRR = Relative risk ratio, SE = Standard Error, CI = 95% confidence intervals.

PSS-4 refers to the four-item Perceived Stress Scale, and PHQ-9 refers to the nine-item Patient Health Questionnaire.

5.2. Regression Analysis

A multinomial logistic regression model investigated the relationship between perceived

stress, receiving mental heath information from a HCP, and counselling uptake post-

intervention. The model was significant (X2(6) =28.80, p=0.0001), and results indicated that,

compared to not seeking counselling at all, receiving mental health information from a HCP

(Relative Risk Ratio = 8.14, SE = 5.86, p=0.004), and greater perceived stress (Relative Risk Ratio

= 1.36, SE =0.15, p=0.005) were both significantly associated with counselling uptake.

Table 8: Summary	<u>of a multinomial</u>	logistic regression	investigating	<u>counselling</u>	<u>behaviour</u>	amongst
the entire sample						

	No Counselling	Counselling at pre-only	Counselling at pre and post	Counselling at post-only (uptake)
PSS-4 scores (continuous)	Base	RRR =1.00	RRR=1.34	RRR=1.36
	outcome	SE=0.10	SE=0.12	SE=0.15
		P=0.98	P=0.001	P=0.005
		CI [0.81, 1.22]	CI [1.12, 1.61]	CI [1.10, 1.69]
Received mental health	Base	RRR=4.47e-7 ¹	RRR = 4.26	RRR = 8.14
information from HCP (ref: did	outcome	SE=0.0	SE = 2.78	SE= 5.86
not receive)		P=0.99	P= 0.026	P= 0.004
		CI [0]	CI [1.19,	CI [1.98, 33.40]
		0.[0]	15.29]	

X2(6)=28.80, p=0.0001, Pseudo R2=0.11, Log Likelihood = -120.98

1: Values approach 0 because of the complete separation between counselling behaviour and receiving mental health information from a HCP. That is, there were no participants who received mental health information and sought counselling at pre-only (see Table 7 for cross tabs). Because seeking counselling at pre-only was not the outcome variable of interest, no adjusted regressions were performed to account for the complete separation.

Notes: RRR = Relative risk ratio; SE = Standard Error; CI = 95% confidence intervals. PSS-4 refers to the four-item Perceived Stress Scale.

Research Question 3: Amongst the sub-sample of participants who wanted counselling preintervention, what factors were associated with counselling uptake post-intervention? *6.1. Bivariate Analysis*

All analysis was conducted on the sub-sample of 65 participants who had indicated that

they wanted, but did not access, counselling pre-intervention. Chi-Squared Tests revealed that

participants who received mental health information from a HCP were significantly more likely

to seek counselling compared to those who did not (40% of those who received information

versus 7.27% of those who did not; X2(1)=8.40, p=0.016). In addition, those who had an annual

income of over \$100,000 per year were also significantly more likely to seek counselling

compared to those who did not (20% of those making over \$100,000 per year vs. 0% of those

making under \$100,000 per year; X2(1)=5.70, p=0.019). T-test results indicated that greater

engagement with the psychosocial app content was associated with counselling uptake (mean

engagement of those who sought counselling = 0.92, mean engagement of those who did not =

0.22, t(63)=-1.74, p=0.044).

No other independent variables, including total engagement with the app, were

associated with counselling uptake for this sub-sample.

Table 9: Significant Bivariate associations between counselling behaviour amongst those who wanted, but did not receive, counselling pre-intervention

	No Counselling	Counselling at pre-only	Counselling at pre and post	Counselling at post-only	Chi Square Test			
Received mental	6 (60%)	N/A	N/A	4 (40%)	X2(1)=8.40,			
nealth information					p=0.016			
Did not receive the	51 (92.73%)	N/A	N/A	4 (7.27%),				
information								
Earn over \$100,000	32 (80%)	N/A	N/A	8 (20%)	X2(1)= 5.70,			
per year					p=0.019			
Earn under	25 (100%)	N/A	N/A	0 (0%)				
\$100,000 per year								
	Means (S	D) for continu	ous independent	variables				
	No	Counselling	Counselling at	Counselling	T-Test			
	Counselling	at pre-only	pre and post	at post-only				
Engagement with	0.22 (1.05)	N/A	N/A	0.92 (1.14)	T(63)=-1.74,			
the psychosocial					p=0.044			
app content								
Note: Fisher's exact r	Note: Fisher's exact n is reported in cases when cell size is smaller than 5							

Discussion

The current study investigates whether engagement with a fertility health app (Infotility) is associated with counselling uptake amongst a sample of fertility patients. First we examined the relationship between participants' sociodemographic, treatment, and psychological characteristics and their engagement with the psychosocial content on the app. We then examined whether engagement with the psychosocial app content and participant characteristics were associated with counselling uptake post-intervention. Finally, we analysed the sub-sample of participants who reported an unmet need for counselling, and investigated whether engagement with the psychosocial app content was associated counselling uptake post-intervention in this group.

1.1. What factors were associated with engaging with the psychosocial app content?

Descriptive findings indicate that about half our participant sample viewed at least one page of the psychosocial information on the app. It is generally difficult to compare rates of engagement between mHealth studies as different measures of engagement are used throughout the literature. One systematic review of 10 digital self-help interventions for depression, anxiety, and low mood reported that across the studies, between 21% to 88% of participants used the intervention at least once or completed one intervention module (Fleming et al., 2018). Real world use data (i.e. data not collected in an experimental trial or intervention setting) of 93 mental health related apps found that about 4% of users opened the app daily (Baumel et al., 2019). Low rates of engagement with mHealth has been attributed to poor user design and a lack of relevancy to the user's needs or goals. In cases where the mHealth app seeks to promote behaviour change, a lack of support for implementing that change is also cited as a reason for low long-term engagement with an app (Torous et al., 2018).

To the author's knowledge, only a few studies of informational interventions with a mental health focus have examined the extent to which participants have viewed the information provided; Gulliver et al. (2012b) found that 81% of participants visited both weeks of a two-week website-based intervention. It is again difficult to compare the rates of viewership between the website-based intervention and the current study, as the interventions contained different varieties of information. The intervention tested by Gulliver et al. (2012b) centered on mental health, while Infotility included a range of information, from reproductive health, fertility test and treatment procedures, and psychosocial information. The comparatively lower rates of viewership for the psychosocial content on Infotility could reflect the range of subjects provided. For example, some fertility patients may have used the app to learn more about the medical aspects of infertility, as opposed to the psychosocial.

Amongst the entire participant sample, those with an unmet need for counselling demonstrated greater engagement with the psychosocial app content. These preliminary results suggest that an unmet need for counselling may be a factor driving engagement with psychosocial information. Interestingly, neither perceived stress nor depression was associated with greater engagement with the psychosocial content. This may reflect the correlation between these participant characteristics – most of those who had an unmet need for counselling were also those with greater psychological distress. It may also reflect sample size, as only a small number of participants demonstrated a high level of distress. Those participants with greater distress may have been more engaged with other sections of the app. Our findings may also indicate that by themselves, neither perceived stress nor depressive symptomatology are factors that influence how and why patients engage with psychosocial information. For example, it may suggest that beyond experiencing distress, it is the condition of having an unmet need that drives patients' engagement with an informational resource.

Descriptive analysis indicated that men were less engaged with the psychosocial content compared to women, and those with secondary infertility were less engaged than those with primary infertility. However, neither gender nor parity were significant in the regression analysis. These results may reflect the comparatively small number of men and those with secondary infertility in the study: there were 41 men and 125 women in our participant sample and 31 participants had secondary infertility while 134 had primary infertility. Although preliminary, our findings relating to gender may reflect broader patterns in the consumption of online health information, where women are more likely to report using the internet for health information compared to men (Kontos et al., 2014; Smail-Crevier et al., 2019).

The current study is one of the few to examine how fertility patients who are immigrants engage with informational interventions. Our results suggest no significant difference in the extent to which immigrants and non-immigrants engaged with the psychosocial app content. These findings are surprising, as a prior study of fertility patients found that immigrants were more likely than non-immigrants to want mental health information (Dawadi et al., 2018). However, this may not be the case for the sample of immigrants recruited in the current study. By virtue of being fertility patients, the immigrants in our sample have navigated the healthcare system to receive specialized treatments and are able to pay for them. Alternatively, the lack of difference in engagement may also suggest that the psychosocial content was equality relevant to both immigrants and non-immigrants. This potentially reflects our efforts to ensure that all content was culturally tailored, and relevant to fertility patients from diverse backgrounds.

Finally, it is important to note that the linear regression model used in the current study to investigate engagement with the psychosocial app content explained 14% of variance in engagement. This may be in part due to the small sample size of our study, or of unmeasured factors such as the amount of time the participant had in their daily routines to use the app.

Future intervention studies should continue to include a measure of the extent to which participants have engaged with the information provided, who is engaging with the information, and why they are choosing to do so. Such data could better inform researchers about the utility of the intervention being studied.

1.2. What factors are associated with counselling uptake amongst the total participant sample?

A key finding of the current study is the association between receiving mental health information from a healthcare provider and counselling seeking in fertility patients. A crosssectional survey study by Dawadi et al., (2018) also reported an association between the receipt of information from a HCP and use of counselling services by fertility patients; the current research replicates these findings using a pre-post study design. Our findings also suggest that the modality through which psychosocial information is provided may influence the relationship between information provision and counselling uptake. Boivin et al., (1999) previously discussed the utility of providing fertility patients with written information about counselling services, suggesting that it was less effective than providing the information in person (although the authors did not quantitatively compare different modalities of information provision and their associations with counselling uptake). Information provided in person, by a credible source and an authority figure such as an HCP may be more compelling to patients and therefore be more likely to lead to mental health help-seeking behaviour compared to information provided via a mHealth app.

Engagement with the psychosocial app content was not significantly associated with counselling uptake post-intervention amongst the entire sample of participants. Infertility is a stressful experience but not all participants develop clinically significant levels of distress or depressive symptomatology because of their condition (Fisher & Hammarberg, 2012). As such, participants may engage with the psychosocial app content because they find the information useful or relevant but may not necessarily choose to seek counselling. In addition, having access to psychosocial information related to infertility may be useful to patients in ways other than encouraging mental health help-seeking behaviour. Prior studies suggest that fertility patients may not be receiving as much psychosocial information as they would like in clinical settings (Dancet et al., 2010; Dawadi et al., 2018; Read et al., 2014; van Empel et al., 2009), and research suggests that the effective delivery of patient educational materials is associated with increased patient satisfaction (Friedman et al., 2011). The results of the current study speak to the potential for information delivered via an mHealth app to reach many fertility patients.

The fact that psychosocial engagement was not associated with counselling uptake could also reflect the *type* of information that was included in the psychosocial content. The psychosocial information provided spoke to the challenging nature of infertility, how to recognize symptoms of depression, and methods of coping, including seeking counselling. However, apart from telling participants to speak to their family doctor about counselling if they felt they needed it, the app did not provide other information to navigate the mental healthcare systems in Ontario and Quebec, or the addresses of nearby services. Providing more information about accessing mental health services may result in a stronger association between engaging with the psychosocial app content and counselling uptake.

Finally, greater perceived stress was also significantly associated with counselling uptake post-intervention, and it is not surprising that this group was more likely to seek counselling. 1.3. What factors were associated with uptake amongst the sub-sample of participants with an unmet need for counselling?

About a third of our sample reported that they had an unmet need for counselling preintervention (they wanted counselling, but had not sought it), in line with prior research (Boivin et al., 1999; Laflont & Edelmann, 1994; Read et al., 2014; Wischmann et al., 2009). Within this sub-sample, our bivariate analysis indicated that seeking counselling post-intervention was significantly associated with receiving mental health information from a HCP. Greater engagement with the psychosocial app content and earning an annual income of over \$100,000 per year were also significantly associated with seeking counselling post-intervention.

Within the sub-sample of participants with an unmet need for counselling, our results again highlight the association between receiving mental health information from a HCP and seeking counselling post-intervention. In this sample, engagement with the psychosocial app content may also be related to help-seeking behaviour post-intervention. This speaks to the potential for information delivered via an mHealth modality to encourage mental health helpseeking for those with an unmet need for counselling in cases where they have not received mental health information from a HCP. However, when interpreting these findings, it is important to consider directionality, as the participants who engaged highly with the psychosocial app content may have already been more likely to seek counselling.

Our results also suggest that earning under \$100,000 per year is a barrier to counselling seeking for those with an unmet need for mental health support. At the time of the study, the services provided by a psychotherapist or counsellor were not covered by the provincial healthcare plan in Ontario or Quebec ("What OHIP covers," 2019; "Quebec Program for Mental Disorders," 2019). Another consideration is that not all patients are eligible to receive provincial health coverage for fertility treatments and may be paying for most fertility-related costs out of pocket. Therefore, even though the participants in the current study were relatively high earners, they may still face financial barriers to seeking counselling. Some fertility clinics may offer one counselling appointment for free, but require patients to pay for further sessions. Prior studies affirm that the cost of mental health treatment is a barrier to access in Canada (Slaunwhite, 2015), and studies of those with an unmet need for mental health care in the United States also suggest that income is a barrier to access (Mojtabai et al., 2011; Odeja & Bergstresser, 2008). Future studies should examine the issue of income and access to counselling in a larger sample of fertility patients, but one policy recommendation of the current exploratory results is that psychotherapy services should be covered by provincial health insurance plans. This may improve access to counselling and mental health outcomes for fertility patients with lower incomes who have an unmet need for counselling.

2. Limitations

A primary limitation is the sample size of our study, which impacted the types of analysis we could conduct. For example, we were insufficiently powered to conduct analysis separately by men and women, as only 41 men completely the study. Instead we analysed men and women together but controlled for gender. In addition, few participants were categorized into our outcome of interest; only 12 participants in the total sample reported seeking counselling post-intervention (8 participants in the sub-sample with an unmet need for counselling). Although we attempted to investigate whether patient characteristics such as gender or immigration status were associated with counselling uptake, our lack of significant findings in this regard may reflect the fact that we were underpowered. Because the number of participants who sought counselling post-intervention was small, it is important to note that our results require replication in future analysis with a larger sample. Future studies of counselling seeking in fertility patients could also employ targeted methods to recruit a greater number of men.

A second, related, limitation is the relatively high rates of attrition during the study period. Of the 387 fertility patients who initially agreed to participate in the study, 264 completed the pre-survey, and 166 completed the post-survey. Other studies of eHealth interventions have similarly reported high rates of attrition (Eysenbach et al., 2005; Melville et al., 2010). However, in the current study, the impact of attrition on sample size is compounded by the fact that relatively few fertility patients seek counselling in the first place. Again, if possible, future pre-post studies should recruit a larger sample of participants to account for the high rates of attrition during the study period.

In addition, the current study was not able to capture patients' engagement with Infotility over time. That is, while we were able to capture the total number of pages a participant viewed, we were not able to capture the date at which they viewed certain pages. Data relating to *when* and *how often* participants engage with the app could be valuable for future research, as it provides a more multi-dimensional measure of participants' engagement with the app (in accordance to the definition of engagement by Lehmann et al., (2012)); provides information on the rates of attrition for app use during the intervention period, and; allow researchers to explore additional questions, such as whether more frequent engagement with the psychosocial sections is associated with mental health help-seeking post-intervention.

Another limitation is that our participant sample was recruited from Montreal and Toronto, two large Canadian cities. As such, our findings may not reflect the experiences of fertility patients elsewhere in Canada, particularly in more rural regions.

Finally, while our results shed light on potential barriers to accessing counselling, our surveys did not explicitly ask participants why they did or did not seek counselling. Future intervention studies should directly ask patients about their reasons for using, or not using, counselling.

3. Conclusion and Implications

The current study contributes novel findings to the emerging literature on how fertility patients engage with informational mHealth interventions, and the relationship between information provision and mental health help-seeking.

Participants with an unmet need for counselling demonstrated significantly greater engagement with the psychosocial app content compared to other patient groups. This finding broadly speaks to the relevance of psychosocial information for patients with an unmet need for counselling, and suggests that participants will engage with psychosocial content if it is easily accessible. A key finding of this study is that receiving mental health information from a HCP was the variable most strongly associated with counselling uptake in the total sample of participants, and in the sub-sample of those with an unmet need for counselling. Engagement with the psychosocial app content was not significantly associated with counselling uptake in the total sample, but was marginally associated with counselling uptake in the sub-sample of participants with an unmet need for counselling. The clinical implication of this is that fertility clinics and HCPs should be more cognizant of fertility patients' informational and psychological needs, and HCPs should be proactive about providing their patients with information about mental health. This could be achieved in person, during clinical visits, or via a mobile health app. The provision of psychosocial information could help patients' better determine whether they have a need for counselling, access counselling services, and consequently improve their mental health outcomes.

Our results also contribute exploratory, but novel, evidence about the extent to which fertility patients with an unmet need for counselling receive psychosocial information from various sources; remarkably more participants viewed at least one page of the psychosocial app content compared to those who received mental health information from their healthcare provider. Psychosocial information provision via an mHealth app may have the potential to reach a large number of fertility patients, and encourage mental health help-seeking. Future research should examine the utility of mobile health information provision for increasing counselling uptake in a larger sample of patients.

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Appendix A

Table I: Non-significant associations between independent variables and pre-interventionpsychological distress

	Under PHQ-9	Over PHQ-9	Chi Square	T1: Mean	T-test	
	Cut-Off	Cut-Off	Test	PSS-4		
	Frequencies	Frequencies		scores (SD)		
Immigrant	42 (72.41%)	16 (27.59%)	X2(1) = 1.35,	7.10	T(164)=-1.06,	
			p= 0.245	(03.45)	p=0.14	
Non-Immigrant	82 (80.39%)	20 (19.61%)		6.53 (3.19)		
Over 100,000/year	74 (77.64%)	36 (22.36%)	X2(1) = 1.23,	6.80 (3.31)	T(165)=-0.56,	
			p = 0.266		p=0.29	
Under 100,000/year	51 (82.26%)	11 (17.74%)		6.50 (3.29)		
University Educated	94 (76.42%)	29 (23.58%)	X2(1) = 0.54,	6.77 (3.30)	T(166)=-0.58,	
			p=0.461		p=0.28	
Not University Educated	32 (82.05%)	7 (17.95%)		6.42 (3.25)		
Advanced Maternal Age	16 (80.00%)	4 (20%)	X2(1) = 0.065,	6.65 (3.66)	T(166)=0.06,	
			p=0.798		p=0.47	
Not Advanced Maternal	110 (77.46%)	32 (22.54%)		6.69 (3.24)		
Age						
Primary Infertility	103 (78.03%)	29 (21.97%)	X2(1)=0.064,	6.85 (3.37)	T(165)=1.29,	
			p=0.800		p=0.10	
Secondary Infertility	22 (75.86%)	7 (24.14%)		6 (2.91)		
Did not Achieve a	99 (76.74%)	30 (23.26%)	X2(1)=0.18,	6.86 (3.19)	T(153)=1.31,	
Pregnancy			p =0.660		p=0.10	
Achieved a Pregnancy	17 (80.95%)	4 (19.05%)		5.86 (3.80)		
Got mental health	19 (15.57%)	5 (14.29%)	X2(1)=0.035,			
information			p-0.852			
Did not get mental health	103 (84.43%)	30 (85.71%)				
information						
Note: PSS-4 refers to the four-item Perceived Stress Scale, and PHQ-9 refers to the nine-item Patient Health						
Questionnaire						

	Mean Psychosocial Engagement (reported	T-Test Results
	in standard deviations)	
Immigrant	0.04 (1.06)	T(162)=-0.38, p=0.70
Non-Immigrant	-0.02 (0.96)	
Over 100,000/year	0.04 (0.96)	T(163)=-0.60, p=0.55
Under 100,000/year	-0.05 (1.03)	
University educated	0.05 (1.01)	T(164)=-1.13, p=0.26
Not university educated	-0.15 (0.91)	
	1	
Over 38 years old	0.16 (1.23)	T(164)=-0.81, p=0.42
Under 38 years old	-0.02(0.94)	
2 11		T(450) 0 70 0 44
Did not get pregnant	0.03 (1.00)	T(159)=0.78, p=0.44
Achieved a pregnancy	-0.15 (0.94)	
Linder one year in treatment	0.07 (0.99)	T(160) = -0.59 n=0.56
Over one year in treatment	-0.02 (0.99)	T(100)- 0.55, p-0.50
,		
Received mental health information	-0.09 (0.91)	T(160)=0.51, p=0.61
Did not receive mental health information	0.01 (1.00)	
Did not receive, but wanted mental health	0.09 (1.04)	T(133)=-0.78, p=0.44
information		
Did not receive and did not want mental	-0.05 (0.97)	
health information		

Table II: Non-significant bivariate associations between independent variables and engagement with the psychosocial content

	Frequencies				
	No	Counselling	Counselling at	Counselling	Chi Square Test
	Counselling	at pre-only	pre and post	at post-only	
Woman	91 (72.80%)	10 (8%)	15 (12%)	9 (7.20%)	X2(3)=1.86,p=0.687
Man	30 (81.08%)	1 (2.70%)	3 (8.11%)	3 (8.11%)	
Immigrant	46 (83.64%)	3 (5.45%)	3 (5.45%)	3 (5.45%)	X2(3)=3.89,p=0.289
Non-Immigrant	74 (70.48%)	7 (6.67%)	15 (14.29%)	9 (8.57%)	
Over 100,000/year	66 (67.35%)	8 (8.16%)	14 (14.29%)	10 (10.20%)	X2(3)=7.09,p=0.073
Under 100,000/year	54 (85.71%)	3 (4.76%)	4 (6.35%)	2 (3.17%)	
University educated	92 (75.41%)	9 (7.38%)	12 (9.84%)	9 (7.38%)	X2(3)=1.01,p=0.810
Not university	29 (72.50%)	2 (5%)	6 (15.00%)	3 (7.50%)	
educated					
Over 38 years old	16 (72.73%)	1 (4.55%)	2 (9.09%)	3 (13.64%)	X2(3)=1.63,p=0.692
Under 38 years old	105 (75%)	10 (7.14%)	16 (11.43%)	9 (6.43%)	
Did not get pregnant	101 (73.19%)	10 (7.25%)	15 (10.87%)	12 (8.70%)	X2(3)=2.83,p=0.545
during the intervention					
Got pregnant during	20 (86.96%)	1 (4.35%)	2 (8.70%)	0 (0%)	
the intervention					
Under one year in	55 (80.88%)	3 (4.41%)	5 (7.35%)	5 (7.35%)	X2(3)=3.03,p=0.415
treatment					
One or more years in	63 (70%)	8 (8.89%)	12 (13.33%)	7 (7.78%)	
treatment					
Primary infertility	96 (73.28%)	8 (6.11%)	18 (13.74%)	9 (6.87%)	X2(3)=5.13,p=0.080
Secondary infertility	24 (80%)	3 (10%)	0 (0)%	3 (10%)	
Wanted mental health	47 (69.12%)	6 (8.82%)	10 (14.71%)	5 (7.35%)	X2(3)=6.10,p=0.106
information					
Did not receive mental	57 (85.07%)	5 (7.46%)	3 (4.48%)	2 (2.99%)	
health information					
Wanted counselling at	57 (87.69%)	N/A	N/A	8 (12.31%)	X2(3)=1.60,p=0.239
time one					
Did not want	63 (94.03%)	N/A	N/A	4 (5.97%)	
counselling at time one	- / / -		- (- / /	
Received co-	9 (60%)	1 (6.67%)	2 (13.33%)	3 (20%)	X2(3)=4.09,
intervention		10/0.000		0.10.000	p=0.155
Did not receive co-	122 (76.19%)	10 (6.80%)	16 (10.88%)	9 (6.12%)	
intervention					

Table III: Non-significant bivariate associations between independent variables and counselling behaviour amongst the entire sample

	One-to-one Multinomial Logistic Regression				
	No Counselling	NoCounselling at pre- onlyCounselling at pre and postCounselling			
Engagement with the	Base	RRR=1.10, SE=0.35,	RRR=1.19, SE=0.30,	RRR=1.65, SE=0.46,	
psychosocial content	outcome	p=0.771,	p=0.481	p=0.076,	
		95% CI [0.59, 2.05]	95% CI [0.73, 1.95]	95% CI[0.95, 2.86]	

Total App Engagement	Base	RRR=0.18, SE=0.33,	RRR=0.44, SE=0.26,	RRR=0.44, SE=0.311,		
	outcome	p=0.572,	p=0.095,	p=0.156, 95%		
		95% CI [-0.46, 0.83]	95% CI [-0.08, 0.95]	95% CI [-0.17, 1.05]		
Note: RRR = Relative risk ratio, SE = Standard Error, CI = 95% confidence intervals.						

Table IV: Non-significant bivariate associations between independent variables and counselling	ıg
behaviour among those who wanted counselling pre-intervention	

	Frequencies				
	No Counselling	Counselling at pre-only	Counselling at pre and post	Counselling at post-only	Chi Square Test
Woman	45 (90%)	N/A	N/A	5 (10%)	X2(1)=1.07,p=0.373
Man	12 (80%)	N/A	N/A	3 (20%)	
Immigrant	25 (92.59%)	N/A	N/A	2 (7.41%)	X2(1)=1.03,p=0.452
Non-Immigrant	32 (84.21%)	N/A	N/A	6 (15.79%)	
University educated	46 (88.46%)	N/A	N/A	6 (11.54%)	X2(1)=0.14,p=0.655
Not university educated	11 (84.61%)	N/A	N/A	2 (15.38%)	
Over 38 years old	8 (88.89%)	N/A	N/A	1 (11.11%)	X2(1)=0.01,p=1.000
Under 38 years old	49 (87.50%)	N/A	N/A	7 (12.50%)	
Under one year in treatment	26 (86.67%)	N/A	N/A	4 (13.33%)	X2(1)=0.05,p=1.000
One or more years in treatment	31 (88.57%)	N/A	N/A	4 (11.43%)	
Did not get pregnant during the intervention	49 (85.96%)	N/A	N/A	8 (14.04%)	X2(1)=1.28,p=0.581
Got pregnant during the intervention	8 (100%)	N/A	N/A	0 (0%)	
Primary infertility	48 (85.71%)	N/A	N/A	8 (14.29%)	X2(1)=1.47,p=0.586
Secondary infertility	9 (100%)	N/A	N/A	0 (0%)	
Wanted mental health information	37 (92.50%)	N/A	N/A	3 (7.50%)	X2(1)=0.01, p=1.00
Did not want mental health information	14 (93.33%)	N/A	N/A	1 (6.67%)	
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Above PHQ cut-off	13 (81.25%)	N/A	N/A	3 (18.75%)	X2(1)=1.20,p=0.361
Under PHQ cut-off	42 (91.30%)	N/A	N/A	4 (8.70%)	
Received Co- Intervention	7 (77.78%)	N/A	N/A	2 (22.22%)	X2(1)=0.951,p=0.305
Did not receive co- intervention	50 (89.29%)	N/A	N/A	6 (10.71%)	
	Means (SD) for continuous independent variables				

	No Counselling	Counselling at pre-only	Counselling at pre and post	Counselling at post-only	T-Test
PSS-4 scores pre-	7.36 (3.24)	N/A	N/A	8.62 (2.50)	T(62)=-1.06, p=0.29
intervention					
Total app engagement	0.32 (1.00)	N/A	N/A	0.61 (0.75)	T(61)=-0.79, p=0.43

Note: Fisher's exact p used if cell sizes were smaller than 5.

PSS-4 refers to the four-item Perceived Stress Scale, and PHQ-9 refers to the nine-item Patient Health Questionnaire