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Characterizing Engagement Measures and Profiles in a Mobile Health Intervention, SMS4dads

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Abstract

mHealth interventions can efficiently distribute healthcare information to broad populations. However, take-up, adherence or engagement can be hard to assess. Building on previous efforts to create mHealth engagement indices, we developed an engagement metric to measure men's participation in SMS4dads, a message service for men in transition to fatherhood. Data were collected from 3261 fathers in NSW Australia in 2020–2021. An engagement metric was computed as a proportion of interactions across links and texts. Hazard ratios of dropping out were applied as external validity. To further understand men's engagement, we explored characteristics related to engagement in the program. Engagement scores did not significantly differ for rural or urban fathers. Engagement scores differed for Indigenous status, education level, first child status, antenatal enrollment, smoking status, alcohol use, and psychological distress score. The range of Engagement scores suggests that some men respond to few prompts, while others respond to almost all prompts. Understanding characteristics associated with mHealth engagement can improve precision when tailoring interventions to individual needs and vulnerable groups.

KEYWORDS

m-health intervention, engagement, fathers

mHealth or "digital" interventions are increasingly adopted as a cost-effective method of disseminating healthcare information to a broad population (World Health Organization [WHO], 2018). mHealth refers to mobile technologies used for public health. It includes simple and complex, wireless and mobile hardware such as smartphones, personal digital assistants and monitoring equipment (World Health Organization [WHO], 2018). The software may include applications (commonly known as "apps"), short messages/texts (SMS), multimedia messaging, and social networking media. While population reach and cost savings are motivators for a burgeoning mHealth industry, evidence for the efficacy of digital public health campaigns and behavior change programs is mixed (Marcolino et al., 2018). Moreover, adherence or engagement with the mobile platforms used in mHealth programs can be hard to assess, which may prevent program developers from understanding what features of their mHealth intervention design are acceptable and effective. Difficulty in assessing engagement can also prevent program developers from understanding who, amongst their target population, most uses their program content and features. The aim of this study was to develop an engagement metric using data from an mHealth SMS program and explore how characteristics associated with engagement provide insight into the target audience.

mHealth interventions primarily deliver health information and behavior change programs for physical activity, mental health, obesity and chronic diseases (Marcolino et al., 2018). mHealth interventions have also been adapted into the parenting domain, where program developers provide information to parents (on health and development topics such as infant care or feeding) or interventions to improve parenting quality (Putcha et al., 2023). Parenting digital interventions typically combine apps, texts, e-mails and websites. In 2022, there were more than 6,000 parenting apps available, many of which are commercial

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"for-profit" products. However, gauging the effectiveness and efficacy of programs is challenging. Many programs do not document enough data or describe implementation sufficiently to enable an understanding of program impact. A recent report (Putcha et al., 2023) reviewed over 100 digital parenting tools, but found only 23 with sufficient data availability and implementation description to permit evaluation.

Moreover, the lynchpin for efficacy is engagement. Improved parenting outcomes are strongly correlated with program completion (Day et al., 2021). However, this does not mean that effectiveness data are a proxy for engagement: some studies show parenting outcome improvements are not significantly associated with either high or low levels of engagement (Brager et al., 2019; Crossland et al., 2020). That is, the benefits of engagement arise from a more nuanced experience than a dose effect.

However, measuring engagement in mHealth initiatives is challenging. Most engagement measures described in the research are based on programs that utilize apps and the internet, and less on SMS (for example (Spencer et al., 2020). On an app or website, metrics (or meta-data) such as number of visits, time on page, and completion of sessions can be captured as "extent of engagement." Taki et al. (2017) developed an engagement index for an app-based program for mothers and infants, Growing Up Healthy. The index included (1) click depth (number of pages viewed per day), (2) engagement (frequency of app visits), (3) recency (latency between app visits), (4) interaction (number of push notifications opened), and (5) feedback (satisfaction survey). Engagement varied with some characteristics: analysis of high and low engagement thresholds showed higher engagement among first-time mothers and long-term participants.

However, in SMS programs, when a text-message is sent ("push notification"), there is no meta-data collected that allows researchers to calculate if, when and how many messages (the "program content") are read. Therefore, in programs using SMS only, there is as yet no single method to measure engagement, and researchers' methods variously include documenting feedback requests, posttest response rates and multidimensional "soft" measures, as described below.

Responses to feedback requests, as proxy for engagement, demonstrate participants' responsiveness to program messages. In a literacy text-messaging program, parents received weekly surveys about activity implementation (Cabell et al., 2019). The overall response rate statistic provided an engagement metric. In Kindytxt, a SMS program for child literacy (Barratt-Pugh et al., 2022), parents were sent feedback questions at seven timepoints. Response rate statistics provided an engagement metric.

On a similar principle, engagement could be inferred from pretest and posttest sample comparisons. In a Head Start SMS intervention on parent–child activity, the sample size reduced only by 7%, and 93% of parents completed the final Satisfaction questionnaire (Hurwitz et al., 2015). Ready4K! an early literacy text messaging program experienced a low drop-out rate of about 2% from pre to posttest (York et al., 2019). Both programs appeared to maintain parent engagement throughout. However, these programs may be exceptions. The low response rate to engagement surveys in digital interventions suggests surveys and questionnaires may be impractical in real-world settings (Perski et al., 2019).

Other studies use multiple measures to more robustly characterize engagement. In a text-messaging program for fathers raising children on the autism spectrum (May et al., 2021), engagement was measured with descriptive statistics on four elements: Connection, Attendance, Participation, Enactment (the CAPE model, Piotrowska et al., 2017). Connection was measured by program inquiries via text or the website. Attendance was measured by enrollment, completion rates and dropout timing. Participation was measured through link clicks, and responses to feedback requests, surveys, and unsolicited replies. Enactment was measured by posttest survey responses about putting the information into practice. This broader approach to measuring engagement may enhance the trustworthiness or credibility of program claims and is recommended as one strategy for measuring digital engagement (Yardley et al., 2016), although it is difficult to include these metrics in tests of association or difference.

Understanding SMS program engagement measurement remains impo+rtant. This is even more critical when the mobile technology itself is a specific engagement strategy. SMS technology is a breakthrough for father-focused parenting intervention, since engaging fathers continues to be problematic compared to mothers (de Santis et al., 2020; Gonzalez et al., 2023), and, men's participation rates are lower and attrition rates higher (Fabiano & Caserta, 2018). We can learn from engagement measures for programs that are app or web-based, such as described by Peterson and Carrabis (2008), Piotrowska et al. (2017) or Taki et al. (2017). Taki et al. showed how metadata could measure engagement in an SMS intervention. In this study, we apply Taki et al.'s recommendations to an SMS4dads program and examine engagement.

A second objective of the study is to explore how characteristics associated with engagement provide insight into the target audience of this program: fathers. It is important to understand a program's target audience in order to provide program information relevant to participants' culture, literacy, or specific contexts such as health status or perinatal stage. Delivering irrelevant or unwanted information would be a poor investment as it is likely to promote disengagement. Understanding the characteristics of those who engage will also inform the design of mHealth programs with multiple use points, e.g., self-paced or modularized. Given the contemporary demand to develop human-centered, personalized approaches to public health promotion (Hicks et al., 2023), our study may contribute to program developers' capacity to make best use of proliferating technologies and their applications. Our research objectives were to 1) create an engagement index for an SMS program and 2) examine participant characteristics associated with engagement.

Methods

Setting

SMS4dads (www.sms4dads.com) is an mHealth program that sends brief text-messages to fathers' mobile phones three times

per week across the perinatal period. Message content was derived from multi-stage processes incorporating expert and parent co-design. Topics address father–infant attachment, fathers' support of the mother, and fathers' mental well-being. Program outcomes include supporting the father, promoting the father-infant relationship, and supporting the father-partner relationship. Participants can enroll at any time from 12 weeks' gestation and they receive messages until 48 weeks unless they opt out. The messages are synced to the expected date of birth. Parenting issues are addressed from the father's perspective such as preparation for the birth (taking leave, emotional readiness and connection to the fetus) and common postnatal challenges (supporting breastfeeding, infant crying and regaining intimacy; see example messages in Supplementary material. Of relevance to this study, messages included links to external URL providers of evidence-based information, requests to complete mental health and quality of life screening questionnaires, and requests to complete interactive Mood Checker ratings.

Data was collected through the Focus on New Fathers pilot study (Fletcher, Regan, Leigh, et al., 2023; NSW Health, 2021). The study was commissioned to test the use of an SMS service to identify distressed fathers and link them with mental health services. Four local health districts with urban and rural populations in New South Wales, Australia, participated, and fathers were enrolled at any time from 16 weeks of gestation until 48 weeks after birth. Recruitment strategies were targeted at specific subpopulations such as Aboriginal and rural fathers; however, the texts delivered in the study were identical across all districts. Alcohol use and smoking status were identified at enrollment and messages relating to these behaviors were tailored to users (Kronrod et al., 2022). The retention rate was 80%, relatively high compared with other digital parenting programs for fathers (Fletcher, Regan, Dizon, et al., 2023). Data on participant clicks on message requests and embedded URLS were collected between September 2020 and December 2021. URL analytics and text-message open rates were unavailable due to technical limitations.

Measures in the Study

Participant Characteristics

Demographics. Demographic information was collected at baseline (enrollment) and included Indigenous status, rural or urban location, level of education, first-time father (yes, no), antenatal or postnatal at point of enrollment, alcohol consumption, and smoking status (yes, no).

AUDIT-C. The Alcohol Use Disorders Identification Test (AUDIT-C) (Bush et al., 1998) measures levels of alcohol consumption via three items about respondents' frequency and quantity of alcohol use. A score of four or more is an indicator of at-risk drinking. The variable was dichotomized into two categories, low and high (≥4). This was completed at enrollment and is not part of the engagement metric.

Engagement Metrics

All scales described below (K10, SF12, Mood Checker) were voluntary screens embedded in the intervention design, offered to all participants.

K10 Distress Scale. The K10 distress scale (Kessler et al., 2002) is a brief 10-item screening tool for psychological distress. Participants report on a 5-point Likert scale the frequency of their feelings toward 10 factors representing their mental health during the past 30 days. Scores 10–15 indicate low distress, 16–21 indicate moderate distress, 22–29 indicate high distress and 30–50 indicate very high distress. The message request was sent four times (Weeks −11, +06, +24, and + 45). The variable was dichotomized into 2 levels, low-moderate-high, and very high, as in Australian health surveys (Australian Bureau of Statistics, 2012).

SF12 health Questionnaire (Jenkinson et al., 1997) is a self-report measure assessing the impact of physical and mental health on an individual's everyday life and activities. It is often used as a quality-of-life measure. The message request was sent twice (Weeks +08 and + 46).

SMS4dads Mood Checker. consists of interactive texts sent to normalize difficulties that fathers might experience, and to encourage reflection on mental well-being. An example is: "Most people feel stressed if their new baby cries a lot. How have you coped this week with settling your baby?" The messages are sent at approximately 5-week intervals.

Time to disengagement. (continuous) was calculated as the number of whole weeks in the program during which fathers received messages A dichotomous variable, Disengaged (Yes, No), was also calculated. A previous study of this sample (Fletcher, Regan, Leigh, et al., 2023) found that 18.6% exited the program before the final text. Attrition was higher among smokers, those with risky alcohol consumption, lower education levels, or prenatal enrollment. Age, ATSI status, rurality, and K10 scores were not linked to attrition. Reasons for dropping out ($n = 202$) included "situation changed" (11%), "too busy" (22%), "not helpful" (23%), and "other reasons" (41%).

Engagement Index. Four areas of engagement were used to generate the Engagement Index. These were (1) Information links - the number of clicks on messages sent containing external URL links; (2) Mental health screens - the number of clicks on messages sent containing the K10 mental health questionnaire link; (3) Quality of Life (QoL) screens - the number of clicks on messages sent containing the SF12 health questionnaire; and (4) Mood Checkers - the number of clicks on messages sent containing the Mood Checker link. Engagement in each of these areas was measured as the proportion of engagement offers a participant responded to, over the number of offers he was sent. To ensure equal weighting of the four engagement areas, the Engagement index is a sum of these four proportions. It was transformed to a continuous scale ranging from 0 to 4. On the assumption of unidimensionality,

Cronbach's alpha was used to assess the reliability of the created measure.

Analytic Procedure

Descriptive statistics were created to summarize the baseline demographics of participants. Categorical variables were summarized through frequencies and percentages (n (%)). Numerical variables were summarized through mean and standard deviation (Mean (SD)), and median and interquartile range (Median (Q1, Q3)).

The association between the Engagement Index and time to disengagement with the program was examined using Cox regression. Estimates from the survival analysis were presented as hazard ratios (HR) with 95% confidence intervals (CI). Differences in the distribution of the Engagement Index in the categories of the baseline characteristics were explored using the Kruskal-Wallis test. Results are presented as median and interquartile ranges of Engagement Index by the categories of the predictor, along with the relevant Kruskal-Wallis p-value. Statistical analyses were programmed using SAS v9.4 (SAS Institute, Cary, North Carolina, USA).

Ethics Statement

The study received approval from the Human Research Ethics Committee of the University of Newcastle, Australia. Participants provided informed consent during registration to the program and received an information statement explaining the potential use of their data for research activities, allowing secondary analysis without additional consent. To protect the privacy of participants, identifying data were deleted during extraction and thus all participants were anonymous or unidentified. No compensation was received by participants.

Results

There were $N = 3261$ participants included in the analysis. Across the four health districts, the proportion of ATSI fathers ranged from 1% to 8%; education diploma and above, 48% to 86%; first time fathers, 81% to 88%; and antenatal enrollment, 55% to 66%. Alcohol consumption (AUDIT-C) scores at or above 4 ranged from 15% to 45%, and those who smoked, 4% to 11%.

Fathers were enrolled in the program on average 16.37 weeks (SD10.5), ranging from 0 to 42.6 weeks. Table 1 details the number of messages sent for the four different engagement areas. For example, dependent on their time in the program, the majority of fathers received more than 17 of 65 messages with Information links, received up to two of four Mental Health screens, received one of two QoL screens, and received between four and 10 of 14 Mood Checkers.

Consistency of the Engagement Index

Table 2 shows the raw and standardized Cronbach's Alpha and MacDonald's Omega coefficient (Dunn et al., 2014) for the Engagement Index. Unidimensionality of the index has been assumed to be true. The Cronbach's alpha is not particularly high, suggesting that there might be some evidence against the unidimensionality assumption. However, the low alpha might also be due to having a small number of items (4 areas) comprising the index. McDonald's Omega was calculated as a measure of internal reliability. It was found to be 0.605, where values greater than 0.7 indicate acceptable internal consistency.

Time to Disengagement and Engagement Index

Table 3 shows the hazard ratio of the Engagement Index for disengagement with the program. This model was run as a measure of external validity. It would be reasonable to

Table 1. Messages sent, received, and reacted to by engagement areas $N = 3261$

Engagement areas	Number sent	Range received by any one father	Breakdown of received messages, dependent on time in program	Number of clicks or completions
Messages with Information links	113,778	0–65	8.6% received 0–16 msgs 32.8% received 17–33 msgs 49.2% received 34–48 msgs 9.7% received 49–65 msgs	27,225 clicks (23.9%)
Offers of mental health screens K10	5,131	0–4	8.8% received 0 K10 offer 35% received 1 K10 offers 47% received 2 K10 offers 9.6% received 3 K10 offers 0.001% received 4 K10 offers	1,885 completions (36.7%)
Offers of QoL screens SF12	3,245	0–2	16% received 0 SF12 offer 68% received 1 SF12 offer 16% received 2 SF12 offers	562 completions (17.3%)
Offers of Mood Check	27,470	0–14	6.4% received 1–3 MCs 22% received 4–7 MCs 48% received 8–10 MCs 22.8% received 11–14 MCs	6,991 clicks (25.4%)

Table 2. Consistency measures for the engagement index

Characteristic	Consistency measures	Coefficient
Engagement Index	Cronbach's Alpha (raw)	0.68
	Cronbach's Alpha (standardized)	0.70
	MacDonald's Omega	0.61

Table 3. Association between time to disengagement and engagement index

Predictor	HR (95% CI)	P-value
Engagement Index	0.67 (0.57, 0.80)	<.001

expect that those who had higher Engagement Index scores would have stayed in the program for longer. There is a statistically significant 33% decrease in the hazard of disengagement per 1 unit increase in Engagement Index.

Association Between Engagement Index and Baseline Characteristics

The engagement metrics show varying participation across program elements (median engagement index 0.75, IQR 0.12–1.74, Table 4). The engagement metrics show varying participation across program elements (median engagement index 0.70, IQR 0.07–1.61, Table 4). The data in Table 1 however reveals meaningful interaction with specific components: 36.7% completion rate for K10 screens, 25.4% for mood checks, and 23.9% for information links, though lower for SF12 (17.3%).

The associations between the Engagement Index and baseline characteristics are shown in Table 4. There is sufficient confidence in the evidence (p values range from < 0.001 to 0.037) to suggest that the distribution of the Engagement index differs across some characteristics of fathers in SMS4dads. Higher Engagement scores characterized non-ATSI fathers, fathers with more education, first-time fathers, those enrolling antenatally, those who did not smoke, those who had higher alcohol consumption scores, and those with lower psychological distress scores. Engagement scores did not significantly differ for rural or urban fathers.

Discussion

The aim of this study was to measure engagement in an SMS program and explore how characteristics associated with engagement provide insight into the target audience. Alongside an independent evaluation of the Focus on New Fathers pilot, a better understanding of engagement in mHealth programs may help program developers determine what aspects of their mHealth intervention design are useful, and for whom. Previous research on apps and websites suggested ways in which a metric could be created to represent fathers' engagement with the program content. Adapting

Table 4. Engagement index and baseline characteristics, $N = 3261$

			Engagement Index	
Characteristic	Value	N (%)^	Median (Q1,Q3)	P-value
Aboriginal and/or Torres Strait Islander	No	3189 (97.8)	0.75 (0.12, 1.74)	.005*
	Yes	57 (1.8)	0.34 (0.03, 0.77)	
Rurality	Rural	493 (15.1)	0.70 (0.07, 1.61)	.052
	Urban	2749 (84.3)	0.74 (0.13, 1.75)	
Education	Bachelor degree or Above	2277 (69.8)	0.83 (0.16, 1.80)	<.01*
	Advanced Diploma/Diploma	253 (7.8)	0.55 (0.06, 1.55)	
	Cert III IV	430 (13.2)	0.52 (0.05, 1.53)	
	Year 12	191 (5.9)	0.52 (0.05, 1.46)	
	Year 11 or below	108 (3.3)	0.43 (0.05, 1.15)	
First Child	No	496 (15.2)	0.57 (0.08, 1.46)	.007*
	Yes	2763 (84.7)	0.77 (0.13, 1.75)	
Antenatal/Postnatal	Antenatal	1973 (60.5)	0.79 (0.13, 1.74)	.030*
	Postnatal	1288 (39.5)	0.63 (0.10, 1.67)	
Smoking Status	No	3051 (93.6)	0.76 (0.13, 1.76)	.025*
	Yes	208 (6.4)	0.29 (0.03, 1.22)	
AUDIT C Category	High (≥4)	954 (29.3)	0.90 (0.13, 1.75)	.037*
	Low (<4)	2305 (70.7)	0.69 (0.11, 1.70)	
K10 Category	Low/Mod/High	3123 (95.7)	0.75 (0.12, 1.74)	.027*
	Very High (≥30)	138 (4.2)	0.50 (0.06, 1.49)	

^Including missing responses to demographic questions
*Significant Kruskal-Wallis p-value

techniques from Taki et al. (2017), we created an Engagement metric that represents fathers' involvement or participation in some way.

The Engagement score was generated from four participatory activities embedded in the messages: clicking on links to external information, clicking through a link to complete the K10 mental health screening questionnaire, clicking through a link to complete the SF12 quality of life questionnaire, and clicking on a Mood Checker link. The selective engagement patterns observed, where fathers interacted more with mental health screens and mood checks than other features, suggests participants prioritized elements most relevant to their needs. The formula to create the score represented the number of participations as a proportion of each type of message. To gauge external validity, we demonstrated with the hazard ratio a significant decrease in the risk of disengagement per unit increase in Engagement. This suggests that those who stayed in the program were more engaged than those who left. However, time may confound this outcome, because each person is exposed for a different amount of time.

While overall engagement indices appear modest, completion rates of 25–37% for key components indicate meaningful interaction with the program's core support features, rather than simply passive receipt of information. We found differences in Engagement for several characteristics of fathers. Below we discuss reasons why and the implications for SMS programs.

Indigenous Fathers

Enrollment of ATSI fathers into SMS4dads was incidental; they were not a target population in this version. ATSI fathers were found to have lower engagement scores in comparison to other fathers in SMS4dads. One possible reason for this disparity is that the program may not adequately address their specific needs. Stuart et al. (2015) documented Indigenous fathers' views on support for fathering: the men stressed the significance of factors such as culture, community, and connection. Furthermore, they emphasized that establishing robust and trusting relationships is a prerequisite for meaningful intervention. Similarly, Faulkner's interviews with Aboriginal fathers highlighted the need to tap into men's sense of responsibility, leverage the support of extended family networks, and offer opportunities for fathers to engage their children in cultural activities and knowledge (Faulkner et al., 2021).

These findings underscore the requirement for different resources and support mechanisms to be tailored to meet the needs of Aboriginal fathers for a service to be truly relevant to them. As corroborated by Canuto et al. (2020) review of eight parenting programs for Indigenous fathers, a targeted approach may yield greater success in engaging and supporting this group. An example of such a targeted approach can be observed in *Stayin' on Track* (Fletcher, Hammond, et al., 2017), which employed participatory approaches to develop culturally relevant information for supporting young Aboriginal fathers during their transition to fatherhood. The evidence in the current study highlights the importance of tailoring programs to meet the specific and detailed needs of ATSI fathers and to achieve successful engagement. This has been done subsequently, although not discussed in this paper: *Stayin' On Track* led to the co-design of SMS4DeadlyDads by a SMS4dads First Nations team in consultation with an Advisory Group of senior First Nations men representing Aboriginal Controlled Health organizations.

Fathers with Higher Education

Fathers with higher education tended to have higher engagement with SMS4dads. Approximately 70% of enrolled fathers had a Bachelor degree or higher. People with higher education levels are likely to be more familiar with text-based information, having well-developed abilities in word decoding and inferential thinking (Gough & Tunmer, 1986). They may therefore find it easier to read and process information in text messages. This premise was supported in an experiment with text-based information, where participants with higher education levels were more consistent in their responses than those with lower education levels (Sauer et al., 2011).

Another explanation may be that fathers who have higher education are more "trusting" in the information they receive through these messages. To have trust in social exchanges is to expect that others are cooperative and not opportunistic (Huang et al., 2009). Higher education is generally accepted as a robust predictor of social trust (Huang et al., 2009). Thus, these fathers may expect that in general, SMS4dads will not data mine, harass them, or send inappropriate content, and that it will acquit its intentions in a principled manner. Fathers with less education may be more wary of what information or requests lie ahead of them. The collaborative, interactive nature of the "therapeutic alliance" concept (Horvath, 2001) may also be relevant here. This may be a prompt for program developers to design features that engender trust (Brandt et al., 2013; Fletcher et al., 2020).

First-Time Fathers

First-time fathers tended to have higher engagement with SMS4dads, and made up 85% of the analytic sample. First-time fathers may be more information hungry than 2nd or later birth fathers. This interpretation fits with a robust body of research showing first-time fathers often feel "in limbo" and excluded (Steen et al., 2012) yet have specific information needs (Entsieh & Hallström, 2016) and desires to learn (Venning et al., 2021). Subsequent birth fathers were less engaged; perhaps they were more discerning in their information needs and were able to figure out whether the information was important to them. This differentiation may guide program developers to broaden the scope of their messaging and/or to better understand the information needs of "experienced" fathers.

Fathers Enrolling Antenatally

Fathers who enrolled before the birth of their child were more engaged in the SMS program than fathers who enrolled after the birth. This may be because fathers who enrolled after the birth had not built a "habit" of receiving and occasionally responding to information from the program. Texts may feel intrusive and unmanageable during the early postnatal period when men are

focused on mother and baby needs. A further speculation may be that, for these men, the messages were part of a maelstrom of information, and not accorded any primacy, as compared to SMS4dads being familiar, as if "a mate tapping you on the shoulder" (Fletcher et al., 2019, p. 5). Postnatally enrolled fathers may have had easier access to information, as their partners had interacted with various services during the perinatal period. Therefore, their information needs may have been lower. Options for program developers could include targeting recruitment strategies more tightly to fathers in the antenatal period, or investigating how to increase the relevance or salience of messages.

Fathers Who Did Not Smoke

Fathers who did not smoke were more responsive within the SMS program than fathers who smoked. Reasons for lack of engagement in the program may be linked to the psychological characteristics of men who smoke. Smoking cessation research suggests that in the challenge of quitting, fathers prefer to depend on their own personal strengths and autonomy rather than external resources (Bottorff et al., 2009; Kayser & Semenic, 2013). Similarly perhaps, in facing the challenges of new fatherhood, the need for self-reliance might apply to fathers who smoke; thus they do not engage seriously or consistently with SMS4dads, they rely on their own current know-how. Smoking is also associated with stress and perceptions that smoking provides stress relief (Slopen et al., 2013). It may be that fathers in SMS4dads who smoke are also experiencing higher levels of perceived stress, which may also account for their lower engagement (see further below).

Fathers and Alcohol Consumption

Alcohol consumption likewise is associated with perceptions of stress relief (Sayette, 1999). However, contrary to expectations that alcohol misuse (score over 4 in AUDIT-C) would relate to less engagement, fathers in SMS4dads with higher AUDIT-C scores were more likely to be engaged. We could speculate that fathers who know how much alcohol they consume, may also recognize that alcohol is a problem for them. Enrollment in SMS4dads may be one strategy to modify this behavior and become a good role model (Garfield et al., 2010). From another view, alcohol use is associated with physical and social pleasure and reward (Jones et al., 2001) and shaped by experiences of mateship, leisure, and connection (Muhlack et al., 2018). In this view, fathers enrolled in SMS4dads who drink more than two drinks on most days, are also men who seek social connection and pleasure, whether through social drinking (Roberts et al., 2019) or SMS4dads. Program developers would need to better understand the acceptability of alcohol/health messages to fathers (Dimova et al., 2022), and it may be useful to consider the SMS program itself as provision of stress relief or connection.

Fathers and Psychological Distress

Fathers with lower psychological distress scores, as measured by the K10, tended to be more engaged in the SMS program than fathers with very high distress scores. Potentially, highly distressed fathers are less likely to be emotionally ready for messages about fathering. Previous SMS4dads research has found no link between fathers' distress levels or mood assessment requests and dropout rates, although repeated mental health queries may still affect engagement (Fletcher, Kay-Lambkin, et al., 2017; Fletcher, Regan, Dizon, et al., 2023). Formative SMS4dads research has found highly distressed fathers often had existing GP or psychologist contact. While escalating highly distressed men to appropriate professional support, SMS4dads is most relevant to fathers who are not or only moderately distressed. This is based on evidence showing that rates of very high distress are rising in the Australian population (Butterworth et al., 2020), and distress in fathers across the perinatal period may persist (Kothari et al., 2022) and or worsen across time (Hughes et al., 2020). Targeting the group of fathers who without help or support were likely to progress to very high distress was a key rationale for the program.

In summary, the results highlight the value of using an engagement metric to tailor mHealth programs, as shown by the data on selective engagement and on the seven user subgroups. This differs from the vast number of studies making refinement on qualitative feedback from small numbers of motivated respondents. Conceptually, engagement metrics could demonstrate one mechanism of program outcomes. Consistent participation may indicate fathers' growing commitment to their parenting role, investment in the father-infant relationship, and dedication to effective co-parenting - though these connections warrant future empirical investigation. However, indicators of engagement are necessarily specific to interventions, so a key principle should be within-study validation of any devised metric.

Limitations

Study limitations include potential confounding of engagement with program duration. Each participant is exposed for a different amount of time, due to the varying lengths of enrollment in the program. For example, a participant who only receives two offers to engage is in the program for a relatively short period of time, and only has two opportunities to "miss" one of the offers. So, in a sense it is easier for that person to be rated as 100% in any one engagement area, as they only have to respond twice. Whereas someone in the program who receives four engagement offers, has had a greater period of exposure, and also has more opportunities to "miss" an offer. It is harder for this person to get a 100% as they need to actively respond four times. The potential confounding between engagement and time on treatment illustrates a form of survival bias, specifically immortal time bias. In this case, higher levels of engagement inherently require participants to remain in the study for longer periods, creating a temporal dependency. Addressing this issue is challenging, but possible solutions may include using propensity score weighting methods or jointly modeling the trajectories of both engagement and time to dropout. Nevertheless, retention in the study was high. For that reason, the results we

report here may be conservative and further work needs to consider how to disentangle the information, so effects on longer-term participation are not missed. Exit interviews will be reported in future publications.

Conclusion

The science of mobile health offers many opportunities for reach and scale. It is critical for program developers to understand what features of their mHealth intervention design are acceptable and effective, and for whom their program works best. To do so, they need robust ways of demonstrating the fit of their program to healthcare challenges. Despite evolving technologies, SMS remains valuable for supplementing face-to-face services and reaching populations with limited internet access, particularly in remote regions of Australia, Africa and South America.

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