

Who is (Not) Engaging in a Father-Inclusive Digital Parenting Intervention in Tanzania: An Analysis of Predictors

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Who is (Not) Engaging in a Father-Inclusive Digital Parenting Intervention in Tanzania: An Analysis of Predictors

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Abstract

Background: Digital interventions offer a promising avenue for scalable parenting support in low- and middle-income countries (LMICs), where in-person coverage remains limited. However, engagement disparities may reduce their potential for population-level impact.

Objective: This study examined caregiver-level predictors of engagement with ParentApp, a father-inclusive, smartphone-based adaptation of the Parenting for Lifelong Health Teens program for caregivers of adolescents aged 10–17 years.

Methods: This study was nested within a cluster-randomized factorial trial of ParentApp in Mwanza, Tanzania, implemented according to the optimization phase of the Multiphase Optimization Strategy (MOST). Sixteen clusters (N=614 caregivers, 33.4% male) were randomized to three components: guidance (guided vs. self-guided), app design (unstructured vs. structured), and digital support (enhanced vs. basic). Digitally tracked app engagement outcomes comprised number of modules completed, time to first non-start, and time to first non-completion. Baseline candidate predictors included demographic, socioeconomic, behavioral, and psychological factors assessed via an app-embedded questionnaire. Poisson generalized linear mixed-effects models with random effects for cluster assessed associations between predictors and each outcome. Interaction terms were specified to test whether associations differed by caregiver gender.

Results: Among 614 participants, 596/614 (97.1%) completed module 1; this declined to 281/614 (45.8%) for module 2, with 49/614 (8.0%) completing all 12 modules. Mean content completion across the program was 35.6% (SD 33.1%). Women completed approximately 15% more modules compared to men (incidence rate ratio [IRR] 1.15, 95% CI [1.05, 1.27], P=.003), despite reporting higher financial stress, food insecurity, child maltreatment, and depressive symptoms at baseline (all P?.023; Cohen's d=0.19–0.37). No other main effects or gender interactions were statistically significant.

Conclusions: This is the first known study to investigate caregiver-level predictors of engagement with a digital parenting intervention in an LMIC. Engagement with ParentApp was broadly consistent across caregiver subgroups, with the exception that women completed significantly more modules than men. To equitably engage men and fathers, future studies should pair father-inclusive, identify-affirming content with implementation strategies that reduce social and economic barriers to participation.

<https://pactr.samrc.ac.za/TrialDisplay.aspx?TrialID=24051>

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Original Manuscript

Original Paper

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module 2, with 49/614 (8.0%) completing all 12 modules. Mean content completion across the program was 35.6% (SD 33.1%). Women completed approximately 15% more modules compared to men (incidence rate ratio [IRR] 1.15, 95% CI [1.05, 1.27], $P=.003$), despite reporting higher financial stress, food insecurity, child maltreatment, and depressive symptoms at baseline (all $P\leq.023$; Cohen's $d=0.19-0.37$). No other main effects or gender interactions were statistically significant.

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This is the first known study to investigate caregiver-level predictors of engagement with a digital parenting intervention in an LMIC. Engagement with *ParentApp* was broadly consistent across caregiver subgroups, with the exception that women completed significantly more modules than men. To equitably engage men and fathers, future studies should pair father-inclusive, identify-affirming content with implementation strategies that reduce social and economic barriers to participation.

Trial Registration:

Pan-African Clinical Trial Registry PACTR202210657553944;
<https://pactr.samrc.ac.za/TrialDisplay.aspx?TrialID=24051>

Keywords

digital health; engagement; parenting; mobile phone; fathers; violence prevention; low-and middle-income countries

Introduction

Parenting interventions are central to global efforts to prevent violence against children and promote family wellbeing [1]. Yet in-person delivery remains difficult to scale in low- and middle-income countries (LMICs) due to high costs and logistical barriers [2,3]. Promisingly, there is growing evidence that digital parenting interventions can improve parenting and child outcomes, including among hard-to-reach families in LMICs [4,5]. However, program effects are often small and user engagement is low, warranting investigation into how these interventions can be designed and implemented to sustain engagement and achieve population-level impact.

Engagement is a key mechanism for behavioral change [6]. Research on engagement with digital interventions has largely been conducted within behavioral science, which typically defines engagement as the extent of program use (e.g., amount, frequency, duration, depth), although its operationalization varies widely across studies [7]. While engagement challenges are not unique to digital delivery, they may be amplified by structural inequalities in digital access and use, particularly in LMICs.

Families living in poverty or rural areas often rely on lower-performing devices, have limited internet connectivity, and face digital literacy challenges [8]. In Tanzania, for example, 82% of the population own a feature phone, while only 35% currently own a smartphone [9]. Gender disparities in digital access further compound these barriers. Across LMICs, women are 17% less likely to own a mobile phone and 21% less likely to use the internet than men [10]. These digital divides risk excluding already marginalized families and may deepen health and social inequities if unaddressed. Identifying which parents are most likely to engage—or disengage—is therefore essential for developing equitable and effective digital parenting interventions.

Existing evidence on who engages with digital parenting programs is limited, inconsistent, and

drawn almost exclusively from high-income countries (HICs). Gender disparities are well documented in in-person programs, where fathers engage at markedly lower rates than mothers [11,12]. In a South African trial of the in-person Parenting for Lifelong Health (PLH) Teens program, fathers represented only 3% of participants and were significantly less likely to attend sessions than mothers [13]. Encouragingly, early evidence from HICs suggests mothers and fathers engage at similar rates in digitally delivered parenting programs [14,15]. Whether these findings extend to LMICs remains unknown.

Beyond gender, evidence on caregiver-level predictors remains limited. Sociodemographic factors appear to be the most extensively studied, with lower education and income consistently linked to reduced engagement and increased attrition in HICs [15-19]. Similar associations have been reported in in-person parenting programs in HICs [20]. By contrast, findings from a few in-person programs in LMICs suggest that socioeconomic disadvantage does not reliably predict lower engagement [13]. Evidence on behavioral and psychological predictors is comparatively limited and mixed, with positive parenting practices [19,21] and caregiver mental health [14,18,19,22] associated with both higher and lower engagement in digital parenting programs. To our knowledge, no studies of digital parenting interventions have examined these associations in LMICs.

The current study addresses this gap by examining caregiver-level predictors of engagement in an early version of *ParentApp*, a father-inclusive digital parenting intervention for caregivers of adolescents aged 10–17 years. Using data from a cluster-randomized factorial trial in Tanzania, implemented in accordance with the optimization phase of the Multiphase Optimization Strategy (MOST) [23], we test whether caregiver demographic, socioeconomic, behavioral, and psychological characteristics predict user engagement. We also explore whether these associations differ by caregiver gender. Findings are intended to inform targeted and inclusive strategies to enhance engagement in *ParentApp* and to support the equitable scale-up of digital parenting interventions in

LMICs.

Methods

Study Design

This study was nested within a 2×2×2 cluster-randomized full factorial experiment implemented across 16 low-income urban and peri-urban communities in Mwanza, Tanzania [24]. Each community (cluster) was randomly assigned to one of eight experimental conditions, comprising all possible combinations of three components: guidance (guided vs. self-guided), app design (structured vs. unstructured), and digital support (enhanced vs. basic). The trial aimed to optimize user engagement in *ParentApp*, which was developed in partnership with the United Nations Children's Fund, the World Health Organization, and the Tanzanian national government. The trial was preregistered on the Pan-African Clinical Trial Registry (PACTR202210657553944) on October 11, 2022. Further information about the trial design can be found in the study protocol [25] and the main trial results paper [24].

Participants

Participants were recruited on a rolling basis between October 24, 2022 and December 1, 2022. Recruitment was led by local community leaders, the majority of whom were men, in an effort to enhance community trust and increase program acceptability among families. Eligible participants were required to be at least 18 years old, be a caregiver to an adolescent aged 10–17 years, reside in the same household as the adolescent for at least four nights per week in the previous month, and have regular access to an Android smartphone (operating system OS 5.1.1 or higher).

Interventions

ParentApp

ParentApp is designed to promote positive parenting, prevent violence against adolescents, and reduce risks of sexual violence victimization. It is a smartphone-based adaptation of the in-person PLH Teens program, originally evaluated in South Africa [26], and subsequently implemented across multiple LMICs, including Tanzania [27]. *ParentApp* was developed to expand reach and reduce the costs and logistical barriers of in-person delivery. To support use in settings with limited or intermittent internet access, it operates offline after the initial download.

Development and testing followed a multi-phase process guided by the MOST framework [23]. In the preparation phase, caregiver co-design, multi-country user testing [28], and pilot studies in South Africa and Tanzania identified barriers and facilitators to delivery and provided preliminary evidence of effectiveness. Findings from the preparation phase guided the selection of components evaluated in the optimization phase factorial trial reported here [24]. Factorial trial results yielded an optimized intervention package currently being evaluated in a cluster-randomized controlled trial in Tanzania [29].

The intervention content is organized into 12 modules, delivered via simple text, illustrations, and audio narration in Kiswahili. The first module focuses on parental self-care and includes a baseline questionnaire. Modules 2 to 11 introduce evidence-based strategies to support positive parenting and reduce harsh or abusive discipline. The final module provides a summary of key concepts and includes a post-intervention assessment. Full details on module content, home practice activities, and user interface design are available in Janowski et al. [24].

Experimental Components

Guidance

The guidance component varied the level of human support. In the self-guided condition, participants used *ParentApp* independently after app onboarding. In the guided condition, participants were invited to join facilitator-moderated WhatsApp groups designed to promote peer interaction and program engagement.

App Design

The app design component varied the pacing and visual presentation of the app. In the structured condition, modules were released sequentially over 12 weeks and featured abstract, gender-neutral illustrations. In the unstructured condition, all modules were accessible immediately and included culturally adapted illustrations depicting both male and female caregivers.

Digital Support

The digital support component tested the intensity of onboarding assistance. All participants received basic support in the form of a guided app tour. Those in the enhanced condition also participated in a brief group-based smartphone literacy session covering app installation, mobile data use, and online safety.

Procedures

Cluster-level onboarding sessions were conducted in local schools and community centers, led by staff from Tanzania's National Institute for Medical Research (NIMR) and trained facilitators from Investing in Children and Strengthening Their Societies, a local non-governmental organization. Sessions included study information, eligibility screening, and informed consent, followed by app onboarding and baseline data collection. After obtaining informed consent, NIMR staff assisted participants in installing *ParentApp* and configured the app according to cluster assignment.

Participants then received basic digital-support training, worked through the app's first module, and completed the embedded baseline assessment. Clusters assigned to enhanced digital support received a brief group-based smartphone literacy session. Guided clusters were added to WhatsApp groups co-led by male–female facilitator pairs.

Measures

Engagement Metrics

Engagement data were collected through automated in-app tracking. Use records, including app launches, content viewing patterns, and responses to in-app tasks were uploaded to a Metabase cloud server (Metabase, Inc.) when participants' devices connected to the internet. Additional data, such as visit timestamps, session duration, and frequency of actions or pages viewed, were captured via Matomo Analytics (InnoCraft Ltd). These data were used to derive descriptive indicators and the primary and secondary outcomes. The primary outcome was module completion, operationalized as the total number of modules completed (0–12). Secondary outcomes were time to first non-start (the first module not started) and time to first non-completion (the first module started but not completed). These outcomes were selected to capture cumulative content engagement and early disengagement.

Candidate Predictors

Demographic and Socioeconomic Variables

Baseline data were collected via an in-app questionnaire embedded in the first module. Measures were translated and back-translated into Kiswahili. Candidate demographic predictors included caregiver gender (woman/man) and age (years). Additional demographics (e.g., household composition) were collected but not analyzed here. Candidate socioeconomic predictors were assessed using two items adapted from the Financial Self-Efficacy Scale [30]. One item measured

financial stress (“How many times in the past month have you felt worried or anxious about money?”), rated on a 0 to ≥ 8 frequency scale. The other item measured food insecurity (“How many days in the past month did you run out of money to pay for food?”), rated 0 to 30 days. These two items were analyzed separately due to differences in response formats.

Behavioral and Psychological Variables

Positive parenting was assessed using five items on parental involvement and supervision from the Alabama Parenting Questionnaire [31]. Items were scored from 0 to ≥ 8 and summed to produce a total score, with higher scores indicating greater positive parenting. Harsh parenting was assessed using four items on physical and emotional abuse from the International Society for Prevention of Child Abuse and Neglect Screening Tools-Trial Version [32]. Items were scored from 0 to ≥ 8 and summed, with higher scores indicating greater maltreatment. Caregiver depression was measured using three items from the Centre for Epidemiologic Studies Depression Scale [33]. Each item was scored from 0 to 7 and summed, with higher scores indicating greater depressive symptoms.

Statistical Analysis

Analyses were conducted in R (version 4.5.0). Sample characteristics were summarized overall and by caregiver gender. Gender differences in age, financial stress, food insecurity, positive parenting, harsh parenting, and depressive symptoms were assessed using independent-samples *t*-tests, with Cohen’s *d* calculated to estimate effect sizes. Engagement across the 12 modules was visualized using Kaplan-Meier survival curves stratified by caregiver gender.

Predictors of engagement were estimated using Poisson generalized linear mixed models with cluster-level random intercepts. Models were fit to multiply imputed datasets to address missing baseline data, and estimates were pooled across imputations. The primary outcome (number of modules completed) was modeled using an offset for exposure equal to the number of modules available. Secondary outcomes (time to first non-start and time to first non-completion) were

analyzed as binary indicators (1 = event, 0 = none) with an offset for modules-at-risk, defined as the module at first disengagement for events and the total modules available for non-events.

Each predictor was tested in a separate model, with group-mean centering applied within clusters to isolate within-cluster effects. All models adjusted for experimental components (dummy-coded: guidance, app design, and digital support). Caregiver age and gender (grand-mean centered) were also included as control variables in all models except when either variable served as the predictor of interest. Moderation by caregiver gender was tested by including interaction terms between each predictor and caregiver gender. Gender was represented both as a group-mean centered variable and as a cluster-level mean to disaggregate individual- and cluster-level effects. Model estimates are reported as incidence rate ratios (IRR) with 95% confidence intervals (CIs) and corresponding *p*-values. The Benjamini–Hochberg procedure was applied to control for false discovery rate across models, with significance determined using adjusted critical *p*-value thresholds.

Ethical Considerations

Ethics approval was granted by University of Oxford's Departmental Research Ethics Committee (R69744/RE001) and Tanzanian National Institute for Medical Research (NIMR/HQ/R.8s/Vol.IX/3856). Written informed consent was obtained from all study participants at the onboarding session. To support WhatsApp participation and app–server data synchronization, all participants received 1 GB of mobile data per month for the study duration. Participants received US\$2 upon onboarding completion.

Results

Characteristics of the Sample

Baseline characteristics for the full sample and by caregiver gender are presented in Table 1. The trial included 614 caregivers (409/614 women, 205/614 men), with ages ranging from 18 to 75 years

(mean age 35.94, SD 11.84). Independent-samples *t*-tests indicated no significant gender difference in age or positive parenting practices. However, women reported significantly higher levels of several socioeconomic and psychosocial stressors compared to men, including financial stress (mean 4.55 vs. 3.72; $P < .001$, Cohen's $d = 0.30$), food insecurity (mean 7.88 vs. 6.17; $P = .009$, Cohen's $d = 0.22$), harsh parenting (mean 7.40 vs. 5.07; $P < .001$, Cohen's $d = 0.37$), and depressive symptoms (mean 8.53 vs. 7.80; $P = .023$, Cohen's $d = 0.19$). Although effect sizes were small, the findings suggest consistent gender disparities in exposure to adversity.

Table 1. Gender differences in predictor variables: Means, standard deviations, and *t*-tests.

Measure	Overall		Female		Male		Gender comparison ^a	
	n	mean (SD)	n	mean (SD)	n	mean (SD)	Cohen's d	P value
Age (years)	577	35.94 (11.84)	386	35.70 (11.15)	191	36.43 (13.13)	0.06	.507
Financial stress	574	4.27 (2.75)	379	4.55 (2.73)	195	3.72 (2.73)	0.30	.001
Food insecurity	576	7.30 (7.78)	381	7.88 (8.09)	195	6.17 (7.01)	0.22	.009
Positive parenting	614	10.89 (6.78)	409	10.95 (6.84)	205	10.79 (6.69)	0.02	.777
Harsh parenting	614	6.62 (6.42)	409	7.40 (6.42)	205	5.07 (6.14)	0.30	.000
Parental depression	614	8.29 (3.95)	409	8.53 (4.12)	205	7.80 (3.56)	0.19	.023

^aGender differences were assessed using independent samples *t*-tests. Cohen's *d* represents the standardized mean difference between female and male caregivers, with positive values indicating higher scores for women. Effect sizes are interpreted as small ($d = 0.20$), medium ($d = 0.50$), and large ($d = 0.80$).

Program Engagement

Descriptives

Of the 614 enrolled caregivers, 97.1% (n=596) initiated the first module, and 90.2% (n=554) completed it. This initial uptake was followed by a marked decline in engagement. By module 2, only 59.8% (n=367) had started the module, and 45.8% (n=281) had completed it. On average, participants started 4.57 modules (SD 4.13) and completed 3.40 modules (SD 3.64) out of the 12 available (Table 2). The mean content completion rate across all 12 modules was 35.57% of the program (SD 33.10%). Completion rates were higher among participants assigned to the guided delivery, unstructured design, and enhanced digital support conditions.

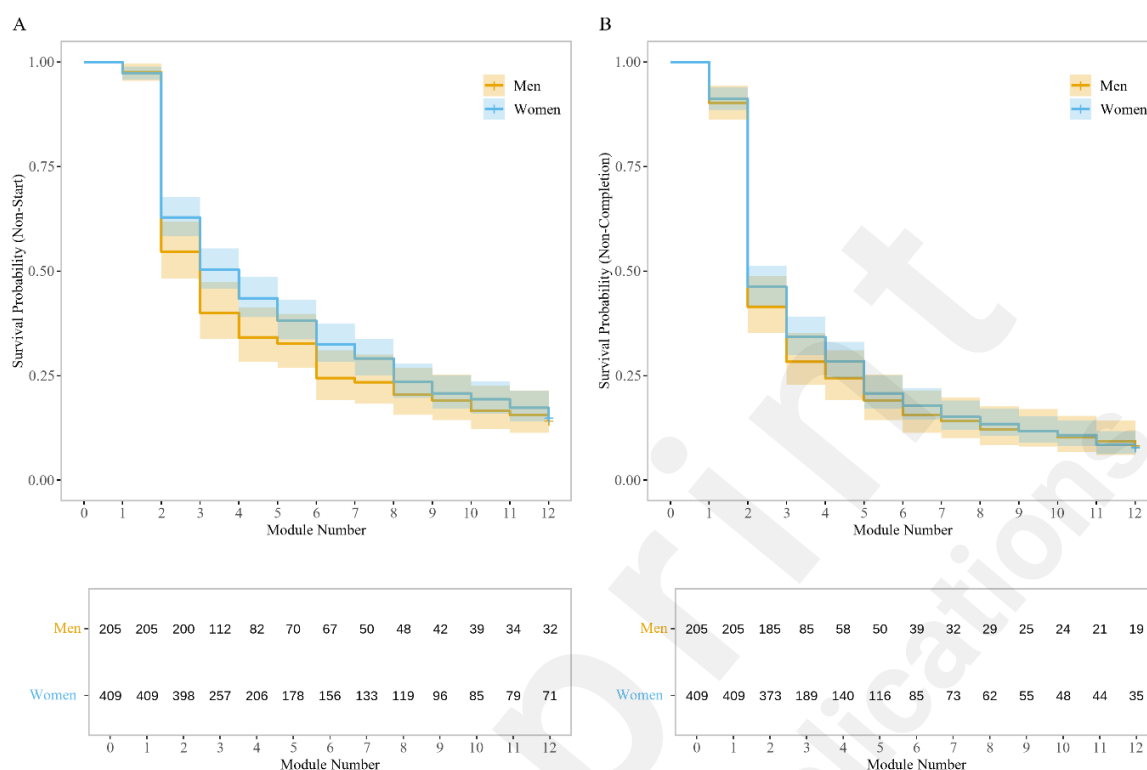
Kaplan–Meier survival analyses indicated that the median retention time among content users was 31 days (95% CI: 25–36), measured from first app launch to final data synchronization with the server. As shown in Figure 1, risk of disengagement was highest immediately after the first module. Although not statistically significant, women showed slightly lower risk of disengagement than men on both time-to-first non-start and time-to-first non-completion outcomes.

Table 2. Mean number of modules started and completed, overall and by component^a.

Variable	Overall	Guidance		App design		Digital support	
		Self-guided (n=330)	Guided (n=284)	Structured (n=332)	Unstructured (n=282)	Basic (n=295)	Enhanced (n=319)
Modules started	4.57 (4.13)	4.22 (3.92)	4.99 (4.33)	4.34 (4.03)	4.84 (4.23)	4.43 (4.04)	4.71 (4.21)
Modules completed	3.40 (3.64)	3.09 (3.41)	3.77 (3.85)	2.91 (3.04)	3.99 (4.16)	3.26 (3.51)	3.54 (3.75)

^aNote: Values represent mean scores with standard deviations (SD) in parentheses. Possible range = 0–12.

Figure 1. Kaplan–Meier survival curves showing time to first non-start (A) and time to first non-completion (B), stratified by caregiver gender^a.



^aNote: Plots reflect survival probability (i.e., continued engagement) across modules. Risk tables indicate the number of participants still engaged at each module. Shaded areas indicate 95% confidence intervals.

Predictors of Engagement Outcomes

Each of the three engagement outcomes was regressed on seven baseline predictors, yielding 21 primary hypothesis tests. To control for the false discovery rate within each outcome, the Benjamini–Hochberg procedure was applied separately to each set of seven tests [34]. The procedure compares each *P* value to a ranked critical value, and only those below the adjusted threshold are interpreted as statistically significant. Statistically significant effects are highlighted in bold in Table 3.

Caregiver gender was the only baseline characteristics significantly associated with module

completion. On average, women completed approximately 15% more modules than men (IRR 1.15, 95% CI [1.05-1.27], $P=.003$; Table 3). While associations between caregiver gender and the two secondary outcomes followed a similar direction, they did not reach statistical significance.

Table 3. Baseline predictors of program engagement outcomes^a.

Predictor	Modules Completed		First Non-Start		First Non-Complete	
	IRR ^c (95% CI ^d)	<i>P</i> value	IRR (95% CI)	<i>P</i> value	IRR (95% CI)	<i>P</i> value
Caregiver Gender^b	1.15 (1.05-1.27)	.003	0.90 (0.74-1.08)	.251	0.92 (0.77-1.10)	.370
Caregiver Age	1.02 (0.98-1.07)	.291	0.96 (0.90-1.04)	.325	0.99 (0.92-1.07)	.797
Financial Stress	1.02 (1.00-1.04)	.060	0.98 (0.93-1.01)	.156	0.98 (0.95-1.01)	.308
Food Insecurity	1.00 (1.00-1.01)	.667	1.00 (0.99-1.02)	.519	1.00 (0.98-1.02)	.413
Positive Parenting	1.00 (0.99-1.02)	.566	1.00 (0.99-1.02)	.711	1.00 (0.99-1.02)	.711
Harsh Parenting	1.00 (0.99-1.01)	.866	1.00 (0.98-1.01)	.698	1.00 (0.99-1.04)	.932
Parental Depression	0.99 (0.98-1.01)	.219	1.00 (0.98-1.03)	.827	1.01 (0.99-1.04)	.316

^aNote: All predictors were group-mean centered within clusters. Caregiver gender was dummy-coded (0 = male, 1 = female); estimates represent effects for women relative to men (reference group). Each model includes dummy-coded delivery components (guidance, app design, digital support) as covariates. Caregiver age and gender (grand-mean centered) were included as covariates unless they were the predictor in a given model.

^bEffect significant below the Benjamini-Hochberg procedure's critical value.

^cIncidence rate ratio.

^dConfidence interval.

Gender as a Moderator of Engagement Predictors

To examine whether the associations between baseline characteristics and engagement outcomes differed by caregiver gender, moderation models were estimated for each of the seven predictors across all three outcomes (Table 4). As with the main effects models, the Benjamini-Hochberg procedure was applied separately for each outcome to control the false discovery rate. Two interaction effects between gender and the baseline variables food insecurity and caregiver depression were marginally significant for the module completion

outcome, but neither meet the Benjamini–Hochberg threshold for statistical significance. No significant gender interactions were observed for the secondary outcomes, indicating that the associations between baseline characteristics and disengagement did not vary meaningfully by caregiver gender.

Table 4. Moderation of baseline predictors of program engagement outcomes by caregiver gender^a.

Predictor	Outcome	Main Effect IRR ^b (95% CI) ^c	P value	Interaction Effect IRR (95% CI)	P value
Caregiver Age	Modules completed	1.02 (0.98-1.06)	.412	0.92 (0.84-1.00)	.054
	First non-start	0.97 (0.90-1.05)	.493	1.09 (0.92-1.28)	.328
	First non-complete	0.99 (0.93-1.08)	.946	1.08 (0.92-1.27)	.327
Financial Stress	Modules completed	1.02 (1.00-1.04)	.057	0.99 (0.96-1.03)	.758
	First non-start	0.98 (0.95-1.01)	.147	1.01 (0.94-1.09)	.755
	First non-complete	0.98 (0.95-1.02)	.305	1.00 (0.93-1.07)	.933
Food Insecurity	Modules completed	1.00 (1.00-1.01)	.472	0.98 (0.97-1.00)	.029
	First non-start	1.00 (0.99-1.02)	.539	1.01 (0.98-1.04)	.533
	First non-complete	1.00 (0.98-1.01)	.381	1.02 (0.99-1.04)	.251
Positive Parenting	Modules completed	1.00 (0.99-1.01)	.494	1.01 (0.99-1.03)	.371
	First non-start	1.00 (0.99-1.02)	.700	0.99 (0.96-1.03)	.689
	First non-complete	1.00 (0.99-1.02)	.680	0.99 (0.96-1.02)	.486
Harsh Parenting	Modules completed	1.00 (0.99-1.01)	.947	1.01 (1.00-1.03)	.152
	First non-start	1.00 (0.98-1.01)	.683	0.99 (0.96-1.03)	.739
	First non-complete	1.00 (0.99-1.01)	.862	0.98 (0.95-1.02)	.325
Caregiver Depression	Modules completed	0.99 (0.98-1.01)	.375	0.97 (0.94-1.00)	.041
	First non-start	1.00 (0.98-1.03)	.860	1.03 (0.97-1.09)	.383
	First non-complete	1.01 (0.99-1.04)	.322	1.02 (0.97-1.08)	.450

^aNote: All predictors were group-mean centered within clusters. Caregiver gender was dummy-coded (0 = male, 1 = female); interaction terms estimate differential effects for women compared to men (reference group). Gender was included as both a cluster-mean centered variable (within-cluster effect) and a cluster-level mean (between-cluster effect). Caregiver age (grand-mean centered) was included as a covariate in all models except when it was the predictor. All models also adjust for the three dummy-coded delivery components (guidance, app design, digital support).

^bIncidence rate ratio.

^cConfidence interval.

Discussion

This study provides the first known analysis of caregiver-level predictors of engagement in a digital parenting program in an LMIC, with the notable strength of including a large proportion of male caregivers (33.4%). While nearly all participants initiated the program, engagement dropped substantially after onboarding, with the steepest decline occurring after module 1. This mirrors broader trends in digital health interventions, where attrition is typically concentrated in the early stages of program use [35]. These findings support prioritizing early-stage retention strategies that are responsive to both context and gender.

Principal Results

Of the baseline characteristics examined, caregiver gender was the only statistically significant predictor of engagement. Women completed approximately 15% more modules than men, a finding that contrasts with several digital parenting studies in HICs, where engagement is often similar across genders [15]. One possible explanation is that women's higher engagement may reflect greater exposure to adversity. In this study, women reported significantly higher levels of financial stress, food insecurity, depressive symptoms, and harsh disciplinary practices. These stressors may have increased the perceived relevance of the intervention and, in turn, motivation to engage.

This interpretation aligns with the Health Belief Model, which posits that individuals are more likely to adopt health behaviors when they perceive the risks of inaction as high, and the benefits of action as tangible [36]. From this perspective, adversity may have served as a cue to action, outweighing emotional or cognitive barriers that might otherwise prevent engagement [37]. That women sustained engagement despite multiple, overlapping stressors is a notable, policy-relevant finding. It suggests that digital parenting interventions may offer a feasible and acceptable modality for supporting high-risk caregivers in LMICs.

In contrast, the lower engagement observed among male caregivers may reflect a complex interplay of identity, norms, and structural constraints. In Tanzania and many other LMICs, caregiving is typically viewed as a maternal responsibility, while fatherhood is closely tied to provision, protection, and authority [38-40]. When program content is perceived as incongruent with these gendered expectations, or fails to affirm men's aspirations as fathers, it may appear irrelevant or incompatible with their roles. This is echoed in global fatherhood research showing that interventions which acknowledge and support men's caregiving identities and align with their aspirations tend to enhance perceived relevance and achieve higher engagement [11,41].

Lower male engagement may also reflect deeper identity tensions under conditions of economic precarity. Qualitative research from Mwanza, Tanzania describes how many men aspire to be nurturing and involved fathers but face conflicting practical and social pressures from work demands, limited time, and community norms [40]. These experiences not only restrict men's capacity to participate in caregiving but may also lead to internal dissonance when they are unable to fulfil culturally sanctioned roles of fatherhood, a phenomenon that has been described as *moral injury* in fatherhood research [42,43]. Similar findings from Uganda indicate that even when men express egalitarian views, structural constraints and social stigma around caregiving can limit their involvement in parenting programs [44]. These dynamics highlight the need for interventions that go beyond access and inclusion, to actively affirm men's caregiving identities and reduce the opportunity costs of engagement. For instance, integrating parenting content with economic support (e.g., cash transfers or social protection systems) may help offset time burdens and address competing pressures for men [45].

Although *ParentApp* was explicitly designed to be father-inclusive, these findings point to the

importance of adopting more gender-transformative approaches. Such approaches not only include men but actively challenge inequitable norms and support identity shifts in caregiving. As highlighted in a recent systematic review of fatherhood programs in LMICs, gender-transformative interventions foster critical reflection, promote shared decision-making, and engage with normative change at individual and community levels [45]. Promising examples include in-person parenting programs such as REAL Fathers in Uganda [46], Bandebereho in Rwanda [47], and Parenting for Respectability in Uganda [48], which have achieved shifts in father involvement, reductions in intimate partner violence (IPV), and improvements in household dynamics through facilitated dialogue, peer role-modelling, and local leadership.

Emerging evidence suggests that elements of these gender-transformative strategies can be translated into digital formats. One such example is ParentText, a chatbot-based parenting intervention adapted from the PLH program suite and piloted in South Africa and Jamaica. ParentText has been explicitly designed to include content on IPV prevention and promote gender-equitable behaviors [49]. A qualitative study exploring user experiences found that men appreciated the anonymity, accessibility, and nonjudgmental tone of the chatbot, which made it easier to engage with sensitive content around relationships and caregiving [50]. A parallel pre-post pilot study reported modest reductions in women's experience of IPV, as well as improvements in men's attitudes and gender-equitable behaviors. However, overall engagement with the program, and with the IPV-related content in particular, was limited, especially among male users [51]. Together, these findings highlight both the promise and limitations of digital platforms in addressing gender norms and violence prevention. Further research is needed to identify digital design and delivery strategies that most effectively support engagement and behavior change among fathers.

Limitations

Several limitations should be acknowledged when interpreting these findings. First, engagement was operationalized through digital metrics (e.g., module completion), which offer behavioral indicators of app use but do not capture content comprehension or real-world application. This reflects a broader challenge in digital health research, where engagement is often equated with usage alone, without consideration of learning or behavior change outcomes [52]. Moreover, these metrics do not capture users' subjective experiences, such as interest, attention, or emotional resonance, which may be equally important in understanding meaningful engagement [7]. Future research should therefore incorporate multidimensional measures that capture both the quantity and quality of engagement, alongside users' subjective experiences.

Second, the range of caregiver characteristics assessed at baseline was limited by the brief, app-embedded format of the survey. Key variables such as perceived digital skills and prior experience with technology were not captured, although these factors have been shown to influence engagement with digital interventions [53,54]. The study also did not measure adolescent-level characteristics, such as child mental health symptoms, which have been positively associated with parental engagement in previous research [52]. Accounting for these variables in future studies may improve the precision of engagement models and support more targeted intervention strategies.

Third, while the overall sample size was relatively large, the study may have been underpowered to detect gender interaction effects, especially given the smaller proportion of male caregivers in the sample. Future studies should consider adequately powered subgroup analyses to explore gender-specific patterns of engagement. Further, although the sample was drawn from low-income urban and peri-urban settings, all participants were required have

regular access to a smartphone. As such, findings may not be generalizable to caregivers in rural areas or those with limited access to digital technology. Broader implementation research is needed to understand how structural barriers such as digital access, network reliability, and device sharing influence engagement, including in rural and more resource-constrained settings.

Conclusions

Notwithstanding these limitations, the findings delineate clear priorities for practice and policy. Across demographic, socioeconomic, behavioral, and psychological factors, only caregiver gender significantly predicted engagement, with women completing more modules than men. The absence of associations with other baseline characteristics suggests that *ParentApp* was broadly accessible, including among caregivers facing high levels of adversity. However, the marked drop-off immediately after onboarding indicates a critical need to front-load retention efforts. Early engagement may be strengthened by providing timely support, establishing immediate relevance, and affirming the caregiving identities of both women and men. Over the longer term, embedding gender-transformative content and linking digital programs to broader social protection systems may be necessary to improve engagement and achieve sustainable public health impact in LMICs.

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Conflicts of Interest

RJ's doctoral research is based on this trial. JML is the chief executive officer, and LDC is a voluntary trustee of Parenting for Lifelong Health (PLH), a charity based in the United Kingdom and South Africa. JML receives occasional fees for providing training and supervision for PLH programs. Members of the research team have worked on other studies of PLH, which contributed funding to their respective universities but not directly to them. The intellectual property of the intervention is owned by the developers of the original intervention under a Creative Commons Attribution-NoDerivatives and NonCommercial 4.0

International Public License. No profit or financial gain will be made from the implementation and dissemination of the intervention.

Data Availability

The datasets generated or analyzed during this study are not currently publicly available due to ongoing analyses but will be made available via the Open Science Framework upon study completion. In the interim, datasets are available from the corresponding author on reasonable request.

Authors' Contributions

RJ led the conceptualization, data analysis, and writing of the original, revised, and final manuscript drafts. LDC, YS, GJM-T, and L-JVN contributed to the critical revision of the manuscript. GJMT provided key input into the statistical analysis. All authors read and approved the final version of this manuscript.

Abbreviations

CI: Confidence interval

HIC: high-income country

IPV: Intimate partner violence

IRR: Incidence rate ratio

LMIC: low- and middle-income country

MOST: Multiphase Optimization Strategy

NIMR: National Institute for Medical Research

PLH: Parenting for Lifelong Health

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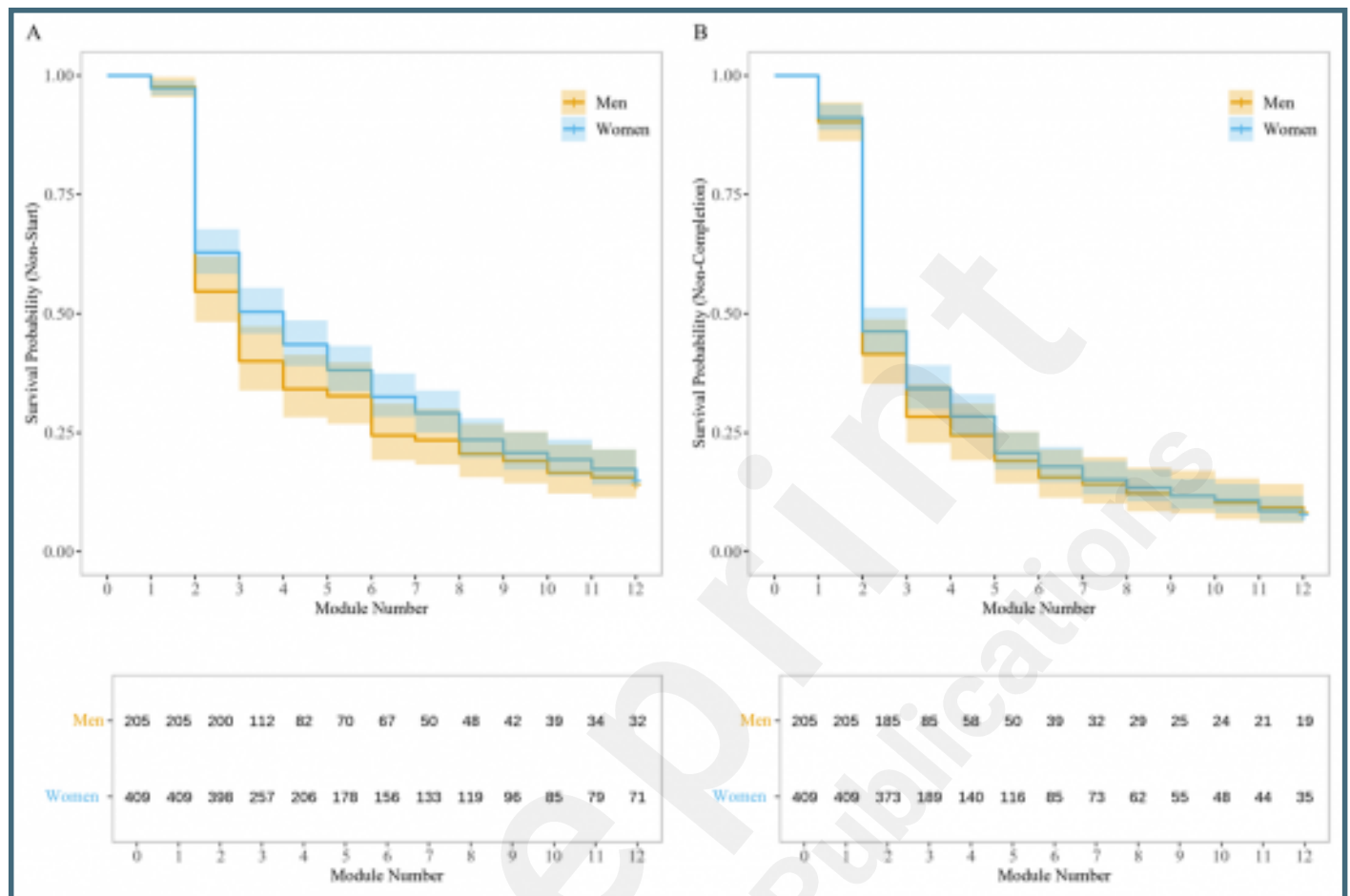
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Supplementary Files

Figures

Kaplan–Meier survival curves showing time to first non-start (A) and time to first non-completion (B), stratified by caregiver gender.



Related publication(s) - for reviewers eyes onlies

Main trial results paper published in the Journal of Medical Internet Research. The submitted manuscript presents new, non-overlapping analyses focused specifically on caregiver-level predictors of engagement.

URL: <http://asset.jmir.pub/assets/414e81706163415c498e6bd309c8d9ea.pdf>

