Digital tools to improve parenting behaviour in low-income settings: a mixed-methods feasibility study

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ABSTRACT

Introduction Digital parenting interventions could be potentially cost-effective means for providing early child development services in low-income settings. This 5-month mixed-methods pilot study evaluated the feasibility of using *Afinidata*, a comprehensive *Facebook Messenger*-based digital parenting intervention in a remote rural setting in Latin America and explored necessary adaptations to local context.

Methods The study was conducted in three provinces in the Cajamarca region, Peru, from February to July 2021. 180 mothers with children aged between 2 and 24 months and regular access to a smartphone were enrolled. Mothers were interviewed three times in-person. Selected mothers also participated in focus groups or in-depth qualitative interviews.

Results Despite the rural and remote study site, 88% of local families with children between 0 and 24 months had access to internet and smartphones. Two months after baseline, 84% of mothers reported using the platform at least once, and of those, 87% rated it as useful to very useful. After 5 months, 42% of mothers were still active on the platform, with little variation between urban and rural settings. Modifications to the intervention focused on assisting mothers in navigating the platform independently and included adding a laminated booklet with general information on child development, sample activities and detailed instructions on how to self-enrol in case of lost phones.

Conclusions We found high access to smartphones and the intervention was well received and used in very remote areas of Peru, suggesting that digital parenting interventions could be a promising path forward for supporting low-income families in remote parts of Latin America.

WHAT IS ALREADY KNOWN ON THIS TOPIC

⇒ Digital parenting interventions are potentially cost-effective means for providing early child development services in low-income settings but have not been well-studied to date.

WHAT THIS STUDY ADDS

⇒ This mixed-methods pilot study in a very remote setting in Latin America showed that 88% of local families with children between 0 and 24 months had access to smartphones with internet and 42% were still engaging with a digital parenting intervention after 5 months.

HOW THIS STUDY MIGHT AFFECT RESEARCH, PRACTICE OR POLICY

⇒ High access to smartphones suggest that digital parenting interventions could be a promising path forward for supporting low-income families in remote parts of Latin America, but mothers might benefit from additional instructions to navigate all features of digital interventions on their own.

INTRODUCTION

According to latest estimates, over 250 million young children are at risk of missing their developmental potential due to early life adversity.[1] Early life interventions are increasingly recognised as key for ensuring children's optimal development and long-term well-being.[2 3]

One of the most promising interventions for low-income settings are home visiting programmes, where trained facilitators regularly visit parents following a structured curriculum to improve knowledge and care practices related to early child development (ECD).[4 5] Such programmes have been successfully implemented across the world[6–9] and in Peru.[10] The national Peruvian home visiting programme (*Programa Nacional Cuna Más* (PNCM)[11]) is one of the world's largest, serving families with children aged under 36 months from areas of poverty. While a recent evaluation has shown PNCM to positively impact ECD and be cost-effective at scale,[12] the programme can currently only support the most vulnerable.

The rapid rise in cell-phone coverage and internet access globally means digital parenting interventions may be one means for addressing gaps in ECD services in Peru and many other low-income and middle-income country (LMIC) settings.[13 14] *Afinidata* is one example of a comprehensive digital parenting support platform leveraging this opportunity using a *Facebook (FB) Messenger* chatbot.[15] The intervention is described in detail below and in online supplemental annex 1.

Despite their potential, there is limited evidence on how feasible digital parenting interventions are in practice, especially in remote rural settings in LMIC. The current study describes the results of a 5-month mixed-methods study testing reach, reception and use of the *Afinidata* parenting platform

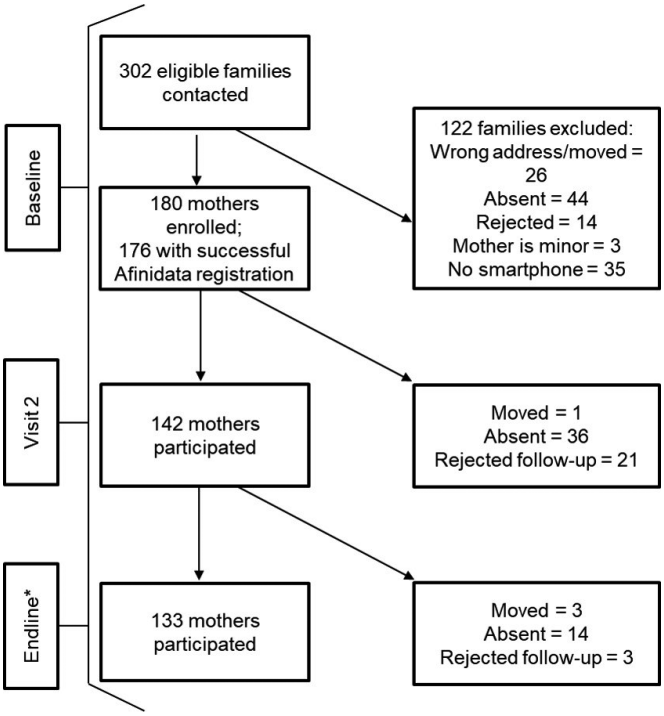

Figure 1 Flow chart of study enrolment. *For endline, 31 mothers who were absent for visit 2 were contacted again.

while exploring necessary adaptations to local context. We also summarise lessons learnt for the implementation of *Afinidata* in a full-scale randomised controlled trial (RCT; https://clinicaltrials.gov/ct2/show/NCT05202106).

METHODS

Setting

The results reported in this study follow the framework for feasibility studies[16] and Strengthening the Reporting of Observational Studies in Epidemiology standards.[17] Community leaders and local authorities were aware of the study. No incentives were given for participation. The study was conducted in the provinces of San Marcos, Cajabamba and Cajamarca in northern Andean Peru, located between 1900 and 3900 m above sea level. The region is predominantly rural and representative of many rural and peri-urban settings in Andean South America, with a large share of poor and remote households engaged in farming. Communities were classified in accordance with the Peruvian National Institute of Statistics and Informatics as urban (communities with >2000 inhabitants with contiguous, grouped homes forming streets) or rural (scattered or grouped houses of up to 2000 inhabitants per community[18]). The study area is partially covered by PNCM.

Participants

Using administrative data on recent births, we identified all eligible families and visited them at home. We recruited 180 adult mothers with children aged between 2 and 24 months who either owned or had regular access to a smartphone.

The intervention

The *Afinidata* platform (www.afinidata.com) uses *FB Messenger* to interact with pregnant mothers and parents of children aged 0–6 years from low-income settings through automated chatbots. *Afinidata* was designed for LMIC families and includes minimal text and data-intensive features.

Similar to home visitors, a 'virtual tutor' asks about the child's well-being through messages and push-notifications and makes two to three suggestions for development-promoting activities that parents can do with their children. Parents can reach out to the chatbot anytime, seeking advice or sharing their child's achievements. The system tracks parents' reactions to the recommended activities, children's age and development over time and uses this feedback to provide parents with customised activity recommendations.

During the study, mothers received a weekly push-message with age-appropriate informative content and a reminder to use *Afinidata*. Mothers could also respond to questions about their children's development, which were summarised into a simple graphical report. We screened all 641 activities and messages for the relevant age group (2–24 months) for local language, cultural appropriateness and availability of playing materials (see also online supplemental annex 1 for more details).

Procedures

We conducted 5 months of extensive field-testing with local mothers from February to July 2021, squarely during the COVID-19 pandemic in Peru.

First, we measured internet and phone connectivity in 142 communities in all three provinces for all four national cellphone providers. Measurements were taken in the central plaza, or in central schools, health centres or main roads. Using SIM cards for each provider in the same ZTE-BLADE-A3-2020 smartphone, we started a conversation with *Afinidata* in *FB Messenger* and opened the platform-generated link for an activity. Of the 136 communities with successful activity-download through at least one provider, we selected 49 communities for this study. We also noted presence of administration building, health centre and school for each community.

Mothers were shown how to use *Afinidata* and completed a baseline interview in their home. After 2 months, mothers gave detailed qualitative and quantitative feedback on *Afinidata* content during a second visit. Simultaneously, we called 27 mothers who were not using *Afinidata* to inquire about technical difficulties and reasons for non-use and conducted seven focus group discussions (FGD) and two in-depth interviews with a mix of urban and rural mothers with varying levels of engagement in *Afinidata*. After 5 months, we conducted a final visit asking about additional family characteristics, mothers' digital literacy and their platform use and satisfaction.

Measures

Main outcome measures

Use of the app over time was measured automatically by *Afinidata*. We defined mothers as active users if they interacted with *Afinidata* at least weekly, either asking for an activity, choosing a *Frequently Asked Question* or updating their child's development. Some other interactions, such as responding to push-messages, requesting tips on development or asking the virtual tutor direct questions, were not tracked in the system.

Demographic, socioeconomic and literacy measures

Sociodemographic data collected at baseline included household characteristics, reception of conditional cash transfers for poor families called 'Juntos',[19] mother's and child's age (in years and months, respectively), mother's education and economic activity. For reading comprehension, mothers answered three content

Table 1 Demographic characteristics of sample

	Total		Urban		Rural		Diff test
	N/Mean	Column %/SD	N/Mean	Column %/SD	N/Mean	Column %/SD	*p*-value
Participants (n, row %)	180	100.0%	41	22.8%	139	77.2%	
Family characteristics							
Age child (months)	9.6	4.84	10.8	5.70	9.3	4.53	0.131
Age mother (n=179, years)	29	6.13	29	6.08	29	6.17	0.328
Mother's education (completed secondary or higher, n=178)	56	31.5%	21	51.2%	35	25.5%	0.002
Mother is mainly at home with children (*Ama de casa*)	153	85.0%	29	70.7%	124	89.2%	0.004
Mother answered all reading comprehension questions correctly	143	79.4%	37	90.2%	106	76.3%	0.052
Family's main economic activity is agriculture (n=133)	69	51.9%	10	32.3%	59	57.8%	0.013
House has dirt floor	69	38.3%	2	4.9%	67	48.2%	<0.001
Household received conditional cash transfers	98	54.4%	18	43.9%	80	57.5%	0.123
Access to community resources							
Family lives in community with school	176	97.8%	41	100.0%	135	97.1%	0.272
Family lives in community with health centre	106	58.9%	41	100.0%	65	46.8%	<0.001
Family lives in community with local administration building	172	95.6%	41	100.0%	131	94.2%	0.116
Internet connectivity and digital literacy							
Number of providers in community	3.77	0.56	4.00	0.00	3.70	0.62	0.001
Family has internet signal in the house	169	93.9%	40	97.6%	129	92.8%	0.264
Mother owns smartphone	152	84.4%	39	95.1%	113	81.2%	0.032
Prepaid phone (vs monthly plan)	119	66.1%	22	53.7%	97	69.8%	0.055
Monthly cost of phone (Soles):							0.028
<16 Soles (US$4)	67	37.2%	11	26.8%	56	40.3%	
Between 16 and 30 Soles (US$4–8)	90	50.0%	20	48.8%	70	50.4%	
>30 Soles (US$8)	23	12.8%	10	24.4%	13	9.4%	
Mother's digital literacy score (n=133)	10.86	4.5	14.35	4.54	9.8	3.93	<0.001
Social media usage (self-report)							
Mother uses *FB* (n=179)	169	94.4%	41	100.0%	128	92.8%	0.076
Mother uses *FB Messenger* (n=179)	152	84.9%	40	97.6%	112	81.2%	0.032
Mother uses *WhatsApp* (n=179)	173	96.6%	41	100.0%	132	95.7%	0.174
Afinidata usage (self-report after 5 months)							
Mother used *Afinidata* (n=133)	128	96.2%	30	96.8%	98	96.1%	0.858
Mother rated *Afinidata* positively (useful or very useful, n=128)	123	96.1%	30	100.0%	93	94.9%	0.207
Mother intends to use *Afinidata* in the future (n=128)	126	98.4%	30	100.0%	96	98.0%	0.430

Diff, difference; FB, facebook.

questions after reading a sample activity. Results are presented as percentage who answered all questions correctly.

Internet connectivity, phone use and digital literacy

At baseline, mothers reported internet signal availability in the house, their phone ownership, type of contract, monthly cost and social media usage. At endline, mothers also reported on their satisfaction and future use of *Afinidata* and completed the Survey of Adult Skills digital literacy scale (Programme for the International Assessment of Adult Competencies; Cronbach's alpha=0.79).[20]

Data analysis

Statistical analyses were conducted using STATA V.16 and Python's statsmodels and scipy libraries. Participant characteristics are presented as means, SD and relative percentages. We compared participants from urban and rural communities with mothers who were active versus inactive at endline using χ^2 test and two-sided Mann-Whitney U test (non-corrected for continuity). Additionally, we analysed participants' engagement over time by mapping the weekly percentage of active mothers by phone ownership and setting (urban/rural).

In the FGD and qualitative interviews, we asked in-depth questions on *Afinidata* satisfaction and specific in-platform features. Following simulation study by Namey *et al*,[21] we estimated needing three to five FGD to reach 80%–90% saturation. FGD and interviews were tape-recorded and summarised in detailed notes. Notes were translated and analysed for common themes using a reflexive thematic approach.[22] Finally, themes were compared with the data collected in the phone calls to mothers who were not using *Afinidata* and from the feedback on *Afinidata* content from the second visit.

RESULTS

Reach of the digital intervention

The five included urban communities had full internet connectivity for all providers and all resources present. Among the 44 rural communities, 10 (22%) had connectivity with only 1–2 phone providers. Figure 1 shows a participant flow chart. After up to 3 attempts at contact, 133 mothers were interviewed at a final visit. Table 1 shows a general description of the sample, as well as phone and social media use by urban and rural setting. Of all eligible families, 12% (35) were excluded because there was no smartphone available for the mother to use. Among included

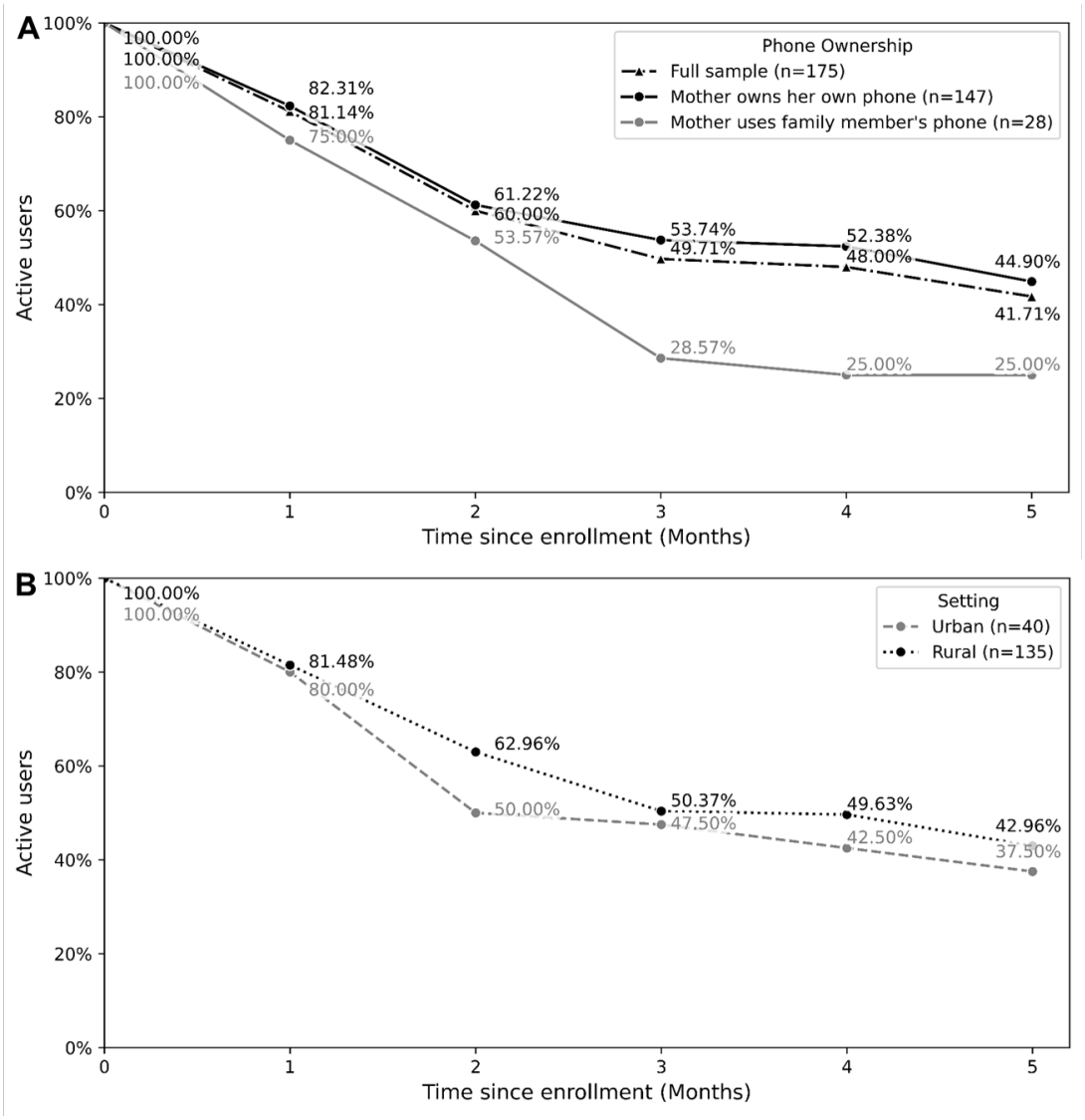

Figure 2 Showing (A) *Afinidata* platform use over time by phone ownership and (B) *Afinidata* platform use over time by urban and rural setting.

families, 16% (28) of mothers used a smartphone belonging to their husband or another family member.

Reception and use of the intervention

Two months after baseline, 84% of mothers reported ever using the platform and of those, 87% rated it as useful to very useful (mean=4.37/5, SD=1.00). These results are similar to automatically collected rates by *Afinidata* after 1 month (see figure 2A). Figure 2A also presents weekly engagement for mothers who had their own smartphone and those who used a family member's phone. Results show generally higher engagement by mothers with their own phones. Figure 2B presents the same analysis by urban versus rural setting, and shows no meaningful differences between groups. Overall, 42% (73) of mothers were still active after 5 months. These mothers did not differ by age of the child (under or over 12 months), level of education or social media usage at baseline.

During the second visit, mothers gave feedback on specific activities they had received. Most mothers reported spending between 20 and 30 min on the activities per session. Only 11% of mothers recalled an activity they did not like. Recommendations for improvement included simpler wording and materials. Interviews with 16% of mothers who self-reported not using the platform revealed that barriers were mainly lack of time, followed by lost phone or lost access to a borrowed phone. Similarly, follow-up calls to 27 mothers without activity in the platform for over a month showed that mothers often did not re-instal the platform if they switched phones.

In five FGD and two in-depth interviews mothers expanded on the topics above. Data analysis of the FGD and in-depth interviews showed that we had reached saturation on themes. Examples of original quotes and translations are included in online supplemental appendix 2. Overall, *Afinidata* was received very positively, and several mothers recounted spending more time engaging with their children, feeling closer to their children or involving their husbands in the activities.

Mothers who experienced problems with materials reported substituting or moving on to the next activity without negative impact on their perception of the intervention. Most mothers cited time constraints as the main barrier for participation. For those mothers with school-aged children, this was mainly due to additional demands on managing virtual classes during the COVID-19 pandemic. Additionally, sometimes mothers lost access to their phone because their older children needed it for

Table 2 Summary of modifications to the intervention based on participant feedback

Issue	Data source	Adaptation to intervention or study protocol
Optimising procedures for subsequent trial		
Field team and *Afinidata* need real-time communication channels to troubleshoot enrolment issues	Field team observations	► Designated WhatsApp group between field team and *Afinidata* back-end team for technical support and to ask for manual data correction or enrolment. ► Field team has access to *Afinidata* dashboard. ► Development of detailed trainings and technical manuals on how to troubleshoot enrolment problems with the family.
Mothers have problems re-enrolling into *Afinidata* after loss of phone: Several mothers self-re-registered with another FB account, generating multiple IDs under different names	Field team observations, user surveys, focus groups	► Adapted enrolment protocol and developed in-depth training manuals for field interviewers: field workers spend more time to assist mothers in self-enrolment and give instructions on all available options at baseline visit. Balance between accurate data entry and letting mothers experience the interaction with *Afinidata* on their own to increase knowledge and comfort with the chatbot. ► *Afinidata* incorporated back-end programming to associate users who re-register with previous accounts. ► Field workers leave a printed booklet with sample activities and detailed information on how to re-enrol in case mothers switch phones.
12% of approached households do not have access to a smartphone	User surveys, field team observations	► Field workers leave a printed booklet with general information on child development, sample activities and detailed information on how to self-enrol when a smartphone is available at a later point in time.
Find additional strategies to increase retention	Compliance data, user surveys	► Protocol and scripted calls every 3 months to inactive users to inquire about technical difficulties.
Additional support to resolve technical difficulties during sign-up is needed	Field team observations	► Adding a new technical support button to the platform that connects directly to an *Afinidata* collaborator. ► Field workers are showing mothers how to ask for technical support within the chatbot at baseline visit.
Some mothers are asking interviewers for help on how to disengage from the programme FB blocked the chatbot for all mothers for 48 hours after mothers blocked the *Afinidata* chatbot	Field team observations, 'FB block'	► Included programming for users to drop out directly within the platform to avoid users blocking messages. ► During enrolment field interviewers explain what to do if parents prefer to stop receiving messages and content from *Afinidata*. ► Developed an additional application to secure alternative means of communication in case of a 'FB block' as an alternative channel of communication.
Adaptation to local context		
Photos and descriptions of certain activities were not representative of local cultural context or were depicting toys or resources not readily available in the local cultural context	Field team observations	► New photos were taken for 114 activities. ► *Afinidata* made 214 adaptations to content such as replacing words or substitute materials that were costly or hard to find locally. ► *Afinidata* categorised all existing content based on the Nurturing Care Framework to assist in a more balanced coverage of topics around health, nutrition, responsive caregiving and other topics.
Limit amount of questions needed to generate information on developmental milestones	Focus groups	► Development of a new algorithm to place a child in the appropriate *Afinidata* developmental status groups.
Make report on developmental milestones more understandable for families	Focus groups	► Testing of different layout options and final development of a new report on developmental progress of the child for the families.
Optimise push-message timing and frequency	Focus groups	► Changed time of day when push notifications are sent to users.

school. Technical difficulties, lack of credit or loss of phone were not perceived as relevant barriers for use.

Adaptation of the intervention

We changed various components of *Afinidata* or the RCT protocol following the detailed feedback (see table 2 for a summary). The most important lessons learnt were to include additional steps to facilitate self-enrolment or re-enrolment by the mother. For this, we designed a laminated booklet containing general information on ECD, sample activities and detailed self-enrolment instructions. To increase comfort and agency in using the platform, interviewers assist mothers in experiencing the platform features during the baseline visit of the RCT, and we added real-time communication between the field team and *Afinidata* to provide technical support during enrolment.

DISCUSSION

Digital parenting interventions are potentially cost-effective yet untested means for expanding access to ECD programmes in LMICs. In this study, we extensively tested the reach, reception and use of *Afinidata*, a *FB Messenger*-based 'virtual tutor' for parents, and explored necessary adaptations to local context in a remote rural setting in Latin America.

Our results show that there was high access to internet and smartphones throughout the rural and remote region. Only six of the most remote villages out of 142 communities were excluded from the study area for lack of connectivity. Among eligible families, 88% had a smartphone and 94% of participating households had internet signal inside their homes. Moreover, 84% of mothers owned their own device, and almost all were already using *Facebook* (94%) and *WhatsApp* (96%). This shows a tremendous potential to reach most of the primary caregivers of young children through interventions that use those channels in a typical LMIC setting.

Overall, participant feedback showed that the *Afinidata* platform was received very positively. Similarly, a recent study in the Peruvian Amazon region showed high acceptance of a mobile health-assisted curriculum by caregivers and facilitators and increased knowledge on child health among caregivers in the digitally enhanced home visit intervention.[23] Most mothers visited at endline reported that they would continue to use *Afinidata* in the future. However, this contrasts with actual usage data from the platform.

While there was high initial engagement with *Afinidata*, there was a rapid decline in use over 2 months, and after 5 months only 73 (42%) mothers were still engaging weekly. Digital parenting interventions commonly have to contend with high attrition rates.[24 25] In programmes that resemble *Afinidata* (ie, freely available online-only universal prevention programmes for parents), completion rates as low as 15%[26] to 7%[27] have been reported. Since we only measured part of the possible interactions with the system, our results likely underestimate engagement with the platform. This means, in comparison with similar interventions, measured engagement at 5 months was high, but more data over longer time periods are needed.

Keeping users engaged is a crucial and challenging step for all self-guided digital interventions. Using push-messages and other content are important means to maintain interest in the intervention. The

following RCT will measure such interactions, expand our knowledge on engagement beyond 5 months and investigate additional barriers and encouragement for engagement.

As expected, mothers who were using a family member's phone showed lower rates of engagement, with only 25% still engaging weekly with the platform after 5 months. Importantly, we found no meaningful differences in engagement between urban or rural participants. Furthermore, there were no differences in use by mothers' level of education, social media use or age of the child, indicating that the intervention is similarly relevant and accessible for mothers across different contexts. Lack of credit, technical difficulties and loss of phone were not perceived as barriers for engagement by the mothers, although field observations showed that mothers often did not re-instal the platform after they switched phones.

Because we found few concerns regarding the content of *Afinidata*, we focused on modifications that would assist mothers in navigating the platform in our RCT (eg, teaching how to self-enrol, ask for technical support or leave the platform). Two key lessons learnt were: (1) while the use of the platform quickly becomes intuitive, mothers in remote areas with poor connection greatly benefit from personal assistance with the initial installation and exploration of features; (2) it is beneficial to accompany the digital intervention with a physical booklet giving instructions for later self-enrolment for families who might not have a smartphone present during the visit or who change phones later. While this investment in initial enrolment and ongoing technical support requires additional staffing, the overall costs associated with these changes are still well below those of an in-person intervention.

Limitations

This study had several limitations. Most importantly, we did not assess impact on maternal or child outcomes or cost-effectiveness of the intervention—this will be done in the ongoing RCT. Our results could be biased by losing the least satisfied users for follow-up. Excluding families without access to a smartphone means that this was not a truly representative sample.

CONCLUSION

Our results show that access to smartphones is high in remote areas of Peru. Participant feedback showed that digital ECD interventions are well-received by mothers initially. While app-use declined over time, engagement was higher than in similar self-guided digital interventions. Furthermore, engagement after 5 months was similar for mothers across urban and rural settings with diverse individual characteristics. Digital parenting interventions could thus be a promising path forward for supporting families in remote parts of Latin America and other LMICs.

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Competing interests AC is CEO of *Afinidata* and has thus interest in the success of this platform. She was not involved with the analysis of the data and did not influence the way results were presented. All other authors declare no conflict of interest and have no financial interests to disclose.

Patient consent for publication Not applicable.

Ethics approval This study was approved by the Universidad Peruana Cayetano Heredia (SIDISI: 202522-Ref 030-03-21) and the Ethics Commission for Northwest and Central Switzerland (EKNZ: AO_2021-00002). Participants gave informed consent to participate in the study before taking part.

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