

ORIGINAL RESEARCH

# There's No App for That: Assessing the Impact of mHealth on the Supervision, Motivation, Engagement, and Satisfaction of Community Health Workers in Sierra Leone



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## Abstract

**BACKGROUND** The unprecedented access to mobile phones in resource-poor settings has seen the emergence of mobile-health (mHealth) applications specific for low- and middle-income contexts. One such application is the Mobile Technology for Community Health Suite (MOTEC Suite). Given the importance of community health worker (CHW) perceptions of a health program toward its successful implementation, this study explores whether the introduction of an mHealth application, as a human resource management tool, is associated with changes in CHW perceived supervision, motivation, work engagement, and job satisfaction over time.

**METHODS** We employed a 3-arm randomized longitudinal cohort design in Bonthe District, Sierra Leone. Three hundred twenty-seven CHWs were assessed over an 18-month period, with 3 different rounds of data collection. CHWs were assigned to 3 different intervention groups and given either a mobile phone with access to both the application and to a closed user group; a phone set up on a closed user group but with no application; or no mobile phone but the same level of training as the previous 2 groups.

**RESULTS** Findings indicated that there were no initial or sustained differences in perceived supervision and motivation across the 3 experimental groups over time with the introduction of the MOTEC Suite as a human resource management tool. Furthermore, there was no significant change in the self-reported measures of work engagement and job satisfaction across each of the intervention groups over time.

**DISCUSSION/CONCLUSION** Findings suggest that there are no systematic changes in perceived supervision, work engagement, job satisfaction, or motivation between CHWs who received a mobile phone set up on a closed user group with the MOTEC Suite application and those who either only received a phone with the closed user group or no phone at all. Therefore, the results of this study do not provide sufficient evidence to support the use of mobile technology or mHealth applications to strengthen these organizational factors within CHW programs and interventions. We argue that strengthening the organizational factors within CHW programs must therefore extend beyond the introduction of a technological solution.

**KEY WORDS** mHealth, community health workers, Sierra Leone, organizational factors

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The authors declare they have no competing interests.

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## INTRODUCTION

The evidence for the effectiveness of community health workers (CHWs) is strong, and with appropriate support and sufficient training, CHWs can substantially strengthen health systems in areas with scarce human resources for health.<sup>1</sup> As a result, CHWs have been deployed across a number of different maternal and child health interventions.<sup>2–4</sup> World Vision Ireland's Access to Infant and Maternal Health (AIM-Health) uses CHWs to regularly promote 7 key health intervention messages targeting pregnant women and 11 intervention messages targeting mothers of children younger than 2. Dubbed the 7-11 Timed and Targeted Counseling (7-11 TTC) strategy, these health interventions are encouraged using a behavior change communication and counseling approach, held across a minimum of 10 household visits by a CHW. In Sierra Leone, World Vision Sierra Leone trains CHWs in the 7-11 TTC approach in collaboration with the Bonthe District Health Management Team. Moreover, all selection, training, and supervision of CHWs is done in accordance with the Policy for Community Health Workers in Sierra Leone, introduced in 2012 by the Ministry of Health and Sanitation.<sup>5</sup> The policy states that CHWs must undergo a minimum 10-day basic training course; each CHW is expected to serve between 100–500 people, should be willing to serve as a volunteer, and must be a resident of the village and willing to work with the community. The policy also states that a staff member from the peripheral health unit (PHU) is expected to supervise CHWs on a monthly basis and make quarterly visits to supervise CHWs in their communities.

Motivation is widely recognized as an important mediating factor between work environment and organizational outcomes, such as job satisfaction and work engagement,<sup>6</sup> all of which influence one's desire to stay in an organization or health program.<sup>7,8</sup> Promoting professional ethos and positive perceptions of self-efficacy has also been determined to strengthen motivation and engagement of health workers across a variety of contexts.<sup>9,10</sup> Similarly, health workers' perceptions of their supervisor and health program, as well as the extent of community and social support, are influential in their retention and motivation.<sup>11–13</sup>

CHWs are not exempt from the same underlying system and organizational factors that affect more qualified health workers. Like any other health worker, the quality of health services delivered by

CHWs is compromised by a lack of proper investment in supportive organizational policies and structures.<sup>14,15</sup> Inadequate supervision, lack of resources, poor working conditions, low engagement, insufficient community support, the absence of refresher training, unrealistic expectations regarding workload, and low satisfaction have all been identified as factors contributing to the failure of CHW programs over time.<sup>8</sup> Factors found to influence the sustainability or scale-up of CHW programs include elements of ongoing management and supervision, contextual compatibility, and effective design of programs, as well as integration and support of programs within a larger health system.<sup>16</sup> Put simply, the organizational and social factors influencing the relationships between CHWs, their communities, and the wider health system are vital to the overall success of CHW programs.<sup>12,17</sup>

The rapid expansion of information communication technology in low-resourced settings has given rise to a number of mobile health (mHealth) applications designed specifically for CHW programs.<sup>14</sup> The Mobile Technology for Community Health (MOTEC Suite) is one such application. The MOTEC Suite is designed to address critical gaps in health information and human resource management caused by limited resources, inadequate training, and insufficient supervision, all of which lead to lapses in care delivery.<sup>18</sup> As part of the AIM-Health program in Sierra Leone, the MOTEC Suite is being used to help CHWs register pregnant women and their children for the program, alert CHWs when household visits are overdue, allow CHWs to make referrals to their affiliated PHU, and collect household data during household visits.

**Rationale.** Given that perceptions of supervision, motivation, job satisfaction, and work engagement of CHWs are key factors influencing health care delivery, then it stands to reason that the successful implementation of targeted community health interventions, mHealth or otherwise, should consider these organizational factors. That said, there is a lack of evidence-based research on the specific application of mHealth solutions in relation to the management of CHWs in low- and middle-income contexts, with few studies demonstrating an impact on clinical health outcomes and fewer still focusing on underlying organizational factors of CHW management, motivation, and supervision.<sup>19</sup> Recently, with impetus from systematic reviews and protocol designs, there has been a push toward gathering more insight into the extent of an

information communication technology effect, particularly its mHealth application for health care users, front-line workers, and administrators.<sup>20–22</sup> However, the evidence supporting the impact of mobile phones in health care, particularly as a human resource management tool for CHWs, remains scarce and often lacking in rigor.<sup>23</sup> This is the first study that assesses the effects of both mobile phones and the MOTECH Suite application on the perceived organizational factors of a CHW program or intervention.

**Research Objectives.** As part of a larger program of research with CHWs in Sierra Leone, the aim of the study was to explore whether CHWs reported systematic changes in perceived supervision, work engagement, job satisfaction, and motivation as a result of the introduction of the MOTECH Suite. To achieve the study objective, 2 primary research questions were posed. First, are there statistically significant changes in the self-reported measures of perceived supervision and motivation over time after the introduction of the MOTECH Suite as a human resource management tool? Second, are there statistically significant changes in the self-reported measures of work engagement and job satisfaction after the introduction of the MOTECH Suite as a human resource management tool? Given the promise of mobile phones in the extant literature, we hypothesized that the introduction of the MOTECH Suite would lead to increases in perceived supervision, motivation, engagement, and satisfaction of community health workers over time.

## METHODS

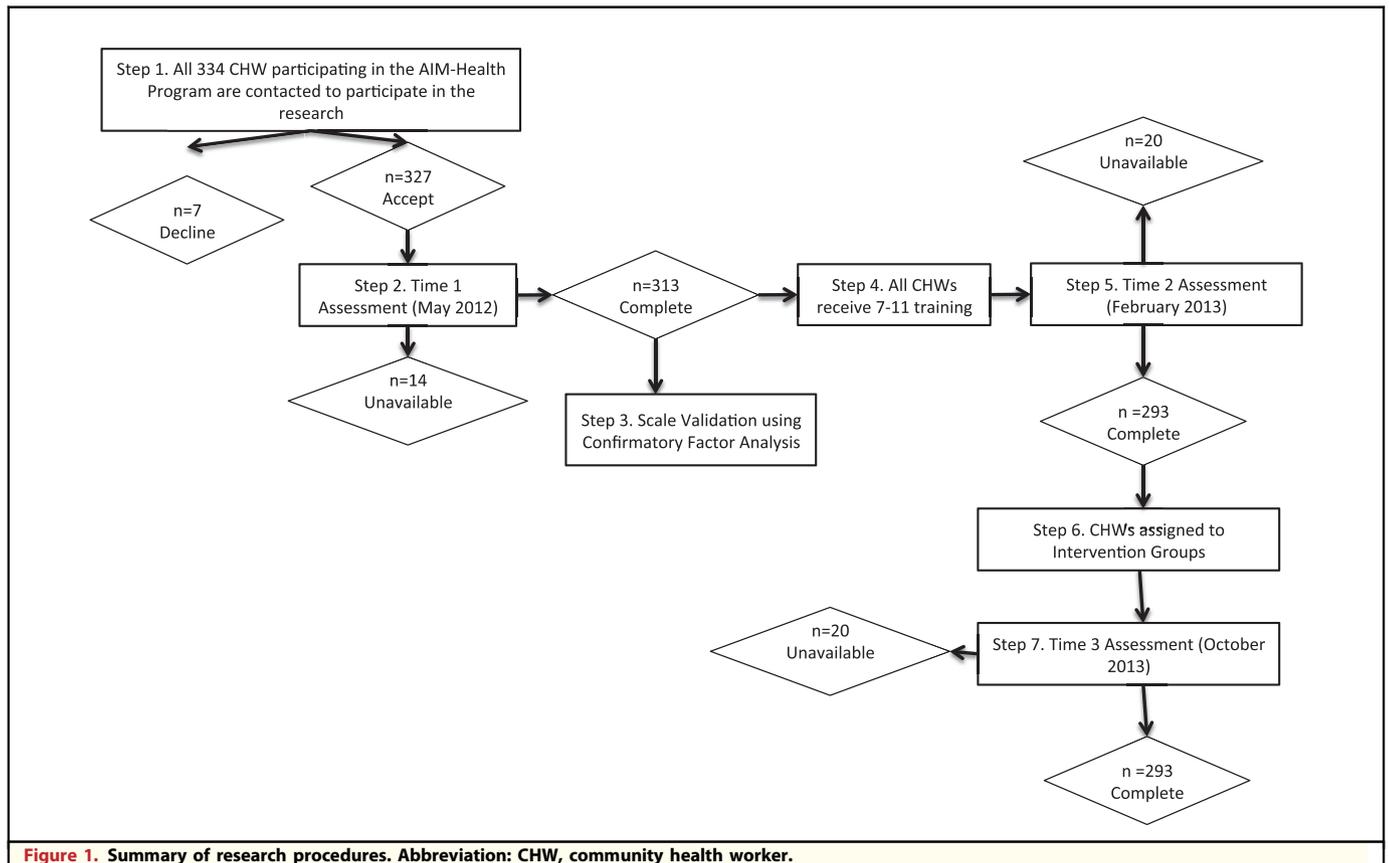
**Participants and Procedures.** Located in southern Sierra Leone, Bonthe District is comprised of 11 chiefdoms and 1 municipality. Participants were recruited using a list of all CHWs enrolled in the AIM-Health program implemented in 4 of these 11 chiefdoms (Jong, Imperi, Sogbeni, and Kpanda Kemoh). Of the 334 CHWs initially recruited into the WV program, 327 agreed to participate. This sample was well above the 270 CHWs considered necessary to detect a significant effect of 0.15, with a 2-sided significance of  $\alpha = .05$  and a power of 85%. **Study Design.** The implementation of the MOTECH Suite within the AIM-Health program presented a unique opportunity to introduce a 3-arm randomized longitudinal cohort design to address the study's objective. The longitudinal component permitted the monitoring of changes across data collected at 3 different time points. The

first round of data collection (Time 1) took place in May 2012, with 2 subsequent follow-up rounds of data collection (Times 2 and 3) taking place in February and October 2013. Time 1 data collection marked the initial selection and enrolment of CHWs into WV Ireland's AIM-Health program. Time 2 data collection followed the 7-11 TTC training of CHWs. Time 3 data collection took place after 8 months of CHW participation in the program with regular household visits in their community. CHWs were randomized to 1 of the 3 intervention groups *after* Time 2 data collection. CHWs affiliated with the same health center were randomly assigned to the same intervention group to minimize contamination across intervention groups. The overall study design and procedures is conceptually summarized in [Figure 1](#).

CHWs from all 3 intervention groups received training in maternal and child health care services, as per the 7-11 TTC strategy. CHWs belonging to the first experimental group (Group 1) received 7-11 TTC training only. Therefore this first group acted as a control group for the implementation of a mobile phone component. The second group (Group 2) also underwent the 7-11 TTC training and was given a mobile phone *without* the MOTECH Suite application. The CHWs assigned to this second group, however, were set up on a closed user group that allowed them to make unlimited calls to one another and to their supervisor based in the peripheral health unit. In the third and final experimental group (Group 3), CHWs received the 7-11 TTC training, were set up on a closed user group, and were given a mobile phone equipped with the MOTECH Suite. This third intervention group allowed us to assess the contribution of the MOTECH Suite, above and beyond the impact of the phone itself. It is worth noting that the Time 3 assessment took place 8 months after the experimental group allocation to allow for any novelty effect of receiving a mobile phone to wear off.

**Measures.** Self-reported surveys are well-established methods in organizational research, program evaluation, and human resource management, used for scaling the psychological states of respondents, such as job attitudes, satisfaction, motivation, and engagement; assessing the effectiveness of experimental manipulations across intervention groups; and soliciting respondents' perceptions of an external environmental variable, such as supervision.<sup>24,25</sup>

Perceived supervision was assessed using the validated Perceived Supportive Supervision Scale



**Figure 1. Summary of research procedures. Abbreviation: CHW, community health worker.**

(PSSS) (Vallières et al., forthcoming).<sup>26</sup> Currently available in 9 languages, the PSSS is an 11-item scale measuring perceived CHW supervision across 3 approaches to supervision: supportive supervision, traditional approaches to supervision, and regular supervision. Supportive supervision serves in contrast to more traditional forms of supervision, which research suggests can hinder health worker motivation.<sup>27,28</sup> Regular supervision, as a feature of both traditional and supportive supervision, was captured through statements such as, “My supervisor meets with me regularly” and “My supervisor knows when my next supervision meeting will take place.”

CHW motivation was assessed using the Volunteer Functions Inventory (VFI), as developed by Clary et al.<sup>29</sup> Adopting a functional approach to motivation, the VFI provides a useful framework for understanding the motivations of volunteers and has been a widely used scale to measure volunteer motivation in low- and middle-income communities.<sup>30,31</sup> The VFI contains 30 items, ascribed to 6 different functions potentially served by volunteering (values, understanding, self-esteem, social,

career-development, and protective). The value motive measures CHW volunteering to express values related to altruistic and humanitarian concern for others. Of the 6 functions, values is considered most easily expressed across differing volunteering activities and contexts<sup>32</sup> and to be inherently more intrinsic.<sup>33,34</sup> The understanding motive measures CHWs volunteering to learn more about the world through their volunteering experience; the self-esteem motive describes when individuals volunteer to increase their own feelings of self-worth, self-improvement, and self-esteem; the social motive describes when CHWs volunteer to seek and gain approval or conform to normative or social pressures of importance to others or to get along with individuals in their group; the protective motive describes CHWs volunteering to reduce negative affect feelings about themselves; and the career development motive describes CHWs volunteering with the prospect of making connections with people and gaining experience in a field that may eventually lead to job prospects and enhancement of their career.<sup>29</sup>

Work engagement was assessed using the Utrecht Work Engagement Scale (UWES).<sup>35</sup> Translated in more than 23 languages to date, the UWES was chosen because it has been widely validated across a number of contexts.<sup>36</sup> A mean engagement score was used to indicate general levels of engagement, with a higher score indicative of greater work engagement. Lastly, volunteer job satisfaction was assessed using the Minnesota Satisfaction Questionnaire (MSQ) short form,<sup>37</sup> where greater scores on the MSQ are indicative of high job satisfaction. For all scales, respondents indicated how much they agreed with the item statement, ranging from *strongly disagree* (= 1) to *strongly agree* (= 5).

**Language Considerations.** The initial questionnaire (composed of the PSSS, VFI, UWES, and MSQ) was translated into Krio, Sierra Leone's *lingua franca* and subsequently piloted to ensure cultural relevance. In addition, to ensure consistency and that no content was lost in translation, the tool was back-translated into English. A total of 8 enumerators were trained to administer the survey tool in Krio, Mende, and English. Because Mende is a predominantly oral language, the survey tool was ultimately left in English and administered by the enumerator in the language most familiar to the participant.

**Ethical Considerations.** Informed written consent was obtained from all participants. In the instance where a CHW was illiterate, signatures were obtained in the form of a fingerprint using an inkpad. Ethical approval for this study was obtained from the Health Policy & Management/Centre for Global Health Research Ethics Committee, Trinity College Dublin, and the Sierra Leone Ethics and Scientific Review Committee, Connaught Hospital, in Freetown, Sierra Leone.

**Scale Reliability and Validation.** To ensure the validity of the scales used within the Sierra Leonean context, each scale was subjected to confirmatory factor analysis at Time 1 and Cronbach's  $\alpha$  was employed as an indication of scale reliability. In addition, a number of precautions were also taken to reduce response bias, including reiterating to participants that they could withdraw from the study at any time without consequence to their involvement in the AIM-Health program, allowing participants to disperse (under trees, etc.) while answering the questionnaire to ensure that nobody outside of the research team could overhear their answers, and having only participants' unique numbers on the survey form.

**Data Analysis.** After the validation of the scales, items from each subscale were averaged to determine a mean score for each type of supervision (traditional, supportive, regular) and motive (self-esteem, protective, social, values, and understanding), as well as a mean satisfaction and work engagement score for each participant. Change scores were then calculated for the factors of each of these scales, resulting in the creation of 9 additional variables representing single change scores for each factor from Time 1 to Time 3 and another 9 additional variables representing single change scores from Time 2 to Time 3 for each participant. Given that the intervention groups were only assigned after the Time 2 assessment, an additional variable representing change scores from Time 1 to Time 2 was considered superfluous to address the study's objectives. Because the creation of these new variables required that a participant had completed the questionnaire at all 3 time points, only participants who completed all 3 assessment were included in the final analysis.

A 1-way between-groups analysis of variance (ANOVA) was first used to test for differences in change scores among the various intervention groups, before the introduction of the MOTECH Suite. We then formally tested for significant differences in changes scores across the different intervention groups for the following 9 primary outcome measures: *changes* in job satisfaction, work engagement, volunteer motivation (as measured by protective, social, self-esteem, and values and understanding factors), and perceived supportive supervision (as measured by supportive, tradition, and unsupportive supervision factors), across the 3 intervention groups. To adjust for the increased risk of a type I error associated with multiple comparisons (ie, 9 dependent variables), a Bonferroni adjustment was applied. A new  $\alpha$  level of .006 ( $.05/9 = .006$ ) was used for determining statistical significance. If a significant difference between the 3 groups was detected, post-hoc tests were applied to ascertain where the differences occurred. The 3 different groups were also tested for homoscedasticity using Levene's test, where significant differences ( $P < .05$ ) were considered a violation of the assumption of the homogeneity of variances. If a significant difference between the 3 groups was detected, post-hoc tests (Tukey's honest significant difference test) were applied to ascertain where the differences occurred. The 3 different experimental groups were also tested for homoscedasticity using Levene's test, where significant

differences ( $P < .05$ ) were considered a violation of the assumption of the homogeneity of variances.

## RESULTS

**Demographics.** A total of 327 of the 334 CHWs agreed to participate in the study, representing 26 PHUs. Overall, 292 CHWs were available to complete the assessments at all 3 time points, for a retention rate of 89%. CHWs moving outside the program area as a result of marriage, illness, or death and CHWs leaving the program to pursue economic activities were some of the more common causes of loss to follow-up of participants. The number of CHWs assigned to each PHU ranged from 8–32 CHWs, depending on the size of the PHU's catchment area. At Time 1, a little more than half of participants (54.7%,  $n = 179$ ) identified as female and 43.5% ( $n = 142$ ) identified as male. Just less than a third of participants identified as Christian (30.9%,  $n = 103$ ), with the remaining identifying as Muslim (67.0%,  $n = 223$ ). More than a third (36%,  $n = 117$ ) of CHWs had never attended school, less than a fifth (19.1%,  $n = 62$ ) had attended some level of secondary school, 11.7% ( $n = 38$ ) attended some level of primary school, and 20.9% ( $n = 68$ ) had attended some level of junior secondary school. Only 9.8% ( $n = 32$ ) of all CHWs interviewed had some level of tertiary education. Illiterate CHWs (47.8%) were administered the survey with the help of an enumerator in either Krio or Mende. Literate CHWs (52.2%) self-administered the questionnaire in English, without the assistance of an enumerator. Just less than half (46.2%,  $n = 154$ ) of CHWs were aged 26–40 years, 15.9% ( $n = 53$ ) were younger than 26 years, and 33.3% ( $n = 111$ ) were between 41 and 60 years old.

**Scale Validity and Reliability.** Results of the confirmatory factor analysis testing the factor structures of each scale found the 3-factor structure of the PSSS was validated. Exploratory methods applied within the context of measurement modeling revealed that the MSQ and the UWES in this context are best explained in terms of a single general latent factor.<sup>38</sup> A 4-factor (values and understanding, protective, self-esteem, and social) structure for the VFI yielded the best model fit. Cronbach's  $\alpha$  for the adapted PSSS, VFI, UWES, and MSQ were  $\alpha = .60$  ( $\alpha = .738$  without the traditional supervision factor),  $\alpha = .75$ ,  $\alpha = .79$ , and  $\alpha = .82$ , respectively. Raw mean scores for these variables across each intervention group at each time point are reported in Table 1. Results of ANOVA revealed no significant

differences in mean scores across intervention groups before the introduction of the MOTTECH Suite.

**Differences in Perceived Supervision and Motivation.** Although similar trends were observed across the 3 intervention groups, no significant differences in the change scores were observed between them. With the exception of Group 1, supervision scores across all intervention groups decreased from Time 1 to Time 3. However, no statistically significant differences were found across the change scores of the various intervention groups for perceived supportive supervision ( $F[2,286] = 1.145$ ,  $P = .320$ ), for traditional supervision ( $F[2,286] = 0.294$ ,  $P = .745$ ), or for regular supervision from Time 1 to Time 3 ( $F[2,286] = 2.210$ ,  $P = .113$ ).

The mean change scores for supervision scores across the 3 intervention groups are presented in Table 2. An increase across change scores for perceived supportive supervision was observed between Time 2 and Time 3; however, no statistically significant differences in the change scores were observed between the intervention groups ( $F[2,291] = 0.452$ ,  $P = .637$ ). Nonsignificant differences were also observed between the experiment groups for decreasing traditional supervision from Time 2 to Time 3 ( $F[2,291] = .557$ ,  $P = .574$ ) and regular supervision from Time 2 to Time 3 ( $F[2,291] = 0.086$ ,  $P = .918$ ).

**Differences in Motivation.** The change scores for volunteer motives are presented in Table 3. Overall, CHWs reported an increase in the protective, social, and self-esteem motives and a decrease in the values and understanding motive between Time 1 and Time 3. However, no significant differences in change scores were observed among the intervention groups for the protective ( $F[2,287] = 0.247$ ,  $P = .781$ ); social ( $F[2,287] = 0.501$ ,  $P = .606$ ); self-esteem ( $F[2,289] = 0.212$ ,  $P = .809$ ); or values and understanding motives ( $F[2,289] = 0.700$ ,  $P = .497$ ) between Time 1 and Time 3. An increase in motive scores was observed across all intervention groups from Time 2 to Time 3. Once again, however, no significant differences in change scores were observed among the intervention groups for the protective ( $F[2,291] = 1.014$ ,  $P = .364$ ); social ( $F[2,291] = 1.356$ ,  $P = .259$ ); self-esteem ( $F[2,291] = 1.828$ ,  $P = .163$ ); or values and understanding motives ( $F[2,291] = 0.982$ ,  $P = .376$ ).

**Differences in Work Engagement and Job Satisfaction.** The mean change scores for work engagement and job satisfaction are presented in Table 4. Overall, average engagement and

**Table 1. Descriptive Statistics for All 9 Outcome Variables by Intervention Group, Across 3 Time Points**

	Intervention Group	Time 1			Time 2			Time 3		
		n	Mean (95% CI)	SD	n	Mean (95% CI)	SD	n	Mean (95% CI)	SD
SS	7-11 only	109	4.29 (4.21/4.36)	.38	107	4.22 (4.16/4.28)	.31	107	4.31 (4.21/4.41)	.54
	7-11 + CUG	110	4.34 (4.26/4.43)	.44	100	4.23 (4.17/4.30)	.34	100	4.26 (4.14/4.38)	.61
	7-11 + App	94	4.45 (4.37/4.52)	.41	86	4.25 (4.20/4.31)	.26	86	4.32 (4.23/4.40)	.39
TS	7-11 only	109	2.80 (2.63/2.96)	.86	107	2.61 (2.49/2.74)	.66	107	2.46 (2.35/2.56)	.56
	7-11 + CUG	110	2.82 (2.65/2.99)	.91	100	2.52 (2.39/2.64)	.65	100	2.46 (2.33/2.59)	.70
	7-11 + App	94	2.65 (2.33/2.86)	1.01	86	2.51 (2.36/2.66)	.74	86	2.40 (2.27/2.53)	.62
RS	7-11 only	109	4.26 (4.16/4.36)	.52	107	4.09 (3.98/4.19)	.56	107	4.05 (3.93/4.18)	.65
	7-11 + CUG	110	4.06 (3.92/4.19)	.72	100	4.09 (3.97/4.20)	.59	100	4.09 (3.95/4.22)	.68
	7-11 + App	94	4.33 (4.23/4.42)	.48	86	4.15 (4.06/4.24)	.42	86	4.14 (4.02/4.27)	.58
Pr	7-11 only	109	3.67 (3.51/3.83)	.87	107	3.84 (3.74/3.94)	.53	107	4.05 (3.94/4.16)	.58
	7-11 + CUG	110	3.76 (3.60/3.91)	.83	100	3.72 (3.57/3.85)	.73	100	4.05 (3.92/4.18)	.67
	7-11 + App	94	3.73 (3.54/3.91)	.90	86	3.86 (3.72/3.99)	.62	86	4.05 (3.90/4.18)	.66
So	7-11 only	109	3.66 (3.53/3.80)	.70	107	3.47 (3.34/3.60)	.66	107	4.03 (3.92/4.15)	.60
	7-11 + CUG	110	3.71 (3.57/3.85)	.73	100	3.59 (3.48/3.70)	.60	100	3.98 (3.85/4.10)	.63
	7-11 + App	94	3.70 (3.51/3.87)	.86	86	3.64 (3.51/3.77)	.60	86	4.01 (3.88/4.13)	.58
Va&Un	7-11 only	109	4.40 (4.33/4.48)	.39	107	4.20 (4.15/4.27)	.31	107	4.41 (4.36/4.47)	.31
	7-11 + CUG	110	4.42 (4.35/4.51)	.40	100	4.26 (4.19/4.33)	.35	100	4.38 (4.33/4.44)	.28
	7-11 + App	94	4.44 (4.35/4.52)	.40	86	4.23 (4.16/4.30)	.33	86	4.37 (4.29/4.44)	.33
SE	7-11 only	109	4.35 (4.23/4.47)	.64	107	3.86 (3.71/4.02)	.79	107	4.51 (4.43/4.58)	.39
	7-11 + CUG	110	4.15 (4.00/4.29)	.76	100	3.96 (3.80/4.12)	.80	100	4.44 (4.35/4.53)	.48
	7-11 + App	94	4.21 (4.07/4.35)	.68	86	3.94 (3.74/4.09)	.80	86	4.40 (4.29/4.49)	.46
Sat	7-11 only	109	4.29 (4.23/4.36)	.35	107	4.24 (4.19/4.29)	.25	107	4.41 (4.37/4.46)	.24
	7-11 + CUG	110	4.32 (4.26/4.39)	.33	100	4.18 (4.13/4.23)	.27	100	4.36 (4.31/4.40)	.25
	7-11 + App	94	4.36 (4.29/4.43)	.34	86	4.22 (4.17/4.27)	.23	86	4.38 (4.32/4.44)	.28
WE	7-11 only	109	4.29 (4.22/4.36)	.39	107	4.12 (4.04/4.19)	.37	107	4.35 (4.37/4.46)	.36
	7-11 + CUG	110	4.20 (4.12/4.29)	.45	100	4.11 (4.02/4.18)	.41	100	4.31 (4.22/4.39)	.42
	7-11 + App	94	4.32 (4.23/4.41)	.44	86	4.21 (4.12/4.29)	.38	86	4.40 (4.32/4.49)	.41

Note: N at time 1 = 313; N at time 2 = 293; N at time 3 = 293.  
95% CI = 95% confidence intervals for the sample mean; 7-11 = strategy used by World Vision encouraging behaviour change communication and counseling approach, across a minimum of 10 visits by a community health worker. App, MOTECH Suite; CUG, closed user group; Pr, protective motive; RS, regular supervision; Sat, job satisfaction; SD, standard deviation for the sample; SE, self-esteem motive; So, social motive; SS, supportive supervision; TS, traditional supervision; Va&Un, values and understanding motive; WE, work engagement.

satisfaction scores increased across all intervention groups from Time 1 to Time 3. However, no statistically significant differences were found across the change scores of the various intervention groups for the work engagement ( $F[2,286] = 0.041, P = .960$ ) and job satisfaction ( $F[2,285] = 1.740, P = .177$ ). Increased scores were also consistently observed across the 3 intervention groups from Time 2 to Time 3, again with no statistically significant differences found among the 3 groups for work engagement scores ( $F[2,291] = 0.137, P = .872$ ) and job satisfaction scores ( $F[2,290] = 0.029, P = .972$ ).

Table 5 presents the overall ANOVA results comparing the change scores across each of the intervention groups from Time 1 to Time 3 and Time 2 to Time 3.

## DISCUSSION

When comparing the 3 study intervention groups, our results suggest that there were no statistically significant changes in the self-reported measures of perceived supervision and motivation over time with the introduction of the MOTECH Suite as a human resource management tool (research question 1). We also failed to find any statistically significant changes in the self-reported measures of work engagement and job satisfaction over time after the introduction of the MOTECH Suite application as a human resource management tool (research question 2). Taken together, these findings suggest that there are no systematic changes in perceived supervision, work engagement, job satisfaction, and

**Table 2. Changes in Perceived Supportive Supervision of Community Health Workers by Intervention Group**

	Intervention Group	n	Mean $\Delta$ Score	SD
Change in SS from Time 1 to Time 3	7-11 only	105	0.016	0.704
	7-11 + CUG	99	-0.098	0.725
	7-11 + App	85	-0.120	0.580
	Total	289	-0.063	0.678
Change in SS from Time 2 to Time 3	7-11 only	108	0.109	0.635
	7-11 + CUG	100	0.059	0.664
	7-11 + App	86	0.027	0.494
	Total	294	0.068	0.607
Change in TS from Time 1 to Time 3	7-11 only	105	-0.533	1.230
	7-11 + CUG	99	-0.397	1.228
	7-11 + App	85	-0.478	1.3678
	Total	289	-0.471	1.2688
Change in TS from Time 2 to Time 3	7-11 only	108	-0.256	0.997
	7-11 + CUG	100	-0.112	1.036
	7-11 + App	86	-0.233	1.107
	Total	294	-0.200	1.042
Change in RS from Time 1 to Time 3	7-11 only	105	-0.219	0.768
	7-11 + CUG	99	0.019	0.981
	7-11 + App	85	-0.176	0.786
	Total	289	-0.125	0.855
Change in RS from Time 2 to Time 3	7-11 only	108	-0.046	0.849
	7-11 + CUG	100	-0.008	0.798
	7-11 + App	86	-0.004	0.743
	Total	294	-0.021	0.800

7-11 = strategy used by World Vision encouraging behaviour change communication and counseling approach, across a minimum of 10 visits by a community health worker. App, MOTECH Suite; CUG, closed user group; mean  $\Delta$  score, mean change score; RS, regular supervision; SD, standard deviation; SS, supportive supervision; TS, traditional supervision.

motivation among CHWs who received a mobile phone set up on a closed user group with the MOTECH Suite application and those who either only received a phone with the closed user group or no phone at all. These results are largely consistent with the findings from a similar study conducted within WV Tanzania, whereby the introduction of a similar mobile application was found to have no long-term impact on CHW job satisfaction, self-efficacy, or performance.<sup>39</sup>

The results of this study do not provide sufficient evidence to support the introduction of a closed user group or the MOTECH Suite application on their own to strengthen these organizational factors within CHW programs. Other CHW projects have demonstrated increases in worker performance after the integration of supportive supervision and regular monitoring.<sup>40,41</sup> However, when it comes to mHealth, it is often unclear whether efforts to strengthen supportive supervision and regular monitoring preceded the introduction of mobile technology or whether supervision and regular monitoring

were introduced with the technology. Indeed, some studies have found that even with the introduction of mobile phones, there is a marked decrease in worker performance when supervisory and supportive elements are removed.<sup>42</sup> Comparably, our results indicate that supervision, job satisfaction, engagement, and motivation change scores remained high, regardless of which intervention group the CHWs were assigned to. Furthermore, recent mHealth programs for CHWs have recognized the need for technology that integrates supervision to support the work of CHWs.<sup>43</sup>

Outside of technology there are additional, and arguably more influential, factors attributable to maintaining the motivation, satisfaction, and engagement of CHWs. Although the motivational and functional potential of CHWs using mobile phones in health and development programs has been highlighted qualitatively by some,<sup>12</sup> other characteristics of the CHW program, including the CHWs themselves, program management, communication and social support, and cultural and contextual influences,

**Table 3. Changes in Volunteer Motive Scores of Community Health Workers by Intervention Group**

	Intervention Group	n	Mean $\Delta$ Score	SD
Change in Pr Motive from Time 1 to Time 3	7-11 only	107	0.375	1.058
	7-11 + CUG	99	0.306	1.000
	7-11 + App	84	0.270	1.138
	Total	290	0.321	1.060
Change in Pr Motive from Time 2 to Time 3	7-11 only	108	0.201	0.775
	7-11 + CUG	100	0.333	0.781
	7-11 + App	86	0.190	0.804
	Total	294	0.243	0.786
Change in So Motive from Time 1 to Time 3	7-11 only	107	0.355	0.988
	7-11 + CUG	99	0.226	0.829
	7-11 + App	84	0.263	1.036
	Total	290	0.284	0.950
Change in So Motive from Time 2 to Time 3	7-11 only	108	0.543	0.918
	7-11 + CUG	100	0.381	0.742
	7-11 + App	86	0.369	0.856
	Total	294	0.437	0.845
Change in Va&Un Motive from Time 1 to Time 3	7-11 only	108	−0.006	0.548
	7-11 + CUG	99	−0.074	0.502
	7-11 + App	85	−0.088	0.516
	Total	292	−0.053	0.523
Change in Va&Un Motive from Time 2 to Time 3	7-11 only	108	0.203	0.401
	7-11 + CUG	100	0.124	0.430
	7-11 + App	86	0.139	0.463
	Total	294	0.157	0.430
Change in SE Motive from Time 1 to Time 3	7-11 only	108	0.157	0.850
	7-11 + CUG	99	0.232	0.927
	7-11 + App	85	0.171	0.826
	Total	292	0.187	0.868
Change in SE Motive from Time 2 to Time 3	7-11 only	108	0.299	0.505
	7-11 + CUG	100	0.181	0.581
	7-11 + App	86	0.167	0.526
	Total	294	0.220	0.540

95% CI = 95% confidence intervals for the sample mean; 7-11 = strategy used by World Vision encouraging behaviour change communication and counseling approach, across a minimum of 10 visits by a community health worker. App, MOTECH Suite; CUG, closed user group; mean  $\Delta$  score, mean change score; Pr, protective motive; RS, regular supervision; SD, standard deviation for the sample; SE, self-esteem motive; So, social motive; SS, supportive supervision; TS, traditional supervision; Va&Un, values and understanding motive.

arguably play a greater role in determining these outcomes.<sup>8,10,16</sup> We build the argument that in order for applications such as the MOTECH Suite to serve as effective human resource management tools, enhancing the motivation, satisfaction, retention, and engagement of CHWs, they must also consider such extenuating factors. When considering the potential and scalability of mHealth approaches to strengthen health systems and enhance health care service delivery, the mobilization of resources and availability of technology must still be met with *engaged* health workers.<sup>19</sup> Put another way, the contribution of mHealth toward improved health outcomes hinges predominantly on the engagement and the motivation of the people using the

technology. If the organizational factors that motivate and engage CHWs to work within mHealth programs are not simultaneously addressed, then the technology itself is arguably futile.

This is not to diminish the favorable applications of mHealth for other uses, such as serving as disease self-management tools,<sup>44</sup> assisting with treatment adherence<sup>45</sup> and behavioral change,<sup>20,46,47</sup> and providing effective sources of health information.<sup>21</sup> CHWs having the ability to contact other CHWs and the health facility directly can also provide patient reassurance and enable CHWs to communicate program and health messages directly and simultaneously to their working groups.<sup>48</sup> Similarly, the use of the MOTECH Suite contributes to other

**Table 4. Changes in Work Engagement and Job Satisfaction Scores of Community Health Workers by Intervention Group**

	Intervention Group	n	Mean Δ Score	SD
Change in Work Engagement from Time 1 to Time 3	7-11 only	107	0.067	0.535
	7-11 + CUG	98	0.088	0.676
	7-11 + App	84	0.065	0.595
	Total	289	0.074	0.601
Change in Work Engagement from Time 2 to Time 3	7-11 only	108	0.230	0.481
	7-11 + CUG	100	0.206	0.536
	7-11 + App	86	0.192	0.556
	Total	294	0.211	0.521
Change in Job Satisfaction from Time 1 to Time 3	7-11 only	106	0.116	0.434
	7-11 + CUG	99	0.030	0.414
	7-11 + App	83	0.005	0.471
	Total	288	0.055	0.439
Change in Job Satisfaction from Time 2 to Time 3	7-11 only	107	0.176	0.356
	7-11 + CUG	100	0.171	0.341
	7-11 + App	86	0.163	0.373
	Total	293	0.170	0.355

7-11 = strategy used by World Vision encouraging behavior change communication and counseling approach, across a minimum of 10 visits by a community health worker. App, MOTECH Suite; CUG, closed user group; mean Δ score, mean change score; SD, standard deviation.

important outcomes and may still prove useful in the management of a CHW program, including data collection times and improved CHW adherence to household visit schedules. Although these advances still merit support, we have yet to see evidence of their long-term effects.

Equally as important as reporting on the successes of mHealth is reporting on the limitations of mHealth. This is particularly true for the improvement of health services and systems, where the pressures of technological innovation need to be juxtaposed by evidence-based practice and rigorous research on the effectiveness of interventions.<sup>49</sup> Failure to find favorable outcomes in mHealth research can serve as a potential warning against applying overly “technocentric” approaches to what are often complex, human-centered problems.

Despite the ubiquity and increased access to mobile technology among vulnerable populations worldwide,<sup>50</sup> effectively extending such applications into health services and programs requires a greater integration with human intent, capacity, and resources.<sup>51</sup> In other words, technology on its own is insufficient to target and strengthen underlying organizational factors, in all their complexity. It must therefore be integrated at the level of programmatic design and supported within a larger health system. Further still should be the investment in organizational policies and structures that improve access to the essential supervision, management, training, and resources for the *people* within these

very systems.<sup>14,15</sup> As Labrique et al<sup>23</sup> rightly point out, technology alone cannot leapfrog the basic requirements and resources necessary for infrastructural change.

Underlying organizational factors bear critically on the outcome of CHW programs, as well as the outcomes of health care delivery at a larger scale. This study supports the idea that strengthening the organizational structures within CHW programs extends beyond the introduction of a technological solution. Although one of the aims of the MOTECH Suite is to provide timely and accessible health information to key participants, this application alone is not what will lead to having what Toyama<sup>51</sup> calls a “transformative” impact on strengthening human resources for health. Advancements in technology for health (including mHealth) must therefore be coupled with investments in infrastructure and institutional capacity. This will in turn strengthen the organizational structures necessary for supportive supervision and effective human resource management, resulting in greater motivation and engagement of CHWs. More research is needed to better understand if, and how, mobile health interventions for CHWs can best affect such organizational factors.

**Limitations.** Despite the merits of this study, we acknowledge that this study is not without limitations. As previously noted, high scores were maintained across all these factors regardless of which intervention group the CHWs were assigned to

**Table 5. One-way ANOVA Results Comparing Mean Change Scores for Time 1 to Time 3 and for Time 2 to Time 3 Across the 3 Different Intervention Groups**

Variable	Sum of Squares	df	Mean Square	F	Sig	$\eta^2$
<b>Mean <math>\Delta</math> Supportive Supervision</b>						
Time 1 to Time 3						
Between Groups	1.051	2	0.526	1.145	.320	.008
Within Groups	131.315	286	0.459			
Total	132.366	288				
Time 2 to Time 3						
Between Groups	0.334	2	0.167	0.452	.637	.003
Within Groups	107.551	291	0.370			
Total	107.885	293				
<b>Mean <math>\Delta</math> Traditional Supervision</b>						
Time 1 to Time 3						
Between Groups	0.950	2	0.475	0.294	.745	.002
Within Groups	462.105	286	1.616			
Total	463.056	288				
Time 2 to Time 3						
Between Groups	1.212	2	0.606	0.557	.574	.004
Within Groups	316.931	291	1.089			
Total	318.143	293				
<b>Mean <math>\Delta</math> Regular Supervision</b>						
Time 1 to Time 3						
Between Groups	3.193	2	1.597	2.201	.113	.015
Within Groups	207.42	286	0.725			
Total	210.613	288				
Time 2 to Time 3						
Between Groups	0.110	2	0.055	0.086	.918	.001
Within Groups	187.177	291	0.643			
Total	187.287	293				
<b>Mean <math>\Delta</math> Protective Motive</b>						
Time 1 to Time 3						
Between Groups	0.557	2	0.279	0.247	.781	.002
Within Groups	324.15	287	1.129			
Total	324.708	289				
Time 2 to Time 3						
Between Groups	1.252	2	0.626	1.014	.364	.007
Within Groups	179.662	291	0.617			
Total	180.915	293				
<b>Mean <math>\Delta</math> Social Motive</b>						
Time 1 to Time 3						
Between Groups	0.907	2	0.453	0.501	.606	.003
Within Groups	259.804	287	0.905			
Total	260.711	289				
Time 2 to Time 3						
Between Groups	1.929	2	0.965	1.356	.259	.009
Within Groups	207.073	291	0.712			
Total	209.003	293				
<b>Mean <math>\Delta</math> Values and Understanding</b>						
Time 1 to Time 3						
Between Groups	0.384	2	0.192	0.700	.497	.005
Within Groups	79.168	289	0.274			
Total	79.552	291				
Time 2 to Time 3						
Between Groups	0.363	2	0.181	0.982	.376	.007

(continued on next page)

**Table 5. continued**

Variable	Sum of Squares	df	Mean Square	F	Sig	$\eta^2$
Within Groups	53.713	291	0.185			
Total	54.075	293				
<b>Mean <math>\Delta</math> Self-Esteem</b>						
Time 1 to Time 3						
Between Groups	0.321	2	0.16	0.212	.809	.001
Within Groups	218.757	289	0.757			
Total	219.078	291				
Time 2 to Time 3						
Between Groups	1.058	2	0.529	1.828	.163	.012
Within Groups	84.243	291	0.289			
Total	85.301	293				
<b>Mean <math>\Delta</math> Work Engagement</b>						
Time 1 to Time 3						
Between Groups	0.03	2	0.015	0.041	.96	.000
Within Groups	103.97	286	0.364			
Total	103.999	288				
Time 2 to Time 3						
Between Groups	0.075	2	0.037	0.137	.872	.001
Within Groups	79.4	291	0.273			
Total	79.474	293				
<b>Mean <math>\Delta</math> Job Satisfaction</b>						
Time 1 to Time 3						
Between Groups	0.668	2	0.334	1.74	.177	.012
Within Groups	54.71	285	0.192			
Total	55.378	287				
Time 2 to Time 3						
Between Groups	0.007	2	0.004	0.029	.972	.000
Within Groups	36.76	290	0.127			
Total	36.767	292				

Mean  $\Delta$  Values and Understanding  
 $\eta^2$ , partial eta squared (a measure of effect size for use in ANOVA); ANOVA, analysis of variance; df, degrees of freedom; Sig, P value, where differences in change scores were considered to be significant if  $P < .006$ .

and could have created some sort of “ceiling effect,” whereby the potential to measure increasing scores across variables was reduced. However, mean scores of 5 were observed in less than the recommended 15% of respondents.<sup>52</sup>

Although failure to detect significant differences between the groups may be due to a power issue, calculations used to determine sample size and unexpected trends offer some indication that type II error (or the failure to reject a false null hypothesis) may be less likely. Despite our best efforts to minimize these effects, as with studies that rely on self-report measures, it is possible that social-desirability bias (or demand characteristics) was responsible for influencing CHWs’ responses to the questionnaire.<sup>53</sup> Although best practice advocates for the use of different samples between exploratory and confirmatory analysis,<sup>54</sup> the practice of validation studies applying exploratory methods

within the context of measurement modeling is not uncommon.<sup>55</sup> Lastly, the study itself would have focused attention on the CHWs and may have translated favorably into overall perceptions of the program and intervention.

## CONCLUSIONS

In relation to strengthening the underlying organizational structures of CHW programs, the results of this study do not provide sufficient evidence to support the use of the MOTECH Suite application on its own to increase motivation, job satisfaction, supervision, and engagement of CHWs. Considering this is the first study that assesses the effects of both mobile phone technology and the MOTECH Suite application on the perceived organizational factors of CHW programs, the operational outcomes of this research and lack of statistically

significant findings are all the more critical to disseminate. This study supports the need for additional research assessing the impact of mHealth interventions on organizational structures and warns against an over-reliance on technology to solve complex, human resource for health problems.

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