International Journal of Medical Informatics 98 (2017) 41–46

Contents lists available at ScienceDirect

International Journal of Medical Informatics

journal homepage: www.ijmijournal.com

Female respondent acceptance of computer-assisted personal interviewing (CAPI) for maternal, newborn and child health coverage surveys in rural Uganda

Hannah Faye G. Mercader[a,*], Jerome Kabakyenga[b], David Tumusiime Katuruba[b], Amy J. Hobbs[a], Jennifer L. Brenner[a]

[a] Cumming School of Medicine, University of Calgary, 3280 Hospital Drive NW, Calgary, AB, T2N 4Z6, Canada
[b] Maternal Newborn and Child Health Institute, Mbarara University of Science and Technology, P.O. Box 1410 Mbarara, Uganda

ARTICLE INFO

Article history:
Received 24 November 2015
Received in revised form
19 September 2016
Accepted 28 November 2016

Keywords:
Computer-assisted personal interviewing
Maternal and child health
Method acceptability
Uganda

ABSTRACT

Introduction: High maternal and child mortality continues in low- and middle-income countries (LMIC). Measurement of maternal, newborn and child health (MNCH) coverage indicators often involves an expensive, complex, and lengthy household data collection process that is especially difficult in less-resourced settings. Computer-assisted personal interviewing (CAPI) has been proposed as a cost-effective and efficient alternative to traditional paper-and-pencil interviewing (PAPI). However, the literature on respondent-level acceptance of CAPI in LMIC has reported mixed outcomes. This is the first study to prospectively examine female respondent acceptance of CAPI and its influencing factors for MNCH data collection in rural Southwest Uganda.

Methods: Eighteen women aged 15–49 years were randomly selected from 3 rural villages to participate. Each respondent was administered a Women's Questionnaire with half of the survey questions asked using PAPI techniques and the other half using CAPI. Following this PAPI/CAPI exposure, semi-structured focus group discussions (FGDs) assessed respondent attitudes towards PAPI versus CAPI. FGD data analysis involved an immersion/crystallization method (thematic narrative analysis).

Results: The sixteen FGD respondents had a median age of 27 (interquartile range: 24.8, 32.3) years old. The majority (62.5%) had only primary level education. Most respondents (68.8%) owned or regularly used a mobile phone or computer. Few respondents (31.3%) had previously seen but not used a tablet computer. Overall, FGDs revealed CAPI acceptance and the factors influencing CAPI acceptability were 'familiarity', 'data confidentiality and security', 'data accuracy', and 'modernization and development'.

Discussion: Female survey respondents in our rural Southwest Ugandan setting found CAPI to be acceptable. Global health planners and implementers considering CAPI for health coverage survey data collection should accommodate influencing factors during survey planning in order to maximize and facilitate acceptance and support by local stakeholders and community participants. Further research is needed to generate best practices for CAPI implementation and LMIC; higher quality, timely, streamlined and budget-friendly collection of MNCH indicators could help direct and improve programming to save lives of mothers and children.

1. Introduction

Each year, an estimated 300,000 maternal and six million under-five deaths occur globally [1,2]. Though these rates are an improvement from two decades ago, maternal and child mortality remains a challenge, and few low- and middle-income countries (LMIC) successfully achieved the reduction targets of both Millennium Development Goals 4 and 5 [3].

Measurement of progress towards maternal, newborn and child health (MNCH) goals is difficult [4]. National-level MNCH data in

Abbreviations: CAPI, computer-assisted personal interviewing; MNCH, maternal, newborn and child health; LMIC, low- and middle-income countries; PAPI, paper-and-pencil interviewing.

* Corresponding author.
E-mail addresses: hfmercader@gmail.com (H.F.G. Mercader), jkabakyenga@gmail.com (J. Kabakyenga), tkaturuba@gmail.com (D.T. Katuruba), hobbs.aj@gmail.com (A.J. Hobbs), jennbrenner@me.com (J.L. Brenner).

http://dx.doi.org/10.1016/j.ijmedinf.2016.11.009
1386-5056/

LMIC are commonly collected using comprehensive household coverage surveys such as Demographic and Health Surveys (DHS) [5] or Multiple Indicator Cluster Surveys (MICS) [6]. However, coverage survey data collection processes are complex and lengthy [7]. Survey implementation, quality assurance, and data management are especially challenged by weak infrastructure such as poor roads and inconsistent electricity, as well as limited resources, funds, and trained personnel. Costs and time for questionnaire printing, collation, quality checks, data entry, and analysis are limiting factors [8–10].

Computer-assisted personal interviewing (CAPI) involves interviewer-administered digital questionnaires using a computerized device and has been proposed and tried as an alternative to overcome the challenges associated with traditional paper-and-pencil interviewing (PAPI). CAPI is increasingly being implemented in LMIC settings, such as for district-level maternal and neonatal health evaluations in Burkina Faso [11], Tanzania, Uganda [12], and Malawi [13], and for national-level DHS data collection in Nepal [14]. When compared to PAPI, the technical advantages of CAPI include improved data quality [14–19], lower long-term costs [13,15,19–24], and time-efficiency (e.g. direct export of collected data into an electronic database) [20,25–30].

However, shifting from PAPI to CAPI in LMIC involves potential obstacles. While some papers have documented acceptance of electronic data collection among local health professionals and data collectors based on post-survey feedback [8,16,19,23,27,31–35], acceptance among survey respondents and community members has been variable. Anecdotal experiences documented from Costa Rica [8], Tanzania [27,32], Nepal [14], Sri Lanka [30], and Fiji [16] expressed positive CAPI uptake by survey respondents, citing local intrigue for CAPI devices and the perception of professionalism associated with CAPI. Suspicion towards CAPI has been reported from South Africa [34] and Angola [36], especially related to concerns of being secretly recorded by the cameras on CAPI devices. In Ethiopia, significantly more refusals in CAPI versus PAPI cohorts were noted [10]. In Kenya, devices used for 'audio computer-assisted self-interviewing' were reportedly associated with devil worship by community members [37].

The Healthy Child Uganda (HCU) partnership within the Maternal, Newborn and Child Health Institute at Mbarara University of Science and Technology in Uganda frequently collects coverage-type data among women and households for evaluation and research purposes. Understanding respondent perceptions are important in helping to determine the appropriateness and best practice methods of shifting from PAPI to CAPI for MNCH-coverage surveys. To date, no published studies have prospectively explored acceptability of CAPI for MNCH-specific surveys among Ugandan or female survey respondents, nor evaluated the factors influencing CAPI acceptability. This study assessed the acceptability of CAPI and its influencing factors to inform MNCH data collection in rural Southwest Uganda.

2. Methods

2.1. Study design and recruitment

HCU has implemented community-based MNCH interventions in rural Southwest Uganda for over a decade, traditionally utilizing PAPI-administered DHS-based household surveys to evaluate project outcomes. This qualitative study conducted in early 2014 was designed to inform potential CAPI use for future HCU evaluation purposes.

Survey respondents were recruited from three randomly selected rural villages in Mbarara District, Uganda. Within each selected village, six respondents were randomly selected based on locally provided village lists. Women were eligible if they were of reproductive age (15–49 years) with a maximum of one respondent per household. Sample size was determined based on logistical limitations while encouraging theme saturation [38].

2.2. PAPI/CAPI exposure

All eighteen respondents who were approached for the study consented and participated in the PAPI/CAPI exposure simulation. Trained and experienced interviewers verbally administered a DHS-based Women's Questionnaire to each respondent in local vernacular. The questionnaire asked women 145 questions regarding demographics, reproductive history, ante- and post-natal care access, child health and nutrition, and fertility planning and pReferences

Half of the questionnaire was administered using PAPI, and the other half was administered using CAPI. Computer-based surveys were conducted using the Epi Info™ software application loaded onto the ASUS Transformer Book T100 tablet computer (10.1-inch touchscreen display, Microsoft Windows 8.1 OS). To control for question order bias, interviewers alternated PAPI/CAPI administration order between respondents. Surveys were approximately one hour in duration and data collected during this simulation were not analyzed.

2.3. Data collection

Immediately following PAPI/CAPI exposure, a brief nine-item survey was administered via PAPI to gather information on respondent demographics, previous exposure to technology, and their overall PAPI/CAPI preference if they completed the survey a second time.

Respondents in each village were then invited to attend a focus group discussion (FGD) in the same afternoon to explore their attitudes towards PAPI versus CAPI and their experiences with each method. Of the eighteen respondents who participated in the simulation, two (11.1%) did not attend a follow-up FGD citing lack of availability for the afternoon sessions. Discussions were led by a trained local facilitator using local vernacular, and followed a semi-structured format based on the following previously piloted guideline questions:

1. How would you describe your level of technology use in your day-to-day life?
2. How did you feel about the tablet computer being used during the interview?
3. Do you consider it acceptable or unacceptable to use tablet computers during an interview? Why or why not?
4. How do you feel about the tablet computer being brought inside your home?
5. Does the topic of the interview have an effect on your feelings about using tablet computers for the interview?
6. How was your relationship with the interviewer throughout the survey?
7. How does your community feel about a tablet computer being brought inside the village?
8. What are some benefits and challenges to using tablet computers to conduct an interview?

FGDs were digitally audio-recorded and accompanied by handwritten notes.

2.4. Data analysis

Audio recordings were transcribed verbatim in vernacular, translated into English, and checked for accuracy by

the FGD facilitator. Inductive coding in NVivo 10 used an immersion/crystallization method (thematic narrative analysis framework) [39]. Codes were compared across all villages to generate major themes and sub-themes. FGD facilitators reviewed results to confirm accuracy and inclusion of key themes.

2.5. Ethical considerations

Ethics approval was obtained from the Mbarara University of Science and Technology Institutional Ethical Review Committee, Uganda National Council of Science and Technology, and the University of Calgary Conjoint Health Research Ethics Board. Informed consent was obtained by signature or thumbprint on paper-based consent forms.

3. Results

3.1. Respondent demographics

Median FGD respondent age was 27 (interquartile range: 24.8, 32.3) years old. Most respondents (62.5%) reported 'Primary' as their highest attended education level. Two-thirds (68.8%) reported ownership or regular usage of a mobile phone or computer. Five respondents (31.3%) reported having previously seen a tablet computer, though none reported prior use.

3.2. CAPI acceptability

When asked individually, eight respondents stated preference for PAPI survey administration and the other eight stated preference for CAPI. However, FGDs revealed that most respondents (even those preferring PAPI) expressed CAPI acceptance overall and identified its advantages. The following qualitative themes were observed as major factors influencing CAPI acceptability: 'familiarity', 'data confidentiality and security', 'data accuracy', and 'modernization and development'.

3.2.1. Familiarity

Most respondents expressed a lack of familiarity and understanding of tablet computer functioning and often related tablet computer usage with their mobile phone experiences. Respondents acknowledged that it is easier to accept and prefer PAPI versus CAPI due to its familiarity:

> [Tablet computers] would be acceptable if we knew how a computer operates. I think we should continue with papers because we are used to them and we know how to read and write on them.

Respondents suggested that PAPI permits better interviewer rapport, whereas unfamiliar CAPI devices may initiate uncertainty and suspiciousness. A few respondents disclosed feeling apprehensive during the CAPI exposure owing to the device's camera features, while others explained that it might be intimidating to have upper class individuals bring unknown technology into their communities:

> I do not know the computer and I have never seen it. Therefore I am so naïve and I might run away from you and ask myself about you and see you at a high level. But when you explain to me, I will find it easy and will not fear.

Despite these potential concerns, all respondents expressed having an overall good rapport with their interviewer during the CAPI exposure, which they attributed to their interviewer's approachable demeanour and efforts to explain the CAPI device and its process in advance. Some respondents suggested that future technology initiatives in the community should first take time to familiarize locals about the new devices in order to facilitate local comfort and acceptance.

3.2.2. Data confidentiality and security

Maintaining data confidentiality and security was important to respondents, who expressed concerns that paper-based surveys could be easily damaged or misplaced. Computers were perceived to be indestructible and able to save data securely for a very long time:

> And what I don't like about a paper, now what if it rains on it? If a storm found us here, where can we put it? But for this [tablet] device, if handled well, it will store the information. With a paper . . . it might become wet and it turn into a chapati.

Respondents suggested that personal data recorded on paper could be easily accessed or tampered with by anyone, since many people know how to use paper. However, with a misplaced tablet computer, few would know how to operate it and access its information.

3.2.3. Data accuracy

Respondents expressed a strong desire for accurate data collection, noting PAPI's allowance for the interviewee to gaze at the interviewer's writing to verify accurate information:

> I would love a paper because I will read what you are writing, if I know how to read. And I will be rest assured that what you are writing is real, and correct you where you have gone wrong.

Conversely with CAPI, respondents cited poor understanding of device usage as a barrier to monitoring documentation. However, some respondents expressed concern that anyone who is literate could easily alter and falsify paper-based data, while CAPI devices were believed to have better methods for accurate data verification. For example, there was a misconception among some respondents that the CAPI devices had audio-recorded their interviews:

> [Computers are] acceptable because, in the case of a paper, what if you write something false about me? You can write wrong things about me. But when it is a computer [and it records my voice], I would tell that that is me speaking . . . A paper may be accusing me, but a computer cannot accuse me.

3.2.4. Modernization and development

Respondents revealed an appreciation for modernization and development in their community, which favoured CAPI usage. Technological devices were cited as a symbol of positive change and development. Many respondents expressed happiness and excitement at the opportunity to see and experience tablet computers for the first time:

> Personally, I like [the computer's] technology because there is a change. Like in the past . . . you would see teachers having [phones] in schools . . . You would feel great and you would get the hopes that in a few years to come . . . you would also own a phone. The same applies to the computer . . . you never know, even if I don't operate it, there is hope that maybe your child will at one time own it.

Some respondents felt that computers could facilitate a more efficient and easier interview process compared to paper, such as more organized data collection:

> [Community health workers] have been coming with their papers and books when they are registering us, [yet] you find someone looking for a specific paper [with your information] and it gets lost. So we get disgusted of being registered on papers

that get lost. For the case of a computer, you will be sure that it's saved, so that's the change we like in community.

Respondents explained that new technology is more easily accepted among men, youth, and educated community members since they have more frequent exposure to it. They noted that men usually play a large role in household decisions regarding technology use, so conflicts may arise if husbands do not approve of their wives using it.

4. Discussion

In rural Southwest Uganda, female respondents generally found CAPI to be an acceptable method for administering maternal, newborn and child health coverage surveys.

CAPI acceptance in this setting was consistent with other studies in sub-Saharan Africa [15,17,27,32,34,36], Asia [14,30,33,40], Oceania [16], and Latin America [8], where there were no reports on major concerns or resistance regarding CAPI use. This study is the first we are aware of that had a primary objective of prospectively and qualitatively exploring factors to CAPI acceptability in a LMIC setting, and not merely reporting outcomes following a survey already in progress. This study's in-depth and focused approach provides us with confidence that, with appropriate orientation, CAPI can be an acceptable data collection method in LMIC. Results provide interesting insights into real and perceived respondent perceptions of what constitutes and is important for CAPI acceptability during data collection.

Three of the major themes identified from respondents as key to CAPI acceptability ('familiarity', 'data confidentiality and security', and 'modernization and development') were comparable to ideas raised by prior studies. Regarding 'familiarity', past studies have also raised acceptability concerns related to the unfamiliarity and multimedia capabilities of CAPI devices [30,34,36]; though in most cases, authors considered these to be relatively minor and easily ameliorated. Other studies similarly revealed respondent CAPI acceptance owing to better 'data confidentiality and security' [14–16,36] and more efficient and easier interview processes [16,33,41]. Like in our study, where some misconceptions overinflated the voice-recording capabilities of CAPI devices, prior authors described local women as having an exaggerated understanding of computer abilities, such as the perception that CAPI devices were omniscient [32,41] or indestructible even from rain [36]. Such confident views from our female respondents (who had minimal past exposure to computers) contrasted with those of educated males in Angola who preferred PAPI, citing the possibility of computer malfunctioning [36]. However, this finding is not necessarily the rule, as varying opinions have been found among men and women from different socioeconomic backgrounds [27,34,36].

Like our findings on 'modernization and development', most other studies described similar excitement from respondents towards being exposed to CAPI devices for the first time [8,27,36]. Interviewer reports believed this respondent interest was due to devices creating the impression of increased survey professionalism [14,16,27,30,32]. In contrast, one study in rural Kenya reported community members felt ridiculed when expensive devices were introduced into their poor communities [37]. Such contrasting outcomes suggest that acceptance may vary depending on local factors. Implementing familiarization of devices in the community, such as providing knowledge about device capabilities and purpose, might contribute to local CAPI acceptance.

Our study appears to be the first to report respondents valuing 'data accuracy' as an important consideration for CAPI. This is an interesting finding as it suggests a local understanding and appreciation for accurate health survey data collection.

To our knowledge, only two studies in Kenya and Angola [36,37] have reported a strong community resistance towards computerized interviewing; the former was attributed to the area's deteriorating political and economic situation, and the latter was attributed to the country's recent civil war (and thus a "suspicion of outsiders").

4.1. Limitations

This study captured CAPI experience reflections using a specific survey tool in a defined population of women only. Added insight may be gained through broader respondent groups (e.g. males, different ethnic groups, higher educated individuals, older populations, etc.) and comparative analysis. Specifically, comparisons of female and male opinions would help to inform the unique female perspective of CAPI acceptance.

Themes presented in this study may also not reflect attitudes within other communities where experiences with technology may be different (positive or negative). Additionally, themes may not capture the potential implications of media and peer-group attitudes during larger-scaled data collection experiences. We also expect that either positive or negative opinions about technology will evolve as community exposure to technology advances.

4.2. Future implications

Globally, further research and evaluation is needed to inform planners, funders, and policymakers on sustainable, best practice models for MNCH [3,4,12]. Coverage surveys are key to understanding progress and demonstrating accountability towards MNCH targets in resource-limited regions. Widespread adoption of electronic data collection tools for such settings are likely inevitable, however further research is needed to inform on best practices for their use [42–44].

Our study is the first to describe factors influencing local CAPI acceptance, which should be actively managed during CAPI survey planning and implementation in communities where prior computer exposure is limited, so that acceptance and support may be facilitated among local stakeholders and community members. To establish familiarity, community familiarization of data collection devices should be conducted prior to the data collection process as part of a good survey practice, as highlighted by other authors [27,30,34,36,41,45]; such awareness can be raised through media, community leaders, and/or orientation sessions about the objectives, benefits, and risks of CAPI devices. At the time of survey instruction and as part of the consent process, interviewers should be trained in how to appropriately and knowledgeably provide information to prospective respondents and/or household members in a manner that addresses acceptability factors. Interviewers should specifically be trained in how to best handle CAPI devices and provide reassurance in case respondents have suspicions or concerns. For example, interviewers may utilize open side-by-side interviewing to avoid intimidation and allow respondents to observe accuracy of data entry [34]. Technical considerations such as protecting devices with an inconspicuous case [46], covering the rear camera, or choosing models without a rear camera may also be considered.

We encourage further research to explore CAPI use and acceptance in different contexts and environments. In particular, how do local perceptions of CAPI affect community expectations, respondent motivations, or data quality? Do local perceptions of CAPI change when implemented on a larger scale? What are the best practice guidelines for CAPI implementation and for obtaining consent in LMIC?

With the conclusion of the Millennium Development Goal agenda and transition towards the Sustainable Development Goals

Summary Points

What Was Already Known on the Topic:

- Measuring maternal and child coverage metrics in LMIC is critical to improving and providing accountability for MNCH programming.
- CAPI is a cost-effective, efficient, and high-quality alternative to PAPI.
- Studies using CAPI from LMIC have reported mixed outcomes of respondent acceptance.

What This Study Added to Our Knowledge:

- CAPI was acceptable to female community members in rural Southwest Uganda.
- CAPI acceptability is influenced by 'familiarity', 'data confidentiality and security', 'data accuracy', and 'modernization and development'.
- Including community sensitization and specific interviewer training regarding CAPI could promote CAPI acceptability in communities where computer exposure is limited.

[47], we must continue our global efforts to improving the health of women and children worldwide. In order to reach the most vulnerable groups, better evidence-based knowledge is needed to inform how to best collect health indicator data widely and to understand the implications of that data collection process on all communities. In our era of computerization and technology, we are now more than ever in the best position to contribute innovative ideas for effective, efficient, and impactful MNCH measurement.

Author contributions

HFGM, JK, and JLB initiated the concept for the study. HFGM developed study tools with coordination assistance from AJH. HFGM and DKT supervised field mobilization and focus group data collection, and HFGM conducted the qualitative analysis. HFGM and JLB drafted and revised the manuscript. All authors contributed to data interpretation and read and approved the final manuscript.

Acknowledgements

This work was carried out with financial support from the Government of Canada through Global Affairs Canada. We thank the many community members who participated in this study; the community health workers, trainers, and local leaders helping with field mobilization; partner institutions and Healthy Child Uganda staff, especially Doreen Ainembabazi, Teddy Kyomuhangi, and Polar Rwandekeye; our research assistants for their technical and translation support; and academic advisor Jennifer Hatfield.

References

[1] N.J. Kassebaum, A. Bertozzi-Villa, M.S. Coggeshall, K.A. Shackelford, C. Steiner, K.R. Heuton, et al., Global, regional, and national levels and causes of maternal mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 2013, Lancet 384 (September (9947)) (2014) 980–1004, http://dx.doi.org/10.1016/S0140-6736(14)60696-6.

[2] H. Wang, C.A. Liddell, M.M. Coates, M.D. Mooney, C.E. Levitz, A.E. Schumacher, et al., Global, regional, and national levels of neonatal, infant, and under-5 mortality during 1990–2013: a systematic analysis for the Global Burden of Disease Study 013, Lancet 384 (September (9947)) (2014) 957–979, http://dx.doi.org/10.1016/S0140-6736(14)60497-9.

[3] M.F. Gaffey, J.K. Das, Z.A. Bhutta, Millennium development goals 4 and 5: past and future progress, Semin. Fetal Neonatal Med. 20 (October (5)) (2015) 285–292, http://dx.doi.org/10.1016/j.siny.2015.07.001.

[4] J. Bryce, F. Arnold, A. Blanc, A. Hancioglu, H. Newby, J. Requejo, et al., Measuring coverage in MNCH: new findings, new strategies, and recommendations for action, PLoS Med. 10 (May (5)) (2013) e1001423, http://dx.doi.org/10.1371/journal.pmed.1001423.

[5] ICF International, The Demographic and Health Surveys (DHS) Program, 2015 [Internet]. [cited 2015 Nov]. Available from: http://www.dhsprogram.com.

[6] UNICEF, Statistics and Monitoring: Multiple Indicator Cluster Surveys (MICS), 2014 [Internet] [updated 2014 Oct 23; cited 2015 Nov]. Available from: http://www.unicef.org/statistics/index_24302.html.

[7] A. Hancioglu, F. Arnold, Measuring coverage in MNCH: tracking progress in health for women and children using DHS and MICS household surveys, PLoS Med. 10 (May (5)) (2013) e1001391, http://dx.doi.org/10.1371/journal.pmed.1001391.

[8] L. Rosero-Bixby, J. Hidalgo-Céspedes, D. Antich-Montero, M.A. Seligson, Improving the quality and lowering costs of household survey data using personal digital assistants (PDAs): an application for Costa Rica, in: Population Association of America Annual Meeting 2005, Philadelphia, USA, 2005, Mar 31-Apr 2.

[9] I. Asangansi, Understanding HMIS implementation in a developing country Ministry of Health context – an institutional logics perspective, Online J. Public Health Inform 4 (December (3)) (2012) e8, http://dx.doi.org/10.5210/ojphi.v4i3.4302.

[10] J.D. King, J. Buolamwini, E.A. Cromwell, A. Panfel, T. Teferi, M. Zerihun, et al., A novel electronic data collection system for large-scale surveys of neglected tropical diseases, PLoS One 8 (September (9)) (2013) e74570, http://dx.doi.org/10.1371/journal.pone.0074570.

[11] P. Byass, S. Hounton, M. Ouedraogo, H. Some, I. Diallo, E. Fottrell, et al., Direct data capture using hand-held computers in rural Burkina Faso: experiences, benefits and lessons learnt, Trop. Med. Int. Health 13 (July (Suppl. 1)) (2008) 25–30, http://dx.doi.org/10.1111/j.1365-3156.2008.02084.x.

[12] T. Marchant, J. Schellenberg, S. Peterson, F. Manzi, P. Waiswa, C. Hanson, et al., The use of continuous surveys to generate and continuously report high quality timely maternal and newborn health data at the district level in Tanzania and Uganda, Implement Sci. 9 (August) (2014) 112, http://dx.doi.org/10.1186/s13012-014-0112-1.

[13] C. King, J. Hall, M. Banda, J. Beard, J. Bird, P. Kazembe, et al., Electronic data capture in a rural African setting: evaluating experiences with different systems in Malawi, Glob. Health Action 7 (October) (2014) 25878, http://dx.doi.org/10.3402/gha.v7.25878.

[14] D. Paudel, M. Ahmed, A. Pradhan, R. LalDangol, Successful use of tablet personal computers and wireless technologies for the 2011 Nepal Demographic and Health Survey, Glob. Health Sci. Pract. 1 (August (2)) (2013) 277–284, http://dx.doi.org/10.9745/GHSP-D-12-00056.

[15] C.J. Seebregts, M. Zwarenstein, C. Mathews, L. Fairall, A.J. Flisher, C. Seebregts, et al., Handheld computers for survey and trial data collection in resource-poor settings: development and evaluation of PDACT, a Palm™ Pilot interviewing system, Int. J. Med. Inform. 78 (January (11)) (2009) 721–731, http://dx.doi.org/10.1016/j.ijmedinf.2008.10.006.

[16] P. Yu, M. de Courten, E. Pan, G. Galea, J. Pryor, The development and evaluation of a PDA-based method for public health surveillance data collection in developing countries, Int. J. Med. Inform. 78 (August (8)) (2009) 532–542, http://dx.doi.org/10.1016/j.ijmedinf.2009.03.002.

[17] B. Caeyers, N. Chalmers, J. De Weerdt, Improving consumption measurement and other survey data through CAPI: evidence from a randomized experiment, J. Dev. Econ. 98 (1) (2012) 19–33, http://dx.doi.org/10.1016/j.jdeveco.2011.12.001.

[18] J. Caviglia-Harris, S. Hall, K. Mulllan, C. Macintyre, S.C. Bauch, D. Harris, et al., Improving household surveys through computer assisted data collection: use of touch-screen laptops in challenging environments, Field Methods 24 (March (1)) (2012) 74–94, http://dx.doi.org/10.1177/1525822X11399704.

[19] K. Thriemer, B. Ley, S.M. Ame, M.K. Puri, R. Hashim, N.Y. Chang, et al., Replacing paper data collection forms with electronic data entry in the field: findings from a study of community-acquired bloodstream infections in Pemba, Zanzibar, BMC Res. Notes 5 (February) (2012) 113, http://dx.doi.org/10.1186/1756-0500-5-113.

[20] M. Ali, J.L. Deen, A. Khatib, G. Enwere, L. von Seidlein, R. Reyburn, et al., Paperless registration during survey enumerations and large oral cholera mass vaccination in Zanzibar, the United Republic of Tanzania, Bull. World Health Organ. 88 (July (7)) (2010) 556–559, http://dx.doi.org/10.2471/BLT.09.070334.

[21] M.A. Onono, N. Carraher, R.C. Cohen, E.A. Bukusi, J.M. Turan, Use of personal digital assistants for data collection in a multi-site AIDS stigma study in rural South Nyanza, Kenya, Afr. Health Sci. 11 (September (3)) (2011) 464–473.

[22] D.G. Dillon, F. Pirie, S. Rice, C. Pomilla, M.S. Sandhu, A.A. Motala, et al., Open-source electronic data capture system offered increased accuracy and cost-effectiveness compared with paper methods in Africa, J. Clin. Epidemiol. 67 (December (12)) (2014) 1358–1363, http://dx.doi.org/10.1016/j.jclinepi.2014.06.012.

[23] J.G. Giduthuri, N. Maire, S. Joseph, A. Kudale, C. Schaetti, N. Sundaram, et al., Developing and validating a tablet version of an illness explanatory model interview for a public health survey in Pune, India, PLoS One 9 (September (9)) (2014) e107374, http://dx.doi.org/10.1371/journal.pone.0107374.

[24] H.N. Njuguna, D.L. Caselton, G.O. Arunga, G.O. Emukule, D.K. Kinyanjui, R.M. Kalani, et al., A comparison of smartphones to paper-based questionnaires for routine influenza sentinel surveillance, Kenya, 2011–2012, BMC Med. Inform. Decis. Mak. 14 (December) (2014) 107, http://dx.doi.org/10.1186/s12911-014-0107-5.

[25] D. Forster, B. Snow, Using microcomputers for rapid data collection in developing countries, Health Policy Plan. 7 (March (1)) (1992) 67–71, http://dx.doi.org/10.1093/heapol/7.1.67.

[26] M.A. Missinou, C.H. Olola, S. Issifou, P.B. Matsiegui, A.A. Adegnika, S. Borrmann, et al., Short report: piloting paperless data entry for clinical research in Africa, Am. J. Trop. Med. Hyg. 72 (March (3)) (2005) 301–303.
[27] K. Shirima, O. Mukasa, J.A. Schellenberg, F. Manzi, D. John, A. Mushi, et al., The use of personal digital assistants for data entry at the point of collection in a large household survey in southern Tanzania, Emerg. Themes Epidemiol. 4 (June) (2007) 5, http://dx.doi.org/10.1186/1742-7622-4-5.
[28] M. Tomlinson, W. Solomon, Y. Singh, T. Doherty, M. Chopra, P. Ijumba, et al., The use of mobile phones as a data collection tool: a report from a household survey in South Africa, BMC Med. Inform. Decis. Mak. 9 (December) (2009) 51, http://dx.doi.org/10.1186/1472-6947-9-51.
[29] S. Kaneko, J. K'opiyo, I. Kiche, S. Wanyua, K. Goto, J. Tanaka, et al., Health and demographic surveillance system in the western and coastal areas of Kenya: an infrastructure for epidemiologic studies in Africa, J. Epidemiol. 22 (February (3)) (2012) 276–285, http://dx.doi.org/10.2188/jea.JE20110078.
[30] D.W. Knipe, M. Pearson, R. Borgstrom, R. Pieris, M. Weerasinghe, C. Priyadarshana, et al., Challenges and opportunities of a paperless baseline survey in Sri Lanka, BMC Res. Notes 7 (July) (2014) 452, http://dx.doi.org/10.1186/1756-0500-7-452.
[31] I.N. Escandon, H. Searing, R. Goldberg, R. Duran, J.M. Arce, The use of PDAs to collect baseline survey data: lessons learned from a pilot project in Bolivia, Glob Public Health 3 (1) (2008) 93–104, http://dx.doi.org/10.1080/17441690701437021.
[32] M. Mitchell, M. Getchell, M. Nkaka, D. Msellemu, J. Van Esch, B. Hedt-Gauthier, Perceived improvement in integrated management of childhood illness implementation through use of mobile technology: qualitative evidence from a pilot study in Tanzania, J. Health Commum. 17 (Suppl. 1) (2012) 118–127, http://dx.doi.org/10.1080/10810730.2011.649105.
[33] S. Zhang, Q. Wu, M.H. van Velthoven, L. Chen, J. Car, I. Rudan, et al., Smartphone versus pen-and-paper data collection of infant feeding practices in rural China, J. Med. Internet Res. 14 (5) (2012) e119, http://dx.doi.org/10.2196/jmir.2183.
[34] A. van Heerden, S. Norris, S. Tollman, L. Richter, M.J. Rotheram-Borus, Collecting maternal health information from HIV-positive pregnant women using mobile phone-assisted face-to-face interviews in Southern Africa, J. Med. Internet Res. 15 (June (6)) (2013) e116, http://dx.doi.org/10.2196/jmir.2207.
[35] D. O'Mahony, G. Wright, Tablet computers for recording tuberculosis data at a community health centre in King Sabata Dalindyebo Local Municipality, Eastern Cape: a proof of concept report, S. Afr. Fam. Pract. 56 (3) (2014) 186–189, http://dx.doi.org/10.1080/20786204.2014.936666.
[36] K.G. Cheng, F. Ernesto, R.E. Ovalle-Bahamon, K.N. Truong, Barriers to acceptance of personal digital assistants for HIV/AIDS data collection in Angola, Int. J. Med. Inform. 80 (May (8)) (2011) 579–585, http://dx.doi.org/10.1016/j.ijmedinf.2011.04.004.
[37] B.S. Mensch, P.C. Hewett, A.S. Erulkar, The reporting of sensitive behavior by adolescents: a methodological experiment in Kenya, Demography 40 (May (2)) (2003) 247–268.
[38] M.M. Hennink, International Focus Group Research: A Handbook for the Health and Social Sciences, Cambridge University Press, New York, 2007.
[39] L.L. Ellingson, Engaging Crystallization in Qualitative Research: an Introduction, Sage Publications, Thousand Oaks, 2009.
[40] K. Jandee, S. Lawpoolsri, P. Taechaboonsermsak, A. Khamsiriwatchara, P. Wansatid, J. Kaewkungwal, Customized-language voice survey on mobile devices for text and image data collection among ethnic groups in Thailand: a proof-of-concept study, JMIR Mhealth Uhealth 2 (1) (2014) e7, http://dx.doi.org/10.2196/mhealth.3058.
[41] L.W. Chang, V. Njie-Carr, S. Kalenge, J.F. Kelly, R.C. Bollinger, S. Alamo-Talisuna, Perceptions and acceptability of mHealth interventions for improving patient care at a community-based HIV/AIDS clinic in Uganda: a mixed methods study, AIDS Care 25 (March (7)) (2013) 874–880, http://dx.doi.org/10.1080/09540121.2013.774315.
[42] World Health Organization, Every Woman, Every Child: From Commitments to Action, World Health Organization, Geneva, 2012.
[43] World Health Organization and International Telecommunication Union, eHealth and Innovation in Women's and Children's Health: A Baseline Review, World Health Organization, Geneva, 2014.
[44] International Telecommunication Union, ICT for Improving Information and Accountability for Women's and Children's Health, International Telecommunication Union, Geneva, 2013.
[45] B. Walther, S. Hossin, J. Townend, N. Abernethy, D. Parker, D. Jeffries, Comparison of electronic data capture (EDC) with the standard data capture method for clinical trial data, PLoS One 6 (9) (2011) e25348, http://dx.doi.org/10.1371/journal.pone.0025348.
[46] A. Bernabe-Ortiz, W.H. Curioso, M.A. Gonzales, W. Evangelista, J.M. Castagnetto, C.P. Carcamo, et al., Handheld computers for self-administered sensitive data collection: a comparative study in Peru, BMC Med. Inform. Decis. Mak. 8 (March) (2008) 11, http://dx.doi.org/10.1186/1472-6947-8-11.
[47] United Nations Department of Economicand Social Affairs, Sustainable Development Goals, 2016 [Internet]. 2015 [cited 2015 Nov]. Available from: https://sustainabledevelopment.un.org.