Reviewer A

The study aims to assess the prevalence of smartphone access and social media use and the correlates of smartphone access among youth in Nairobi, Kenya. Despite the interesting results and in order to be published, some points of this article are to be adapted. Our remarks are described below:

Abstract

Comment 1: - Methods: What is the rationale for having a sample of youth living with HIV?

Response 1: There has been a lot of interest in the HIV field in using mobile communication technology to support youth living with HIV. Given the social determinants of HIV risk, it is conceivable that youth living with HIV would have different levels of access to mobile technology compared with the general population. Disaggregated data are therefore needed to evaluate accessibility of different mHealth interventions among youth living with HIV, in addition to the general youth population. Further, as most research in the mHealth field has focused on general populations of adolescents, the findings do not always translate to vulnerable populations. Thus, focused research is needed within critical populations to improve health outcomes.

Changes in the text: We have added a statement about this on page 6, line 9-11.

Comment 2: - Conclusion: The abstract highlights the results of "accessibility" to new technologies, including cell phone (n=407/600), smartphone (n=288/600) and social media (n=260/600). For the latter two, less than half have access to these technologies. The results obtained show less access for the youngest. Can we really conclude that these smartphone-based interventions are "feasible"? The feasibility study requires further investigation beyond the notion of accessibility. We advise the authors to revise the conclusion of the abstract.

Response 2: We agree that there is a distinction between accessibility and feasibility.

Changes in the text: As advised, we have modified the wording in the abstract (page 3, line 15)

Introduction

Comment 3: - The introduction is well constructed, highlighting the inequalities in access to technologies and therefore to health interventions using these tools.

Response 3: We thank the reviewer for this comment.

Comment 4: - The stated objective is to evaluate the "prevalence among young people": can we talk about prevalence for the research object in question (accessibility), but especially in

view of the sample constituted (number, type)?

Response 4: We have adjusted the wording to refer to "level" of phone access, rather than "prevalence".

Changes in the text: We modified wording on page 5, line 5.

Comment 5: - Indicate in the introduction that access to social media requires a certain level of Internet connectivity. Access to social media by young people will depend on the technologies they have, but also on connectivity to the Internet.

Response 5: We thank the reviewer for this observation, and agree that this should be stated.

Changes in the text: We modified wording on page 4, line 16-18.

Comment 6: - The ambition to create a social media intervention for young people living with HIV should not be taken as the justification for this study. It is the needs of the youth and the specificities of YLWH that need to be made explicit, to explain later why the general population and YLWH recruitment.

Response 6: We thank the reviewer for this observation and agree.

Changes in the text: We modified wording on page 5 line 3.

Methods

Comment 7: - The authors should justify the choice of recruitment sites (although the differences have been described). Why recruit only at the hospital and not elsewhere? How did the authors consider "a referral hospital"? Are we sure that this method of recruitment will reach a diverse (or even representative) sample of the youth population in Nairobi, Kenya?

Response 7: We agree that recruiting at healthcare facilities may have introduced some bias in the population reached, and acknowledge this in the limitations section. Though our goal was not to generate a nationally or regionally representative sample, recruiting at healthcare facilities would be expected to reach a diverse sample, since public health facilities, especially general outpatient services, are attended by the general population as primary care. Our justification for recruiting through healthcare facilities was that healthcare facilities are often the venues through which health interventions – including mHealth interventions – are disseminated. Therefore, technology access among youth attending healthcare facilities would be relevant to subsequent mHealth interventions in this population. The national referral hospital was defined as such based on Kenyan Ministry of Health classification.

Changes in the text: We have provided justification on page 6, line 17-18.

Comment 8: - Rephrase the rationale for the sampling because half of the sample drawn is YLWH.

Response 8: We have rephrased the study design.

Changes in the text: We have rephrased page 6 line 4.

Comment 9:- What criteria do the authors use to define the age of 14-24 year olds? Why not include the youngest age group, given that WHO defines adolescents and young adults as 10-24 years old?

Response 9: Age was defined based on participant self-report. We focused on this age range because we reasoned individuals in this age range would have relatively homogeneous experiences and health needs than the full adolescent and young adult age range.

Changes in the text: We have added information on definition of age and motivation for age range selection on page 6, line 20-21.

Comment 10: - How was the questionnaire constructed? By whom, and through what process? We also advise the authors to make the questionnaire available.

Response 10: The questionnaire was constructed by the study team, through collaborative development of questions and iteration of the instrument. A draft of the questionnaire was piloted with youth attending a study clinic, and revised according to feedback about comprehension.

Changes in the text: We now describe the process of questionnaire development on page 7 line 4.

Comment 11: - Did you receive a favorable opinion from an ethics committee? If so, please specify (with IRB).

Response 11: We apologize for the omission. This research was approved by ethics committees at the University of Washington and University of Nairobi / Kenyatta National Hospital.

Changes in the text: We have added this information on page 8, line 1-3.

Comment 12: - Mention STROBE statment in the method.

Response 12: We have added a statement that the study is presented in accordance with the STROBE statement.

Changes in the text: We have added this information on page 5 line 6.

Results

Comment 13: - The results are informative and highlighted with a description of the population, access to different digital mediums and correlations studied between smartphone access/use and population characteristics.

Response 13: We thank the reviewer for this comment.

Comment 14: - The main results highlight digital access and usage at a given time (2017-2018): 69.3% of the sample has access to a phone, 55% use social networks of which 49.7% use Facebook, while 55.1% never access the internet (inconsistency? Knowing that you need internet access to access these social networks sites. If measurement bias, specify); more access for older and more educated youth.

Response 14: We found that 55.1% of participants never accessed WiFi, not the Internet (Table 2). This is explained by participants using wireless data bundles rather than WiFi.

Changes in the text: None

Comment 15:- In Table 2: more detail on others social networks sites used.

Response 15: We thank the reviewer for this comment. We have added more information on the different sites used.

Changes in the text: Table 2 now lists all social networks that were included in the questionnaire.

Comment 16:- Could the authors have studied the correlations between social media use and population characteristics? Are social media used more by teenagers or young adults? For the more educated?

Response 16: We thank the reviewer for this suggestion. We have added this analysis, which showed very similar findings to the correlates of smartphone access, in an additional table.

Changes in the text: Table 4 now displays these findings. We have added a section to the results (page 10 line 26 – page 11 line 5), and describe this analysis in the methods (page 7 line 14-16) and introduction (page 5 line 5)

Conclusions

Comment 17: - Rename this section as "Discussion". Distinguish between strengths and limitations, future direction and conclusion.

Response 17: We have renamed the section and have added subheadings to distinguish the different headings (summary of findings, comparison with previous work, interpretation and implications for intervention design, limitations, conclusion).

Changes in the text: Subheadings have been added on page 11 lines 1, 2, 13, page 12 line 4, page 14 line 26, page 15 line 15.

Comment 18: - This section needs to be restructured and the discussion points need to be improved and referenced: the authors' interpretations are often isolated from any comparison to the existing literature. Therefore, there is a lack a perspective with other study results. If missing, argue from institutional and political recommendations for health interventions.

Response 18: Thank you for this feedback. We have reorganized the discussion according to the subheadings outlined in response 17, and have introduced additional citations of prior work in the area.

Changes in the text: Restructuring throughout pages 12-15. Additional citations were added throughout the discussion, and a new section was added reporting on other studies on page 12, line 22 – page 13 line 2.

Comment 19: - L230-232: these results need to be discussed further. If half are left out of

mHealth due to lack of access, how can they be reached and provided with a health response?

Response 19: Youth who lack access to smartphones can be reached in-person or using basic phone interventions such as SMS.

Changes in the text: We have expanded discussion of the implications of our analysis for intervention design on page 14 line 17-24.

Comment 20: Moreover, in the study, only 12.1% of the young people interviewed had access to the Internet every day (although the place of recruitment was Nairobi, were they living in the city itself, in other cities, in peri-urban or rural areas? Geographic location is related to Internet and digital accessibility). The issue of Internet access time should be discussed as a determinant of the scope of web-based interventions (exposure time is an element of accessibility that may be related to the interventions effectiveness).

Response 20: All recruitment sites were in urban and peri-urban Nairobi. Our finding was that 12.1% of participants had daily access to WiFi – a larger proportion likely had daily access to the internet by using mobile data. However, we did not ascertain the amount of time or frequency of access to the internet.

Changes in the text: We have added clarification that the recruitment sites were in urban and peri-urban locations in Nairobi (page 6 lines 7-8). We now state the study's limitation in ascertainment of internet access on page 15, line 6-9.

Comment 21: - L245-248: the statement that young people are more likely to be in boarding schools than the sample is based on what reference? We also wonder if these boarding schools could have been recruitment sites (recruitment bias to be mentioned). Why is this an important element to take into account? Because there is more or less access to technologies ?

Response 21: Thank you for pointing out this lack of clarity. Youth are typically not allowed to access their phones in boarding school, though they can access them during school breaks. Our intention was to highlight lower access among youth in boarding schools. We have rephrased this and added a citation to support the high rate of boarding school attendance in East Africa.

Changes in the text: We have rephrased page 13, line 16-20 and added a citation.

Comment 22: - The authors conclude that it is important to specify to whom digital health actions should be directed. Wouldn't this approach increase inequalities in access to health promotion interventions? Shouldn't the authors propose complex public health interventions for all young people, with digital and non-digital functionalities for young people who have no access?

Response 22: Thank you for this suggestion. We agree that simply defining who has access to interventions does not address the risk of perpetuating inequities due to differential access, and it is important for us to develop differentiated interventions depending on technology access.

Changes in the text: We have added a paragraph to the discussion laying out the implications of your findings for intervention design (page 14 lines 17-24).

Comment 23: - Finally, can we think of "city-centric" interventions? Wouldn't it be possible to investigate other contexts of life in Kenya in order to propose health interventions for all, in all places (knowing that individuals change geographical spaces during their life)?

Response 23: We are unsure what the reviewer means by this comment. We hope that the new paragraph outlining implications for intervention design addresses their concern.

Changes in the text: We have added a paragraph to the discussion laying out the implications of our findings for intervention design (page 14 lines 17-24).

Comment 24: - Future directions could feed the perspective: beyond access, study the attractiveness, the feasibility in the use of new technologies for health. What about community-based participatory research, the views of stakeholders, including youth?

Response 24: Thank you for highlighting this aspect. We now include this as a future direction and cite a study by our team that reports on our experience implementing a social media intervention in this population.

Changes in the text: We have added a sentence and citation on page 15, lines 12-13.

This study follows in the tradition of formative mHealth work conducted in emerging countries with populations with urgent intervention support, in this case, young people living with HIV. While the paper is timely and well-written, I have some comments for the authors to address.

• The introduction is succinct yet from my perspective, it still lacks pertinent information that would help situate the importance of the study.

Comment 25: For example, the authors state (pg. 3, ln 71-72) that "literature from high-income countries has shown the feasibility of using smartphone-based and social media interventions for health promotion…". In fact, there are multiple mHealth feasibility studies I have read and reviewed that were conducted in emerging contexts such as South America, South-East Asia, etc. I would encourage the authors to conduct a comprehensive search for said literature and situate the present study within that larger body of work. Perhaps, the case can be made that preliminary work in sub-Saharan Africa is lacking.

Response 25: We appreciate the reviewer highlighting this. We agree that there is significant literature on mHealth approaches in LMICs, though the number of studies focused on *youth* and using *smartphones* in LMICs is limited, as presented in citations 6-10. We have updated the text to acknowledge that previous literature has explored use of smartphone interventions in high and middle/low income settings.

Changes in the text: We have added text on page 4 line 10.

Comment 26: • While it is important to conduct formative work before implementing large-scale interventions, I don't believe it is accurate to state that very few studies have used mHealth interventions in sub-Saharan Africa. Lester and colleagues conducted ground-breaking mHealth studies a decade ago in Kenya. Perhaps the authors are justifying the innovation of their study based on smartphones specifically or their particular population. If that's the case, it might be better to mention briefly the studies that came before, and justify why the present study is important or different.

Response 26: We thank the reviewer for pointing this out; we agree that it is inaccurate to state that few studies have used mHealth in sub-Saharan Africa. We now mention the extensive literature on SMS interventions in LMICs, and specify that interventions among youth, and requiring internet access, are less well-studied.

Changes in the text: Page 4 line 4-5.

Comment 27: • I am concerned about the fact that a waiver of parental permission was obtained for minors without an adult guardian. What was the justification for such a waiver? Was there an incentive for participation and if so, how much was it?

Response 27: A waiver of parental permission was granted by the ethical review committees at the University of Nairobi/Kenyatta National Hospital and the University of Washington on the grounds that many youth manage their own medical care and attend without a caregiver, specifically because they do not want a caregiver present. Obtaining caregiver permission might therefore have incurred additional risks of psychosocial harm. Study activities were assessed to involve minimal risk, so the benefit of protecting participant confidentiality was determined to outweigh the risk of waiving parental permission. There was no incentive to complete the survey.

Changes in the text: We have added information about the motivation for the waiver of parental permission and the incentive (page 6 line 24-26).

Comment 28: • While the study is specifically interested in social media use, the authors unfortunately seem to have a misunderstanding of what social media actually is. Most of the platforms they examined are online messaging apps including Facebook Messenger (Facebook is social media but Messenger is a private messaging feature), Skype, Signal and WhatsApp. It is not to say that one should not examine use of such communication technology platforms but it does bring into question what the authors are aiming to achieve through this study.

Response 28: We acknowledge that there is variability in which platforms are considered "social media", and whether messaging apps are included. Most of the reports we cite on social media do include WhatsApp and Facebook Messenger under the umbrella of social media. We have added clarification about what our definition of social media includes.

Changes in the text: We have added to our definition of social media on page 4, line 9.

Comment 29: • It was interesting to note that only half the study sample had access to a

smartphone. This is an important finding and it reiterates my doubt about framing this study as formative work to develop and implement a smartphone-based intervention. In fact, it is clear that even a mobile phone (i.e., without internet access) intervention in this group would only reach three-fourths of the sample. Since this is an inductive study, I would encourage the authors to revisit the introduction section and reframe the purpose of the study.

Response 29: We thank the author for this comment, and agree that alternate framing of the study is helpful. We have modified the framing in the introduction.

Changes in the text: We have modified page 5, line 4.

Comment 30: • Considering the time frame of the study and the vulnerable sample it examines, it was disappointing to see the lack of technology variables in the study. One of the significant methodological concerns I have is the dependent variable – smartphone use. Since only half the sample had access to a smartphone, it is unclear to me why the authors chose to examine the correlates of smartphone use over mobile phone use. Secondly, by choosing the former, the sample size was essentially halved which is also of concern.

Response 30: Our motivation for focusing on smartphone access and social media use rather than any mobile phone access was that a significant literature already exists on interventions using SMS. We felt that less data was available on access to internet-based interventions, which are gaining in popularity for health interventions. We therefore opted to focus on correlates of smartphone access and social media use.

Changes in the text: We emphasized the growing interest in using smartphone-based interventions for youth in SSA on page 4 line 26.

Comment 31: • The authors are forthright about the limitations of this study. I would however, add to this list the issue of essentially having negated the responses of one-half of the sample that did not have access to smartphones. While it is important to scrutinize what factors predict smartphone use, it is equally if not more important to gauge what factors predict non-adoption of mobile technology? This study would have benefitted from a qualitative component, e.g., conducting in-depth interviews of those youth who do not use any type of communication technology. Nothing can be done at this stage but I would like to see some discussion of this in the conclusion.

Response 31: We agree that qualitative insights about barriers to technology use would be valuable, and now mention this in our limitations.

Changes in the text: We have added this limitation on page 15, line 11-12.

<mark>**Reviewer C**</mark>

The authors report the findings of a survey of adolescents and emerging adults receiving outpatient care in Nairobi, Kenya. Their report indicates that roughly half of young respondents maintain routine access to a smartphone, 90% of whom use social media. Older, more highly

educated, and youth living with HIV (YLWH), all showed increased likelihoods of smartphone access, to varying degrees. The precise nature and distribution of interactive, communication, and networked digital technology access within priority populations is often understudied. This is despite the fact that such findings are of foundational importance to digital health intervention design and sustainment. Surveys such as the work reported here, which offers clear, concrete, and promptly actionable findings, represent important original contributions to the literature. The comments below should aid in shoring up the strengths of the manuscript, while enhancing its attunement to planners and practitioners.

Comment 32: Abstract: Here (lines 35–37), and subsequently, throughout the introduction, smartphone and social media use are often handled indiscriminately. While it seems clear by implication that the intervention under development is social media–based, and intended for smartphone delivery, the two channels cannot always be conflated. For instance, a mobile app–delivered intervention would be inaccessible to a user of internet cafes, while some social media–delivered interventions might be accessible through a desktop browser (and some would not). The manuscript's framing would benefit by more precisely teasing out these distinctions, for example by making clear that the intersection of smartphone access and paid data and social media use is (presumably) of foremost interest to the investigators.

Response 32: We thank the reviewer for pointing out this distinction. We agree that smartphone and social media access are partially overlapping but distinct. In Kenya, the vast majority of internet access is by phone rather than computer, which motivated our focus on smartphone access.

Changes in the text: We have added information on the use of different devices to access the internet and social media (page 4 lines 16-18) and about use of smartphones to access the internet in Kenya (page 4 line 20-21).

Comment 33: Abstract: Here (lines 40–41), and elsewhere, "general outpatient care" is left undefined. While this is, understandably, a catchall designator, some broad-strokes background characterizing these presentations might lend important context: whether, for example, injuries predominate, or routine care for chronic conditions, etc.

Response 33: Thank you for this question. The outpatient facilities at the County and Sub-County hospitals where we recruited participants saw patients for simple ailments such as fever, respiratory infections, diarrhea etc, injuries, and as an entry point for patients with chronic diseases, such as diabetes, who would then be directed to the specialty clinic they need e.g. diabetes clinic. The outpatient facility at the National referral hospital was focused on youth, and offered HIV testing, prevention and mental health services.

Changes in the text: We have added this information to the Methods on page 6, line 13-16.

Comment 34: Introduction: The introduction is admirably concise and to-the-point. But from a technologist's perspective, the urban Kenyan context is a fascinating one, with the rapid adoption of mobile technologies such as M-PESA and the consequent ripples these genuine "disruptions" may have introduced to many Kenyan's daily lives. Some brief coverage of the

socio-technical context of the present work would be of benefit to international readers. If there exists any evidence that young people, in particular, are included or left behind by the broader adoption of consumer mobile tech, it could provide especially rich and implicative context.

Response 34: We thank the reviewer for this insight and agree that Kenyan uptake of M-PESA has had significant impact on the technological context. There is little data on technology access among youth specifically.

Changes in the text: We now include in the introduction a comparison of the Kenyan technological context with global averages, and specifically highlight the broad use of M-PESA and the lack of data about young people's access (page 4 line 21-24).

Comment 35: Methods: The precise study interaction is, as written, unclear. Were the questionnaires staff-administered? Were the tablets provided to participants? In private? Was literacy assessed and accommodations provided for participants who preferred a spoken interaction?

Response 35: Questionnaires we administered by study staff, though participants were given the option of entering their own responses to sensitive questions if they preferred. Questionnaires were administered in a private area of the facility and literacy was not assessed.

Changes in the text: We have added information on the mode and location of questionnaire administration to the methods (page 7 lines 1-3).

Comment 36: Methods: The precise response options for social media use (line 122) are, presumably, what is shown, but this could stated in less ambiguous terms. Was an "other" or open-ended response available?

Response 36: Additional platforms were asked about (Instagram, Signal, Skype, Snapchat, Telegram, Viber).

Changes in the text: We have expanded the "other" category in Table 2.

Comment 37: Results: Young people's ability to spend on cellular data and/or their access to Wi-Fi would, presumably, be as decisive a factor in their access to mHealth EBIs as their ability to acquire a smartphone or navigate social media. Was data/Wi-Fi access differentiated by age, gender, site, or other factor? What might the implications of these patterns of data/Wi-Fi access be for practice and policy?

Response 37: We agree that access to cellular data or Wi-Fi is an important component of accessing online interventions. However, our data collection was not designed to meaningfully assess whether and for whom data access was a limiting factor, or how much additional data youth could access in order to join a social media intervention. We now add this limitation to our discussion.

Changes in the text: We have added a sentence to the limitations (page 14, line 6-9).

Comment 38: Results: There appears to be a typo on line 171: "629" should probably be "329."

Response 38: Thank you for this correction.

Changes in the text: We have corrected the number on page 9, line 25.

Comment 39: Table 2: With 46% of respondents using a social medium other than Facebook or WhatsApp, it would be valuable to provide more granular descriptives covering use of the platforms currently subsumed in the "Other" category.

Response 39: Thank you for this suggestion. We have expanded this category.

Changes in the text: We have expanded the "other" category in Table 2.

Comment 40: Conclusions: The authors account for the implications of their findings, which position smartphone/social media–based intervention delivery as accessible only to the (roughly) older, higher-SES, segments of young people surveyed, in an upfront manner. But the lasting implications of such a pattern for the feasibility and sustainability of mHealth for YLWH and adjacent underserved communities, is under-examined. The addition of specific future directions for intervention, whether to adapt digital EBIs to those without access to the platforms through which they are delivered, or underwrite that access as a prerequisite to intervention, with a recognition of the various shadings of digitally networked ICTs (e.g. feature phones, SMS, eHealth) that might be brought to bear, or, perhaps, to pursue other directions entirely, would strengthen the discussion section considerably.

Response 40: We thank the reviewer for this comment. We have restructured the discussion and added more recommendations for future studies designing mHealth interventions.

Changes in the text: We have added a paragraph discussing these implications on page 14, lines 17-24.

Comment 41: Conclusions: Similarly, the facility-level differences in access warrant some discussion, in particular as to how they might affect the onboarding of smartphone/social media–based interventions trialed and, eventually, implemented in these settings. Would such interventions be "prescribed" by providers in response to certain presentations of refractory risk? Installed by facility staff? Available on app distribution services, or discoverable (or invite-only) environments on specific social media such as Facebook?

Response 41: Thank you for pointing out this consideration. Interventions could be rolled out through a number of models. The few mHealth interventions that have been delivered at scale in resource-limited settings have typically used a registration model in which participants self-register or are registered while waiting for clinic appointments.

Changes in the text: We have added a sentence discussing the implication of facility-level access data for intervention roll-out (page 14 line 7-9).

Comment 42: The title specifies "Implications for Mobile Health Intervention Design." But no specific directions for design or implementation are provided. For example, with older, more highly educated YLWH (somewhat) predominant among young people with smartphone/social media access, perhaps tailoring UIs/content for younger adolescents would not be worth the

effort or resources. Or would it? What would the authors have mHealth and mobile tech designers who wish to reach Kenyan or SSA-based adolescents and emerging adults do, specifically, in response to these findings?

Response 42: Thank you for highlighting this omission. We have reorganized the discussion to highlight implications for design. Depending on the sub-population of interest, we argue that interventions should use a platform with broad access, or develop interventions that can be delivered through multiple different platforms.

Changes in the text: We have added a paragraph addressing design implications on page 14, lines 17-24.

Comment 43: Conclusions: While not every paper needs to be a "COVID paper," providing a touch more specificity concerning the durability of these findings post-COVID (and in the wake of Kenyan-specific COVID response actions, e.g. were tablets distributed to students?) would support more informed readings in 2021 and in future.

Response 43: We thank the reviewers for this question. Tablets were not distributed to Kenyan students, but educational materials were developed for dissemination through TV, radio and online. Additionally, cellular data costs were lowered in an effort to make online materials more accessible. COVID-19 prevention practices such as social distancing and reduced clinic schedules mean using digital technology for social connection and health education are likely even more relevant now than at the time of our data collection

Changes in the text: We have added an explanation of Kenya's COVID-19 educational response and the implications of the study's findings during the COVID era in the discussion (page 15, lines 2-3).