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Perspective

Digital tools for youth health promotion: principles, policies and practices in sub-Saharan Africa

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Abstract

Although digital health promotion (DHP) technologies for young people are increasingly available in low- and middle-income countries (LMICs), there has been insufficient research investigating whether existing ethical and policy frameworks are adequate to address the challenges and promote the technological opportunities in these settings. In an effort to fill this gap and as part of a larger research project, in November 2022, we conducted a workshop in Cape Town, South Africa, entitled 'Unlocking the Potential of Digital Health Promotion for Young People in Low- and Middle-Income Countries'. The workshop brought together 25 experts from the areas of digital health ethics, youth health and engagement, health policy and promotion and technology development, predominantly from sub-Saharan Africa (SSA), to explore their views on the ethics and governance and potential policy pathways of DHP for young people in LMICs. Using the World Café method, participants contributed their views on (i) the advantages and barriers associated with DHP for youth in LMICs, (ii) the availability and relevance of ethical and regulatory frameworks for DHP and (iii) the translation of ethical principles into policies and implementation practices required by these policies, within the context of SSA. Our thematic analysis of the ensuing discussion revealed a willingness to foster such technologies if they prove safe, do not exacerbate inequalities, put youth at the center and are subject to appropriate oversight. In addition, our work has led to the potential translation of fundamental ethical principles into the form of a policy roadmap for ethically aligned DHP for youth in SSA.

Keywords: digital health, young people, adolescents health, LMICs, sub-Saharan Africa, ethics, policy roadmap

Contribution to Health Promotion

- Digital health promotion is increasingly accessible to youth in LMICs, but existing ethical and policy frameworks primarily target high-income settings.
- To remedy this gap, we conducted a World Café workshop with 25 experts predominantly from SSA.
- Participants discussed existing ethical frameworks' limitations and the need to develop guidelines, starting with incorporating local youth input.
- DHP adoption must address barriers and contextualize ethical principles like autonomy, equity, safety, accountability and sustainability within SSA perspectives.
- We developed a policy roadmap for ethically aligned DHP for youth in SSA, translating principles into policies and practices addressing different stakeholders.

INTRODUCTION

Around the world, people, especially young people, are increasingly using digital technologies such as smartphones, wearables and sensor-enabled devices for health monitoring and improvement (Lupton, 2021). This trend goes hand in hand with new evidence suggesting that these digital tools offer health and wellness benefits for young people in low- and middle-income countries (LMICs) (He *et al.*, 2020; Bitto Urbanova *et al.*, 2023). However, the ethical and regulatory considerations surrounding these activities remain little explored, and most research focuses on high-income settings (Labrique *et al.*, 2018; Ho and Malpani, 2022; Thomas *et al.*, 2022).

Prior research has highlighted the potential advantages of digital health promotion (DHP) in LMICs as well as specific concerns, including issues related to traditional health promotion systems, data governance and ethical oversight (Ferretti *et al.*, 2023). These concerns deserve thorough investigation so that the full potential of DHP technology can be realized in these settings. Otherwise, young people who are at the greatest disadvantage and could benefit appreciably from these technologies may instead suffer from the exacerbation of health disparities.

In response to these challenges, ethical and governance frameworks are emerging within the fields of digital health and artificial intelligence (AI), and in the space of meaningful youth engagement (Bulc *et al.*, 2019; Wong, Gray *et al.*, 2021; Wong, Smith *et al.*, 2021; McCradden, 2023; Thai *et al.*, 2023). However, debate is ongoing over whether these principles are sufficiently clear and comprehensive to effectively address shortcomings specific to DHP for youth in LMICs, or whether they may overlook certain ethical issues. Key questions include how to translate ethical principles into practical policies within LMICs, and which steps are necessary to realize these policies within local contexts. Additionally, there is a need to identify the stakeholders involved in these processes and determine differences in comparison with high-income country (HIC) environments.

To develop a comprehensive and globally relevant ethics framework for those working in the field of DHP, it is essential to incorporate perspectives of digital health specialists from different contexts, including LMICs. To explore the unresolved questions and potential policy paths for DHP in LMICs, we convened a workshop titled 'Unlocking the Potential of Digital Health Promotion for Young People in Low- and Middle-Income Countries (LMICs)' in Cape Town, South Africa, in late November 2022. This workshop brought together an interdisciplinary

and international group of 25 participants, including experts in digital health ethics, youth health and engagement, health policy and promotion and technology development. Because it was held in Cape Town, the workshop mainly saw the participation of experts from sub-Saharan African countries such as Botswana, Cameroon, Ghana, Kenya, South Africa and Uganda, who were all involved in conducting research on engaging with youth.

To effectively gather participants' perspectives, the workshop employed the World Café method, enabling knowledge generation and data collection through group discussion, note-taking and integration of different perspectives (Löhr *et al.*, 2020). The workshop consisted of four sessions of small group discussion, with each session building on the others, exploring interconnected questions. Participants were split into three groups and engaged in conversation about DHP for young people in LMICs, with specific examples from SSA. Participants rotated to a new group for each session to encourage idea exchange. Sessions encompassed the following key areas: (i) advantages and barriers associated with DHP interventions tailored to young people in LMICs; (ii) existence and relevance of ethical and regulatory frameworks for DHP across diverse settings; (iii) translation of ethical principles into concrete policies and the implementation practices required by these policies within the unique contexts of SSA. The terms 'youth' and 'young people' were

used interchangeably during the workshop to refer to individuals between the ages of 10 and 35, thereby encompassing adolescents. Although the World Health Organization's definition of adolescents and young adults (AYAs) covers the age range of 10–24 years—with adolescents from 10 to 19 years and young adults from 20 to 24 years (WHO, 2023)—in SSA the latter category often extends to the age of 30–35 (African Union, 2006, 2023; Rocca and Schultes, 2020). The conclusions and key points reached by each group were discussed by all participants during plenary discussions. The key recurrent themes are reported in the following sections (Figure 1).

PART 1: ADVANTAGES AND BARRIERS FOR YOUNG PEOPLE IN ADOPTING DHP

During the workshop, participants engaged in a comprehensive discussion about the concept of DHP, discussing services in the form of apps, social media, wearables, websites, chatbots, radio, SMS, voice messages and calling services. These digital tools collectively form virtual platforms that serve as sources of health-related information, with the potential to motivate individuals to adopt positive health behaviors or continue existing habits that promote health. A diverse range of stakeholders has played a role in the creation and implementation of DHP services so far. This includes entities like the private sector

KEY RECURRENT THEMES ABOUT DIGITAL HEALTH PROMOTION (DHP) FOR YOUTH IN SUB-SAHARAN AFRICA

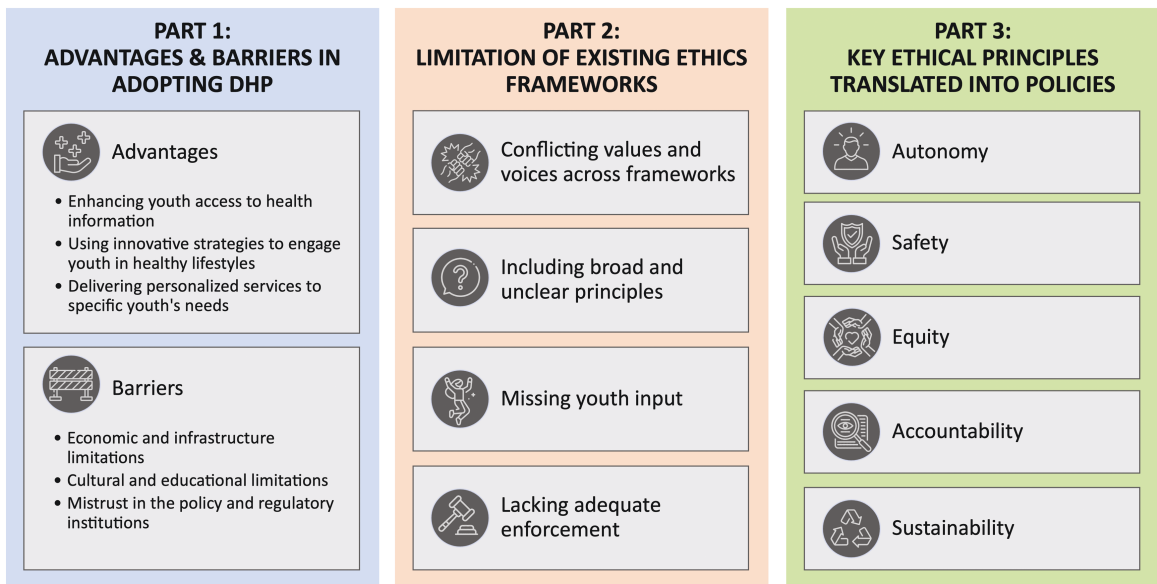


Fig. 1: Key recurrent themes emerged during the World Café discussion sessions.

(composed of health and wellness startups, as well as technology companies with primary operations outside the health sector), research institutions and academia, health ministries and government bodies and non-governmental organizations and foundations (Hampshire *et al.*, 2015; Barron *et al.*, 2018; Pillay and Motsoaledi, 2018; Holst *et al.*, 2021; Mehl *et al.*, 2021; Holly *et al.*, 2022).

While DHP holds promise for empowering young people in LMICs, and specifically in SSA, workshop participants concurred that the adoption of these technologies is not without constraints, due to context-specific concerns. Therefore, to maximize the benefits of these technologies, barriers that hinder them must be addressed in a timely manner.

Advantages

Participants mentioned the potential of DHP to utilize existing technologies to enhance access to health education and guide young individuals toward healthier lifestyles. This approach could help to bridge gaps in existing healthcare services, making health knowledge more accessible to the whole population. By leveraging technology, DHP can empower youth with essential health information and resources.

Furthermore, DHP offers the prospect of going beyond mere awareness of healthy practices. Using incentives like online communities or gamification, it can more actively support young people in making behavior shifts. These innovative strategies are a departure from traditional health promotion methods (such as doctor–patient discussions), and hold promise to be more effective at raising awareness and fostering a culture of self-care.

Lastly, DHP can tap into the vast potential of big data and machine learning models. By finding and utilizing patterns in large datasets, DHP can deliver personalized services and information tailored to individual needs and preferences. This approach aims to nudge individuals toward achieving their health objectives and goals, while affording flexibility around when and where to access resources. User-driven customization is a key feature of DHP, enhancing its relevance and effectiveness.

Barriers

Examining the challenges that youth face in the adoption of DHP in LMICs, and specifically in SSA, it is evident that a range of barriers exist.

Economic and infrastructure constraints are one prominent barrier, particularly in rural areas. The lack of consistent internet access in these regions hinders the online engagement that many DHP solutions require. Additionally, tools are often repurposed for

different uses, potentially rendering them imprecise for their intended health promotion function. For instance, wearables originally built for counting steps are increasingly used for more complex health measures, which can be incorrect if not reviewed and calibrated adequately (Roos and Slavich, 2023). High costs of data plans also pose a significant challenge. As many young individuals cannot afford the necessary hardware, they share devices with family members, which may limit their access to DHP services. Furthermore, as DHP initiatives often rely on insecure funding sources that can be subject to cuts or discontinuation, sustainability is an ongoing challenge.

Cultural and educational considerations present another set of obstacles. Many DHP solutions are developed in HIC contexts and subsequently made available in LMICs, where aspects of youth culture may not align. The content may be generic and not tailored to specific population groups. A more targeted approach addressing specific local customs and cultural preferences, health and digital knowledge levels in settings, or narrower age groups may help to better meet the needs of users. Furthermore, young people in LMICs can face significant competing priorities that come before engagement with digital health (Kabiru *et al.*, 2013). They may be more likely to think of health in terms of emergency or acute conditions, rather than prevention and maintaining healthy routines (Gittings *et al.*, 2022). For instance, in environments where resources are limited and young people may worry considerably about caring for family members, succeeding in education, or working and sustaining themselves financially, healthcare might not emerge as a priority among AYAs who anyway feel strong and healthy. Additionally, digital literacy can be a limiting factor, preventing youth from fully benefiting from DHP technologies. Once young people possess essential digital literacy skills to find and think critically about digital tools and information, they can utilize digital tools to meet their own individual health needs.

Trust issues related to policy and regulatory institutions, as well as DHP providers, present further barriers in the uptake and use of health technology among youth. The absence of effective oversight mechanisms to ensure the fairness and reliability of DHP tools can erode user confidence (Vayena and Blasimme, 2018). For example, users are faced with a DHP market in which reliable and high-quality services can be hard to distinguish from low-quality or biased ones (Abernethy *et al.*, 2022). This is in contrast with the medical device market, which permits only products that have been vetted to meet specific standards of quality and reliability. Additionally, users may fear that data collected via DHP could be misused or shared without their consent, potentially benefiting third parties disproportionately,

a concern sometimes referred to as ‘data colonialism’ (Ferryman, 2021). Moreover, the lack of specific laws regulating data usage and the absence of a clear consent framework contribute to the overall lack of trust in DHP initiatives.

PART 2: EXISTING ETHICS FRAMEWORKS AND CURRENT LIMITATIONS

A major topic of discussion during the workshop was the existence of an adequate ethical framework to orient developers, innovators and other relevant stakeholders in the creation, application and use of DHP solutions. Participants agreed that numerous ethics and policy frameworks for digital health, health promotion, youth health and engagement already exist (Africa NDoHS, 2019; WHO, 2020; Third *et al.*, 2021; Richardson *et al.*, 2022). However, there is a notable absence of guidance specific to DHP for youth. In particular, attendees stressed that compared with tools focusing on diagnostics and treatment, the distinction of targeting healthy young people makes DHP particularly worthy of attention. As youth can be vulnerable, depending on their circumstances and behaviors, health technology addressed to them should be carefully reviewed, given its risks and consequences. In this light, workshop attendees raised concerns about the limitations of current digital health frameworks that could also apply to DHP for youth.

Variety of frameworks with conflicting values

There is an abundance of guidance and frameworks for digital health, and documents tend to reference similar ethical values and principles. Yet, each guide, produced by any number of actors, places emphasis on different aspects and interprets these values differently. Developers can in turn struggle to navigate such complex guidance and policy landscapes. This challenge arises not only from the large number and diversity of these documents but, more fundamentally, from the ambiguity surrounding which entities possess the legitimacy and authority to offer guidance and expect compliance. Furthermore, developers, innovators and communities may not be familiar with the terminology and high-level considerations inherent in such documents, making them challenging to implement. It is essential to establish clear basic standards, if not more generally for DHP, than for youth digital health. These standards should specify which guidelines to follow and which aspects to prioritize, but also offer a transnational perspective, as digital tools often operate across international borders. They should also be accessible for individuals

not trained in ethics, in a format that can be easily understood and applied.

Principles, when identified, are too broad and not translated in actions

Even when a modest number of principles relevant to youth DHP are identified, they tend to be overly broad. Ethics and governance frameworks are often created by policymakers and regulators, referencing more abstract high-level principles. Translation of general principles into concrete actions, based on the context in which a tool is developed and deployed, is needed. Participants mentioned that the broadness of principles is often intended to guide development without overregulating technologies, so innovation can flourish. Moreover, many digital health frameworks and guidance documents provided by international organizations, professional associations or the private sector intentionally maintain broad principles to avoid contradicting country-specific legislation. Yet proliferation of broad principles without actionable recommendations can have negative consequences, such as ‘ethics washing’, with organizations or developers claiming adherence to principles that do not effectively guide policy and practice, hindering the development of ethically aligned innovations. Translation of general principles into more context-specific policies and practices is required to adequately oversee and address technology shortcomings. When ethical values conflict with legal or cultural elements, there should be a reflection on whether to compromise on ethical principles and work within legal and cultural boundaries or revisit regulatory standards to accommodate new perspectives.

Youth input missing in ethics frameworks

In developing governance frameworks for digital health, input from stakeholders involved in the development and use of technologies is necessary, yet seldom included. Particularly for services and tools aimed at youth, it is crucial to incorporate the youth perspective in policy development. Creating opportunities for scenario exploration, dialogue and discussion with young people from the local context is essential for identifying gaps in an ethical framework, distilling common priorities and developing policies to tackle concrete concerns. Therefore, meaningful engagement with end users is justified not only during the technology development phase but also in establishing regulatory standards and ethical guardrails. Yet at this stage of the conversation, workshop participants struggled to define the scope and degree of such engagement, with which youth specifically, will be required to create benefits without disrupting the

process of policy-making. The feasibility and modality of youth interaction should be determined on a case-by-case basis, with awareness that not every policy activity should involve youth in the same way. In order to engage meaningfully, young people should be informed about how DHP works and its local impact, and trained on how to collaborate with adults in policymaking settings.

Ethics frameworks lack adequate enforcement

In LMICs (as in HICs), ethics and policy regulation in the domain of digital health mainly focus on medical devices, with less stringent approaches for other health and wellness tools. Adequate enforcement and accountability mechanisms are often missing for digital health direct-to-consumer products, such as DHP solutions, which are classified as low-risk (Ferretti *et al.*, 2019; Mathews *et al.*, 2019; Guo *et al.*, 2020). Thus, health promotion content on social media or other websites is not regulated, and DHP apps are not tested for safety and quality beyond standards set by the app stores. Moreover, there is no clear process for addressing the lack of scientific validity or misinformation in digital health. Because DHP mainly targets healthy individuals, a group that generally includes AYA, this lack of governance is particularly relevant for them. Participants also noted that tools developed in academic research settings must meet ethics standards for academic research studies and peer-reviewed publication, an additional dimension of accountability beyond tools created in other non-profit or commercial settings (often the case for DHP developed for youth).

PART 3: TRANSLATING RELEVANT ETHICAL PRINCIPLES IN CONTEXTUALIZED POLICIES AND PRACTICES

Participants commented that elements of current digital health ethics frameworks, such as respecting user privacy and addressing discrimination and bias, are also relevant for DHP solutions for young people. Yet they highlighted that certain principles may require a closer look in light of the specific values and socio-cultural perspectives of SSA, and a focus on implications for youth. Participants pointed out that reliance on Western-centric interpretation of ethical principles could make them weaker when deployed across diverse contexts.

Consequently, it is essential to contextualize these principles and create policies to facilitate their implementation in diverse settings. The workshop discussion concentrated on five principles, namely autonomy, equity, safety, accountability and sustainability. In the

following section, we present potential translations of each principle into policy recommendations. The policy roadmap for ethically aligned DHP for youth in SSA (Figure 2) summarizes suggested implementation practices of each policy for different stakeholders (namely policymakers and regulators, as well as developers and implementers).

Autonomy

Autonomy was recognized by participants as respecting the self-determination of individuals who wish to be actively engaged in their own well-being and maintaining good health. This autonomy implies active participation in health decisions, while retaining the choice of how much guidance and nudging to receive—whether from a physician acting in their best interest or from a digital tool that could become overly interfering. Young people need to feel engaged with and heard and have health technologies that are tailored to their needs.

Moreover, autonomy was viewed through the lens of ‘ubuntu’, a cultural concept unique to nations in Africa (Ewuoso and Hall, 2019). In this paradigm, individual decisions are embedded within a communitarian framework, with families and communities contributing to reach agreements that dynamically emerge from these relational engagements. Professional codes of ethics in some sub-Saharan African countries have included the concept of ‘ubuntu’. (Mugumbate *et al.*, 2023) Strong communitarian approaches are often associated with older African generations, and the younger generation tends to practice ‘ubuntu’ more moderately, with greater emphasis on self-interest and personal autonomy (Tusasiirwe *et al.*, 2021). Hence, concepts like relative solidarity (Ogunrin *et al.*, 2018) might better capture the normative tensions experienced by young Africans today (Moodley and Beyer, 2019). Promoting autonomy in terms of relative solidarity through DHP could help young people to become advocates for health literacy and healthy behaviors in their communities, families and professional settings, while still acknowledging the importance of self-determination (Etzioni, 2011).

Additionally, the principle of autonomy was associated with the capacity to control one’s own data, allowing individuals to decide which information to make available to DHP companies and third parties. This includes the right to be withdrawn—a critical aspect for youth who may wish to revisit their agreements as their priorities and needs evolve. In this light, youth need to understand how to protect themselves online and exercise the ability to make decisions about their own health data, while their understanding of privacy and preference for when to contribute their data continue to develop over time.



PRINCIPLES, POLICIES, PRACTICES.

A ROAD MAP FOR ETHICALLY ALLIGNED DIGITAL HEALTH PROMOTION TARGETTING THE YOUTH IN SUB-SAHARAN AFRICA.

AUTONOMY



Tackle digital and health literacy

- Invest more in digital literacy and digital ethics programs from a young age for the public.
- Ensure that digital interfaces are user-friendly and adaptable, based on the user's level of digital and health literacy.
- Promote DHP through advertising and educate young people about the importance of taking care of their own health using publicly recognized figures.

Respect self-determination

- Implement regulations for the right to be forgotten or for users to change their data preferences over time.
- Customize consent forms for young users, making them clear and free of technical jargon.
- Allow for data deletion and removal after a certain period of user inactivity or upon user request.

Respond to users' needs

- Identify and minimize predator-like paternalistic and addictive dynamics within technologies, especially extreme nudging.
- Create DHP repositories categorized by recommended age of use.
- Enable technologies to respond to individual and specific population segment needs, goals, and standards, acknowledging that one-size-fits-all solutions don't work.
- Introduce feedback mechanisms, allowing users to rate tool inputs, and let the tool learn from this feedback.

Adapt to culture and contexts

- Include features for users to share their progress and actions with their community, family, or trusted partners, including physicians.
- Conduct public awareness campaigns highlighting the benefits, limitations, and opportunities of health technologies.

SAFETY



Ensure scientific reliability

- Form multidisciplinary teams of experts to develop technology while addressing safety and quality concerns.
- Ensure transparency regarding data sources used to make recommendations, supported by scientific evidence.
- Implement cross-party checks and reward exemplary companies for ethical practices.

Monitor information quality

- Engage local developers with contextual expertise in both technology and the local environment.
- Periodically assess and update outdated monitoring and evaluation assessments.
- Enhance the capacity of local initiatives with clear data plans and information.
- Include human experts in DHP tools to assist users with data interpretation and information quality, preferably individuals respected by the community.

Keep data secure

- Minimize data collection and usage to protect user privacy.
- Define and enforce policies outlining conditions and responsibilities for sharing data with third parties.
- Invest in cybersecurity and create secure digital spaces.

Protect the most vulnerable

- Adapt tech features to meet the needs of specific youth sub-groups (age 10-14; 15-19; 20-24/30)
- Set conditions for family members to review DHP setting used by the youngest (early teenagers)
- Establish quality standards, safety guidelines, and provide examples of best data collection practices for DHP tools to self-assess.
- Mitigate potential risks to the privacy, economic security, and physical well-being of young people by establishing responsible DHP standards
- Offer training to innovators and users, especially youth, regarding the risks associated with poor-quality tech deployment (such as addressing cyberbullying or indirectly reinforcing unhealthy habits like binge eating)

- Policy Makers & Regulators
- Developers & Implementers
- Policy Makers & Regulators + Developers & Implementers

EQUITY



Increase fair access

- Subsidize data plans and infrastructure costs to ensure wider access to DHPs
- Deploy technologies in public places such as schools, libraries, and youth centres.
- Offer content and informed consent in various formats to accommodate different levels of education and literacy, including visual and audio options.

Reinforce local expertise

- Invest in technical and STEM education and skills development.
- Recruit and train local engineers, UX designers, and innovators.

Promote inclusiveness and engagement

- Conduct awareness campaigns and school activities to educate youth about the use, limitations, and benefits of health technologies.
- Support advocacy groups and youth leaders in sharing health and digital knowledge within their communities and among peers.
- Involve the public, especially youth, in co-designing tech terms and conditions and improving technology over time, allowing contributions and open-source features.

Support just benefit distribution

- Regulate power dynamics between stakeholders, providing incentives for alignment towards public benefit.
- Promote and invest in local companies to boost local gains instead of supporting international corporations.
- Evaluate technology to avoid biases and ensure equity across different youth subgroups, including rural and urban areas.
- Develop technologies that address the needs of the most vulnerable individuals.

ACCOUNTABILITY



Establish oversight mechanisms

- Implement mechanisms for regulating and auditing low-risk digital health tools, with scrutiny levels matching tool complexity and functionality, particularly for technologies impacting minors.
- Establish oversight committees with diverse members, including community representatives and peer technology developers.
- Introduce peer-review mechanisms before approving and releasing technologies to the market.
- Foster engagement and dialogue with the public to gather feedback early, not just at project completion.
- Implement monitoring systems to periodically review the relevance and validity of practices and technologies throughout development, implementation, and efficacy stages.

Foster trust between stakeholders

- Mandate disclosure of conflicts of interest (COI).
- Require transparency in disclosing third-party partnerships and involvement.
- Utilize multi-level accountability mechanisms involving various stakeholders.
- Provide transparent information about how the technology functions, allowing components to be open source, and regularly update users on progress and data usage.
- Collaborate with trusted partners within the community, such as universities, research institutions, NGOs, and local healers.
- Engage youth in activities like focus groups to understand their needs and provide opportunities for feedback, such as rating tools and suggesting improvements.
- Clarify the chain of responsibility in case of problems.
- Include human interactions in technology where necessary, ensuring user engagement.

SUSTAINABILITY



Contain technological waste

- Leverage existing low-tech tools by designing new features compatible with messaging tools and social media, rather than building solutions from scratch (e.g., web services).
- Collaborate with influencers and private sectors that appeal to youth, utilizing existing mechanisms of youth influence and education.

Enable effective and appealing features

- Provide incentives for users to continue relying on DHP tools, such as economic discounts on healthcare services and tech support for achieving individual goals, to ensure that investments in technology are worthwhile in the longer term.
- Develop long-term plans for DHP, considering resource constraints across countries.
- Incorporate interactive features and gamification to maintain user engagement.
- Recognize and endorse exemplary cases of DHP solutions.

Produce adaptable solutions

- Design DHP software and content to be flexible and adaptable to rapidly changing technology and user preferences.
- Create flexible, adaptable, and fast approval standards that can be revised over time and re-evaluated at various stages, including when the tool is already on the market.

Fig. 2: Principles, policies, practices. A roadmap for ethically aligned DHP targeting the youth in sub-Saharan Africa.

To make autonomy actionable, participants recommended broad investment in digital literacy and digital ethics for young people, and ensuring the rights of youth regarding informed consent and control over data preferences. Participants indicated the need to rethink informed consent procedures, to keep pace with fast-evolving technology and the potential for youth to change their minds. Not only should DHP solutions be adapted to specific contexts and cultures but young tech users should be enabled to provide feedback on such tools and be supported to understand the limitations of this technology.

Safety

The discussion around safety emphasized the importance of the confidentiality and security of health data, especially in settings where some health concerns are taboo, or disclosing certain conditions (e.g. sexually transmissible infection, mental health concerns, drug or alcohol misuse) could lead to serious psychological, financial or social harm. Therefore, the conversation about safety primarily focused on the capacity of technology infrastructure to keep youth data safe (regardless of personal preferences for data sharing).

Safety was further interpreted in relation to the quality and scientific reliability of DHP content. DHP solutions should be transparent about their information sources, and the scientific rationale used to formulate behavior recommendations. Transparency and clarity about both information provided and computational processes (such as AI models) embedded in tools would reinforce young people's confidence and trust, as well as their families' acceptance of their use of DHP.

Furthermore, participants argued that increased transparency will help to counter misinformation and misinterpretation which, if left unaddressed, can have harmful consequences, especially for AYAs. Young people are particularly inclined to change their beliefs, attitudes and behaviors when provided with compelling new information; simultaneously their maturity, critical thinking and cognitive capacity are still developing (Howard *et al.*, 2021).

To make the principle of safety actionable, participants stressed the need to create age-specific safety and privacy measures for adolescent tech users. Scientific reliability and information quality must be ensured, including clear disclosure of sources of scientific evidence, and employment of multidisciplinary teams in the process of tech development.

Equity

The discussion on equity in DHP centered on ensuring the fair distribution of technological benefits among stakeholders, preventing some from gaining

disproportionately more than others. This conversation builds upon a global health justice argument, which promotes favoring those in disadvantaged conditions versus those in more prosperous communities. DHP solutions should serve as tools of democratization, extending health knowledge and access to health promotion strategies to youth regardless of socioeconomic background or cultural factors. This is of particular value for young people who have historically been excluded, who are most vulnerable, and for whom DHP may be the only form of health promotion available (e.g. living in rural areas or in poverty).

Equity also meant not only that every stakeholder should have a seat at the table and have the ability to make their voice heard, but that those who are most affected should perhaps have greater representation in proportion to their needs; especially local youth, who should actively participate in developing and co-governing DHP solutions. Workshop participants spoke of community leadership and the importance of local expertise in shaping DHP initiatives.

To make the principle of equity actionable, participants recommended practical steps to ensure fair access to DHP, compensating for educational differences or infrastructure constraints, in addition to meaningful investment in local tech expertise. DHP tools should be designed with awareness of existing biases, prioritizing support of local entrepreneurs and initiatives, so that influence lies foremost within the community.

Accountability

Participants discussed accountability mechanisms in relation to the need to vet technologies for minimum standards of quality, safety and ethical soundness, placing responsibility on developers and deployers for false information, data misuse or unsafe tools.

Moreover, the workshop discussion pointed in the direction of a lack of adequate monitoring for conflicts of interest between various DHP stakeholders. Participants valued awareness of power structures among actors, highlighting the need to reduce these imbalances.

Participants recognized that the virtual dimension of these technologies should not be a reason to exclude guidance from health experts. On the contrary, their involvement should increase the credibility of DHP tools, as reliable resources with concrete implications. Hence, participants discussed the importance of fostering an environment in which all stakeholders can contribute with clarity on their roles and responsibilities.

To make the principles of accountability and responsibility actionable, participants recommended introducing oversight mechanisms for DHP. If not through the creation of specific bodies dedicated to reviewing

these technologies, then at least via pre-market peer review of new tools, early public dialogue to gather feedback, and regulation and auditing procedures that correspond to a tool's risk level in a given context (local evaluation).

Establishing trust among stakeholders, and most importantly with youth, emerged as an additional recommendation to increase accountability. Participants discussed steps such as meaningfully engaging youth at different stages of DHP creation and deployment, incorporating youth and health expert interaction into DHP technology and establishing collaborations with trusted partners, such as universities and local NGOs.

Sustainability

Participants understood the principle of sustainability as encompassing mechanisms to help users select the DHP tool that best fits their needs, with an emphasis on user satisfaction, reducing the likelihood that engagement will drop off. Sustained user engagement means that AYA Health is supported in the long term, likely helping to conserve healthcare resources in the future.

Other participants described sustainability as utilizing existing resources (e.g. exploiting existing technologies) to minimize waste, while developing tools that are easily adaptable, given the fast pace at which technology evolves. At the same time, they acknowledged the limitations of repurposing tools for different aims without first assessing feasibility, and the importance of investment in careful adaptation and system interoperability (LeFevre *et al.*, 2021).

Making sustainability actionable translates into minimizing technological waste, enabling effective and appealing tools features and producing adaptable DHP solutions. Participants believed that measures such as encouraging the use of existing tools, designing flexible technology for a rapidly evolving environment, integrating incentives and gamification to encourage sustained use, and adequately engaging influencers and private sector entities to better appeal to youth, would serve to realize these policies in practice.

CONCLUSION

In this article, we explored and analyzed expert perspectives on unresolved challenges, existing ethical and regulatory approaches, and the policy path forward for the development and adoption of DHP tools for youth in LMICs, particularly in SSA. Our thematic analysis of the workshop outcomes identified and explored three key aspects.

First, participants agreed on the imperative to address barriers and shortcomings that DHP faces in

LMICs, so that the health of youth can benefit from this technology. Second, our workshop highlighted the absence of specific ethical frameworks for DHP for youth in LMICs, suggesting that the ethical principles of existing digital health frameworks can serve as a foundation, but require further adaptation based on the specific context and input of local youth. Minimal regulation of DHP tools, as well as the entities and innovators that develop and distribute them, can strengthen the reputation of this technology and encourage greater adoption among young people. Finally, participants reflected on ethical issues related to DHP, contextualized in SSA; such conversations thematically clustered around the principles of autonomy, safety, equity, accountability and sustainability. Such principles require a translation into concrete policy and practice interventions, in order to improve future development and implementation of DHP in SSA. This policy roadmap, collecting sixty specific recommendations (Figure 2), calls on both policymakers and regulators, as well as developers and implementers, to take concrete action toward establishing ethically aligned DHP that puts youth at the center. The next steps consist of implementing such a wide range of actions. Among others, these include collaborating with influencers and areas of the private sector that appeal to youth; creating DHP repositories grouped by recommended age of use; engaging youth in activities like focus groups, to better understand their needs and deploying health technologies in public places like schools, libraries and youth centers. While implementation processes should be further adapted and refined in each SSA country, we believe that this article and policy roadmap offer solid starting guidance.

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A.F. and E.V. organized and ran the World Café Activity, as well as collected the data. A.F. conducted the data analysis and drafted the manuscript. E.V. was the senior author responsible for acquiring the grant that funded this project and edited the manuscript. This article reports the findings and conclusions from a collaborative, participatory World Café workshop. All authors participated in and collaborated during the workshop, and in so doing contributed substantially to the intellectual content of this article. All authors approved the final version of the manuscript.

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CONFLICT OF INTEREST

None declared.

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