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Access to digital media and devices among adolescents in sub-Saharan Africa: A multicountry, school-based survey

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Abstract

Digital technologies provide unprecedented opportunities for health and nutrition interventions among adolescents. The use of digital media and devices among young adolescents across diverse settings in sub-Saharan Africa is unclear. This cross-sectional study aimed to assess the use of digital media and devices and the socioeconomic determinants of use among young adolescents in Burkina Faso, Ethiopia, South Africa, Sudan and Tanzania. The study included 4981 adolescents aged 10–15 from public schools selected by multistage sampling. Access to various digital media and devices was self-reported by adolescents. Logistic regression models were used to estimate the odds ratios (ORs) and 95% confidence intervals (CIs) for the associations between sociodemographic characteristics and access to digital media and devices. Approximately 40% of the adolescents in Burkina Faso and South Africa, 36% in Sudan, 13% in Ethiopia and 3% in Tanzania owned mobile phones. Compared with boys, girls had a lower ownership of mobile phones

(odds ratio [OR] = 0.79; 95% confidence interval [CI]: 0.68, 0.92; $p = 0.002$), computers (OR = 0.83; 95% CI: 0.70, 0.99; $p = 0.04$) and social media accounts (OR = 0.68; 95% CI: 0.56, 0.83; $p < 0.001$). Higher maternal education and greater household wealth were positively associated with access to digital media and devices. While digital media and devices are promising platforms for interventions in some settings due to relatively high levels of access, their utility in delivering health and nutrition interventions to adolescents in these contexts should be further examined.

KEYWORDS

adolescent, cell phone, cross-sectional studies, digital divide, internet access, social media, sub-Saharan Africa

1 | INTRODUCTION

The vast majority of the world's adolescents live in low- and middle-income countries (LMICs) (Sheehan et al., 2017). Sub-Saharan Africa is the world region where adolescents make up the greatest proportion of the population (Cappa et al., 2012) and is projected to have nearly 400 million adolescents by 2050 (Cappa et al., 2012). Therefore, it is a crucial geographical region for adolescent health and nutrition monitoring and interventions. Adolescents in sub-Saharan Africa, however, have historically been neglected in health and nutrition programming, with insufficient surveillance, research or intervention efforts targeting this overlooked age group (Gates, 2016).

In recent years, sub-Saharan Africa has seen exponential growth in the coverage of internet and cellular network and an increase in digital device ownership (Adler, 2007; Cole-Lewis & Kershaw, 2010; International Telecommunication Union, 2008; Lasica, 2007; Swarts & Wachira, 2010). Adolescents are one of the 'most connected' populations on the planet. Globally, 71% of youth aged 15–24 are 'online' compared with 48% in the general population (Keeley & Little, 2017). Accumulating evidence suggests that children are accessing the internet at increasingly younger ages and that children under 15 years in some settings have similar internet access levels of access as adults aged over 25 (Keeley & Little, 2017). There are, however, more men than women with access to the internet around the world; this digital gender gap is related to the broader gender inequalities and seems to be still widening (International Telecommunication Union, 2015).

Digital platforms are ubiquitous and can be used to deliver personalized messages targeted to individual characteristics and needs. Therefore, digital platforms are promising vehicles for health promotion. Digital platforms may have unique utility in settings with numerous barriers to routine healthcare and health education. Previous maternal and child health projects in sub-Saharan Africa have leveraged digital technologies such as text messaging to improve the health of mothers and their newborn children (Barron et al., 2018; Hackett et al., 2018; Kaufman et al., 2017). Among adolescents in LMICs, digital interventions have focused on sexual and reproductive health, HIV prevention and mental health; accumulating findings from digital interventions suggest that digital media and devices are an effective channel to reach young people in LMICs, to impart knowledge, and to achieve behavior changes (Chandra et al., 2014; Hightow-Weidman et al., 2015; Ippoliti & L'Engle, 2017; Rokicki & Fink, 2017). Few efforts, however, have used digital platforms to improve adolescent nutrition in sub-Saharan Africa. A major obstacle to implementing and scaling up of digital interventions among adolescents is the lack of evidence on their access to digital media and devices. The proportions of adolescents in sub-Saharan Africa with access to various digital media and devices have been investigated in only a few studies and mostly among older adolescents aged 15 and above (Doyle et al., 2021; Gunnlaugsson et al., 2020; Pfeiffer et al., 2014). The access to digital media and devices among young adolescents aged 10–14 and the determinants of access across diverse settings in sub-Saharan Africa are unclear.

Key messages

- There is considerable variation in adolescents' access to digital media and devices across settings in sub-Saharan Africa.
- Access to someone else's phone is the most common channel of digital connection among sub-Saharan African adolescents.
- Male sex, higher maternal education and higher household wealth are associated with greater access to digital media and devices among sub-Saharan African adolescents.
- While digital media and devices are promising platforms for interventions in some settings due to relatively high levels of access, their utility in delivering health and nutrition interventions to adolescents in these contexts should be further examined.

For designing and implementing digital health and nutrition interventions that target young adolescents in sub-Saharan Africa, it is essential to understand their digital connectivity. In this multicountry school-based survey, we aimed to assess the use of digital media and devices among young adolescents aged 10–15. We also aimed to examine socioeconomic determinants of access to digital media and devices among young adolescents.

2 | METHODS

2.1 | Study setting and study design

This analysis used a school-based, cross-sectional survey of young adolescents from five sub-Saharan African countries. The survey was conducted by the Africa Research, Implementation Science and Education (ARISE) Network (Darling et al., 2020). The objective of the survey was to understand the distributions and determinants of health and nutrition of in-school young adolescents aged 10–15.

The study was conducted in urban settings in five sub-Saharan African countries, namely Ouagadougou in Burkina Faso, Addis Ababa in Ethiopia, Durban in South Africa, Khartoum State in Sudan and Dar es Salaam in Tanzania. The study sites, the number of schools and the number of participants per site were determined based on budget allocations, infrastructure, networking with government agencies and schools and research team capacity. The cross-sectional surveys were conducted between March and December 2020.

We used multistage sampling to select schools and adolescents within each school. First, we randomly selected urban or semi-urban administrative units in each city. We selected 5 arrondissements in Ouagadougou, 10 boroughs in Addis Ababa, 2 educational districts in Durban, 4 localities in Khartoum State and 5 administrative districts in Dar es Salaam. Then, we randomly selected public schools in each administrative unit. We included 22 schools in Burkina Faso (approximately 4 schools per arrondissement), 20 schools in Ethiopia (2 schools per borough), 20 schools in South Africa (10 schools per educational district), 12 schools in Sudan (3 schools per locality) and 20 schools in Tanzania (4 schools per administrative district). Finally, we randomly selected approximately 60 adolescents from each school, resulting in approximately 1200 adolescents per country. In Ethiopia, South Africa, Sudan and Tanzania, we enrolled girls and boys aged 10–14 in public primary schools; in Burkina Faso, to account for the different setups of the educational system, girls and boys aged 11–15 were enrolled in public secondary schools. We excluded adolescents who refused to participate, were too ill to be interviewed or were absent during data collection. The coronavirus disease 2019 (COVID-19) pandemic caused disruptions in data collection in South Africa, so only 364 adolescents from 7 schools were enrolled.

2.2 | Data collection

All consenting adolescents were interviewed face-to-face by trained interviewers in local languages using a standardized questionnaire. We developed the questionnaire by adapting from the widely used Global School-based Student Health Survey (World Health Organization, 2019), the ARISE Network Adolescent Health Study Questionnaire (Darling et al., 2020) and other relevant resources (Ballard et al., 2011; Chandra-Mouli et al., 2017; Kennedy et al., 2010; Milner et al., 2008) to ensure the appropriateness of the survey for young adolescents.

The adolescent survey included questions on demographic characteristics, socioeconomic status and media access. The section on access to digital media and devices included five questions, namely (1) access to own cell or a mobile phone; (2) access to someone else's cell or a mobile phone; (3) access to a computer, laptop, or tablet (e.g., iPad); (4) access to social media account or text/chat account (e.g., Facebook, Twitter, Instagram, WhatsApp); and (5) access to the internet at home. The possible answers for each question were 'Yes', 'No', 'Don't know' and 'Refuse to answer'. We obtained written parental consent and adolescent assent, and the interviews were held in private settings within the schools.

2.3 | Data analysis

We calculated the mean and standard deviation (SD) for continuous variables and the count and percentage for categorical variables by country. We calculated for each country the percentages of access to the five types of digital media and devices; the standard errors (SEs) of the percentages were calculated, accounting for clustering by school. We treated 'Don't know' and 'Refuse to answer' as missing data in the analyses.

We examined the associations between sociodemographic characteristics and the five types of digital media and devices. The sociodemographic characteristics included age and sex of the adolescent, maternal education, paternal education and quintiles of household wealth index. We constructed the household wealth index based on household asset ownership (17 assets such as electricity, radio, television and refrigerator) using principal component analysis (Filmer & Pritchett, 2001). We used the missing indicator method to account for missing data for maternal and paternal education by collapsing them into a separate category in the analyses.

We used logistic regression models to calculate the odds ratios (ORs) and 95% confidence intervals (CIs) and used generalized estimating equations to account for clustering by country and school in all models. Multivariate models were additionally adjusted for other characteristics based on data availability and a directed acyclic graph depicting the potential causal relationships (Supporting Information: Figure 1). The primary analyses used the data from all countries pooled together. We conducted secondary country-specific analyses within each country to explore potentially different determinants by country.

We conducted all analyses using SAS 9.4 (SAS Institute Inc.). We maintained a two-sided α level of 0.05 and did not adjust for multiple testing resulting from the examination of numerous types of digital media and devices and their potential determinants. The study aimed to discover potentially important determinants for further investigation, so quantitative adjustments for multiple testing would have inflated the probability of type II error and masked potential associations (Rothman, 1990).

2.4 | Ethics statement

This study was approved by the Institutional Review Boards at Harvard T.H. Chan School of Public Health, the Ethics Committee of the Medical Faculty of Heidelberg University, and ethical review boards in each site, including the Centre de Recherche en Santé de Nouna in Burkina Faso, the Institutional Ethical Review Board of Addis Continental Institute of Public Health in Ethiopia, the University of KwaZulu-Natal Biomedical Research Ethics Committee in South Africa, the Institutional Review Board of Ahfad University for Women in Sudan, and the National Institute for Medical Research in Tanzania.

3 | RESULTS

3.1 | General characteristics

In total, 4981 adolescents from the five countries participated in the study, including 1059 from Burkina Faso, 1200 from Ethiopia, 364 from South Africa, 1101 from Sudan and 1257 from Tanzania (Table 1). The sex distribution of the adolescents was roughly balanced between girls and boys, with the proportion of girls ranging from 50% in Sudan to 57% in Burkina Faso. The mean age (and standard deviation) of the adolescents was 13.5 (1.2) years in Burkina Faso, 12.6 (1.2) years in Ethiopia, 11.5 (1.2) years in South Africa, 12.1 (1.3) years in Sudan and 11.6 (1.2) years in Tanzania.

3.2 | Access to digital media and devices

The percentage of young adolescents who owned mobile phones was 3% in Tanzania, 13% in Ethiopia, 36% in Sudan and 40% in Burkina Faso and South Africa (Table 2). The percentage with access to any (own or someone else's) phone was 56% in Tanzania, 70% in Burkina Faso, 80% in Ethiopia, 84% in South Africa and 95% in Sudan. Across all countries, boys had a greater ownership of mobile phones and greater access to social media accounts (Table 3).

3.3 | Determinants of access to mobile phone

Girls had 21% lower odds of owning mobile phones compared with boys (odds ratio [OR] = 0.79; 95% confidence interval [CI]: 0.68, 0.92; $p = 0.002$) (Table 4). Compared with adolescents whose mothers had no education, adolescents whose mothers had vocational or university education had 2.2 times the odds of owning mobile phones (OR = 2.21; 95% CI: 1.66, 2.94; $p < 0.001$) and 73% higher odds of access to any phone (OR = 1.73; 95% CI: 1.27, 2.36; $p < 0.001$). Greater household wealth was positively associated with all types of mobile phone access. Compared with adolescents in the lowest quintile of household wealth, adolescents in the highest quintile of household wealth had 4.2 times the odds of owning mobile phones (OR = 4.23; 95% CI: 3.06, 5.85; $p < 0.001$), 56% higher odds of access to someone else's phone (OR = 1.56; 95% CI: 1.22, 1.99; $p < 0.001$) and 2.3 times the odds of access to any phone (OR = 2.33; 95% CI: 1.77, 3.07; $p < 0.001$).

3.4 | Determinants of access to other digital media and devices

Girls had 17% lower odds of access to a computer (OR = 0.83; 95% CI: 0.70, 0.99; $p = 0.04$) and 32% lower odds of access to social media account (OR = 0.68; 95% CI: 0.56, 0.83; $p < 0.001$) compared with boys (Table 5). Compared with adolescents whose mothers had no education, adolescents whose mothers had vocational or university education had 3.8 times the odds of access to a computer (OR = 3.78; 95% CI: 2.75, 5.19; $p < 0.001$), 3.1 times the odds of access to social media account (OR = 3.10; 95% CI: 2.15, 4.46; $p < 0.001$) and 94% higher odds of access to the internet at home (OR = 1.94; 95% CI: 1.46, 2.56; $p < 0.001$). Adolescents in the highest quintile of household wealth had 10 times the odds of access to a computer (OR = 9.98; 95% CI: 7.39, 13.49; $p < 0.001$), 3.7 times the odds of access to social media account (OR = 3.68; 95% CI: 2.43, 5.58; $p < 0.001$) and 2.3 times the odds of access to the internet at home (OR = 2.27; 95% CI: 1.90, 2.70; $p < 0.001$), compared with adolescents in the lowest quintile of household wealth. Secondary country-specific analyses showed that the determinants of access to digital media and devices did not seem to materially differ across countries (Supporting Information: Tables 1-5).

4 | DISCUSSION

In this school-based survey conducted among young adolescents in five sub-Saharan African countries, we report considerable variation in access to digital media and devices across settings. Access to someone else's phone was the most common channel of digital connection across sites, followed by own phone. Access to social media accounts appeared low in all countries. Sex, maternal education and household wealth were associated with access to digital media and devices among young adolescents.

Sub-Saharan Africa has seen exponential growth in digital device ownership and internet and cellular network access in recent years (Swarts & Wachira, 2010). With growing access to digital media and

TABLE 1 General characteristics of adolescents in a school-based survey in five sub-Saharan African countries[a]

	Ouagadougou, Burkina Faso	Addis Ababa, Ethiopia	Durban, South Africa	Khartoum, Sudan	Dar es Salaam, Tanzania
N	1059	1200	364	1101	1257
Girls, %	603 (56.9)	657 (54.8)	205 (56.3)	553 (50.2)	656 (52.2)
Age, years	13.5 (1.2)	12.6 (1.2)	11.5 (1.2)	12.1 (1.3)	11.6 (1.2)
Age, %					
10 years	0 (0)	54 (4.5)	94 (25.8)	153 (13.9)	266 (21.2)
11 years	68 (6.4)	188 (15.7)	100 (27.5)	229 (20.8)	321 (25.5)
12 years	167 (15.8)	294 (24.5)	89 (24.5)	261 (23.7)	362 (28.8)
13 years	253 (23.9)	344 (28.7)	63 (17.3)	273 (24.8)	203 (16.2)
14 years	298 (28.1)	320 (26.7)	18 (5.0)	185 (16.8)	105 (8.4)
15 years	273 (25.8)	0 (0)	0 (0)	0 (0)	0 (0)
Maternal education[b], %					
No education	311 (29.4)	225 (20.5)	7 (2.1)	20 (1.9)	33 (3.0)
Primary education	169 (16.0)	430 (39.2)	23 (6.7)	46 (4.3)	462 (41.7)
Secondary education	212 (20.0)	251 (22.9)	166 (48.7)	306 (28.3)	159 (14.3)
Technical/vocational or university education	79 (7.5)	67 (6.1)	55 (16.1)	512 (47.4)	73 (6.6)
Do not have female guardian	126 (11.9)	0 (0)	0 (0)	0 (0)	0 (0)
Do not know maternal education level	162 (15.3)	125 (11.4)	90 (26.4)	196 (18.2)	382 (34.5)
Paternal education[c], %					
No education	178 (16.8)	62 (7.9)	3 (1.6)	11 (1.1)	19 (2.2)
Primary education	140 (13.2)	264 (33.7)	11 (5.8)	16 (1.5)	283 (32.2)
Secondary education	183 (17.3)	237 (30.3)	83 (43.5)	159 (15.3)	114 (13.0)
Technical/vocational or university education	149 (14.1)	99 (12.6)	36 (18.9)	668 (64.4)	81 (9.2)
Do not have male guardian	195 (18.4)	0 (0)	0 (0)	0 (0)	0 (0)
Do not know education level	214 (20.2)	121 (15.5)	58 (30.4)	183 (17.7)	381 (43.4)
Household wealth, %					
First quintile	186 (17.6)	282 (23.5)	31 (8.5)	106 (9.6)	385 (30.6)
Second quintile	190 (17.9)	409 (34.1)	52 (14.3)	69 (6.3)	283 (22.5)
Third quintile	189 (17.9)	266 (22.2)	111 (30.5)	179 (16.3)	249 (19.8)
Fourth quintile	175 (16.5)	158 (13.2)	75 ((20.6)	335 (30.4)	255 (20.3)
Fifth quintile	319 (30.1)	85 (7.1)	95 (26.1)	412 (37.4)	85 (6.8)

[a]Values are mean (standard deviation) for continuous variables and count (percentage) for categorical variables. The percentages may not add up to 100% due to rounding.

[b]One hundred and two adolescents from Ethiopia, 23 from South Africa, 21 from Sudan and 148 from Tanzania had missing information on maternal education level.

[c]Four hundred and seventeen adolescents from Ethiopia, 173 from South Africa, 64 from Sudan and 379 from Tanzania had missing information on paternal education level.

devices, digital platforms are potent channels for health and nutrition promotion. Digital technologies make personally tailored and context-specific interventions possible and enable engagement on topics of taboo and potential social stigma (Barnett et al., 2020; Cole-Lewis & Kershaw, 2010). Previous projects in sub-Saharan Africa have successfully implemented digital technologies such as text messaging to address maternal and child health (Barron et al., 2018; Hackett et al., 2018; Kaufman et al., 2017).

Digital interventions allow for easier engagements with out-of-school adolescents who are difficult or impossible to reach in school

TABLE 2 Access to digital media and devices among adolescents in a school-based survey in five sub-Saharan African countries[a]

	Ouagadougou, Burkina Faso	Addis Ababa, Ethiopia	Durban, South Africa	Khartoum, Sudan	Dar es Salaam, Tanzania
N	1059	1200	364	1101	1257
Possession of own phone	39.8 (2.9)[b]	13.1 (1.5)[c]	39.6 (4.4)	35.6 (4.7)[b]	3.3 (0.9)[c]
Access to someone else's phone	54.4 (2.6)	77.3 (2.5)	69.8 (2.8)	89.9 (2.6)[b]	55.4 (2.5)[d]
Access to computer, laptop, or tablet	18.0 (3.2)	14.5 (1.7)	37.1 (6.9)	56.5 (7.5)	10.1 (2.1)
Access to social media account	15.0 (2.3)	6.4 (0.5)[e]	27.7 (3.8)	24.9 (4.0)	1.8 (0.3)
Internet at home	12.4 (2.6)[e]	3.5 (0.7)[f]	23.4 (6.3)[g]	66.7 (8.2)[c]	2.8 (0.8)[b]
Access to any (own or someone else's) phone	69.8 (2.6)[b]	79.7 (2.2)[b]	84.3 (2.3)	95.4 (1.5)	55.7 (2.5)[f]
Access to any phone and social media account	14.9 (2.3)	6.2 (0.6)[f]	26.9 (3.8)	24.5 (4.0)	1.6 (0.3)
Access to any phone, social media account, computer/laptop/tablet, and internet at home	2.9 (1.0)	0.3 (0.1)	7.5 (3.7)[d]	20.6 (4.1)	0.2 (0.1)

[a]Values are percentage (standard error of percentage) accounting for the clustered design.
[b]One adolescent had missing information.
[c]Two adolescents had missing information.
[d]Three adolescents had missing information.
[e]Five adolescents had missing information.
[f]Four adolescents had missing information.
[g]Nine adolescents had missing information.

settings. However, digital interventions among adolescents in sub-Saharan Africa have not expanded much from the niche of sexual and reproductive health, HIV prevention and mental health (Hightow-Weidman et al., 2015; Ippoliti & L'Engle, 2017; Rokicki & Fink, 2017) into other realms, such as the promotion of balanced diet, physical activity and healthy lifestyle. A systematic review of digital interventions for improving adolescents' dietary behaviors and physical activity concludes that digital interventions that incorporate education, goal setting, self-monitoring and parental involvement are feasible to effect significant health behavior changes in adolescents (Rose et al., 2017). However, almost all studies identified in this review were from high-income countries, with no studies from sub-Saharan Africa.

The lack of data on access to digital media and devices among adolescents in sub-Saharan Africa presents a challenge for providing digital interventions in this setting. Our study fills this knowledge gap by assessing the access to various digital media and devices among adolescents across multiple sub-Saharan African countries. We find appreciable variation in digital connectivity, with young adolescents in Sudan and South Africa having the highest access to digital media and devices. Notably, almost all participants in Sudan had access to their own or shared phones. On the other hand, young adolescents in Dar es Salaam, Tanzania, had the lowest access to digital media and devices, with approximately half of the young adolescents having access to their own or shared phones. This finding is in contrast to a study in Dar es Salaam which reported that over 70% of adolescents aged 15–19 had access to their own mobile phones (Pfeiffer et al., 2014). This discrepancy may be explained by the potentially high technology use among older adolescents. Our findings are consistent with the limited literature that suggests a wide variability in access to digital media and devices across settings. For example, a recent population-based survey in Zimbabwe showed that over 60% of adolescents and young adults aged 13–24 owned a phone, and an additional 4% had access to a shared phone (Doyle et al., 2021). In contrast, a school-based survey in Guinea-Bissau found that one-third of adolescents in secondary schools used mobile internet daily, and many had no experience with digital technology (Gunnlaugsson et al., 2020). Therefore, digital platforms may have greater utility in certain contexts, and future digital interventions must consider the penetration of digital media and devices before implementing the interventions.

The generally high use of own or shared phones across sites suggests the potential of mobile-phone-based interventions, such as those based on text messaging, among sub-Saharan African adolescents. However, access to mobile phones appears largely shared with other household members. To our knowledge, the feasibility of providing digital health and nutrition interventions to adolescents through someone else's phone has not been examined in sub-Saharan Africa. Confidentiality and privacy issues must be considered when adolescents receive mobile interventions through someone else's device. Future research should explore in various settings the potential of delivering health messages to adolescents through shared devices. Access to social media accounts appears low (less than 30%) on all sites. Therefore, digital health and nutrition interventions based on social media platforms may need to be combined with more traditional channels, such as mobile phone texting, to have optimal impacts.

Adolescent boys had higher ownership of mobile phones than girls in our study. A possible explanation is that adult guardians may

TABLE 3 Access to digital media and devices among adolescents in a school-based survey in five sub-Saharan African countries, by country and sex[a]

	Ouagadougou, Burkina Faso		Addis Ababa, Ethiopia		Durban, South Africa		Khartoum, Sudan		Dar es Salaam, Tanzania	
	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Boys
N	603	456	657	543	205	159	553	548	656	601
Possession of own phone	34.4 (3.1)[b]	46.9 (3.0)	12.2 (1.4)[c]	14.2 (2.0)	34.6 (6.3)	45.9 (3.5)	35.1 (4.7)[b]	36.1 (8.1)	2.4 (1.1)[b]	4.3 (1.4)[b]
Access to someone else's phone	51.6 (3.1)	58.1 (3.7)	78.5 (2.2)	75.7 (3.5)	67.8 (3.8)	72.3 (3.1)	89.7 (4.1)[b]	90.1 (3.4)	56.4 (1.9)	54.3 (3.9)[d]
Access to computer, laptop, or tablet	11.4 (1.8)	26.8 (5.4)	14.3 (1.8)	14.7 (2.0)	34.6 (8.3)	40.3 (7.3)	63.5 (9.7)	49.5 (10.6)	9.3 (2.2)	11.0 (2.4)
Access to social media account	9.6 (1.7)	22.1 (3.2)	6.0 (0.6)[e]	6.8 (1.0)[b]	24.9 (2.8)	31.4 (6.9)	23.9 (4.4)	25.9 (6.7)	1.5 (0.4)	2.2 (0.6)
Internet at home	8.5 (1.8)[e]	17.6 (4.4)[b]	3.4 (0.7)[b]	3.7 (1.1)[d]	23.4 (5.4)[e]	23.4 (8.2)[f]	76.8 (8.9)[b]	56.5 (12.2)[b]	2.9 (1.0)[b]	2.7 (1.1)
Access to any (own or someone else's) phone	65.3 (2.9)[b]	75.7 (3.4)	81.1 (2.0)[b]	78.1 (3.1)	83.4 (2.3)	85.5 (2.8)	97.3 (1.3)	93.4 (2.6)	56.6 (1.9)[b]	54.7 (3.9)[d]
Access to any phone and social media account	9.6 (1.7)	21.9 (3.3)	5.8 (0.6)[d]	6.6 (1.1)[b]	24.4 (3.0)	30.2 (6.5)	23.5 (4.5)	25.5 (6.8)	1.4 (0.4)	1.8 (0.5)
Access to any phone, social media account, computer/laptop/tablet, and internet at home	1.7 (0.4)	4.6 (1.9)	0.3 (0.2)	0.2 (0.2)	6.9 (3.2)[b]	8.3 (4.9)[c]	19.9 (4.6)	21.4 (6.8)	0.2 (0.2)	0.2 (0.2)

[a]Values are percentage (standard error of percentage) accounting for the clustered design.

[b]One adolescent had missing information.

[c]Two adolescents had missing information.

[d]Three adolescents had missing information.

[e]Four adolescents had missing information.

[f]Five adolescents had missing information.

TABLE 4 Associations between sociodemographic characteristics and access to mobile phones among adolescents in a school-based survey in five sub-Saharan African countries[a]

	Possession of own phone		Access to someone else's phone		Access to any (own or someone else's) phone	
	Univariate	Multivariate	Univariate	Multivariate	Univariate	Multivariate
Age of adolescent, years	1.39 (1.31, 1.47)	1.46 (1.37, 1.55)	1.01 (0.96, 1.06)	1.02 (0.97, 1.06)	1.09 (1.03, 1.15)	1.10 (1.04, 1.16)
Sex						
Boys	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Girls	0.77 (0.68, 0.87)	0.79 (0.68, 0.92)	0.98 (0.83, 1.15)	0.99 (0.84, 1.17)	0.96 (0.81, 1.15)	1.01 (0.84, 1.21)
Maternal education						
No education	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Primary education	1.36 (1.09, 1.70)	1.41 (1.14, 1.75)	0.93 (0.73, 1.18)	0.91 (0.70, 1.17)	0.93 (0.73, 1.18)	0.93 (0.71, 1.20)
Secondary education	1.93 (1.55, 2.42)	1.93 (1.53, 2.42)	1.49 (1.19, 1.87)	1.34 (1.04, 1.74)	1.80 (1.42, 2.28)	1.66 (1.27, 2.17)
Technical/vocational or university	2.17 (1.64, 2.86)	2.21 (1.66, 2.94)	1.55 (1.19, 2.02)	1.36 (1.00, 1.85)	1.91 (1.48, 2.48)	1.73 (1.27, 2.36)
Paternal education						
No education	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Primary education	0.98 (0.66, 1.45)	0.82 (0.55, 1.20)	0.91 (0.65, 1.26)	0.91 (0.64, 1.29)	0.88 (0.62, 1.25)	0.88 (0.60, 1.27)
Secondary education	1.34 (0.95, 1.91)	1.10 (0.76, 1.59)	1.46 (1.04, 2.04)	1.34 (0.93, 1.94)	1.50 (1.06, 2.14)	1.33 (0.91, 1.94)
Technical/vocational or university	1.67 (1.11, 2.50)	1.26 (0.83, 1.92)	1.60 (1.17, 2.19)	1.39 (0.96, 2.01)	1.78 (1.26, 2.50)	1.42 (0.95, 2.12)
Household wealth						
First quintile	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Second quintile	1.64 (1.31, 2.06)	1.70 (1.31, 2.20)	1.21 (1.00, 1.46)	1.17 (0.97, 1.41)	1.26 (1.04, 1.53)	1.21 (1.00, 1.46)
Third quintile	1.88 (1.53, 2.32)	1.98 (1.57, 2.50)	1.33 (1.07, 1.64)	1.25 (1.01, 1.55)	1.50 (1.18, 1.90)	1.40 (1.11, 1.77)
Fourth quintile	2.66 (2.13, 3.32)	2.73 (2.11, 3.53)	1.81 (1.48, 2.23)	1.64 (1.34, 2.02)	2.19 (1.75, 2.75)	1.96 (1.55, 2.47)
Fifth quintile	4.15 (3.17, 5.44)	4.23 (3.06, 5.85)	1.78 (1.40, 2.26)	1.56 (1.22, 1.99)	2.70 (2.06, 3.52)	2.33 (1.77, 3.07)

[a]Values are odds ratios (95% confidence intervals) from logistic regression models and generalized estimating equations accounting for clustering by country and school. The multivariate analyses adjusted for other characteristics in the table; the multivariate analyses for maternal and paternal education did not adjust for household wealth as it could be a mediator. Missing data on maternal and paternal education were accounted for by using the missing indicator method.

be more likely to purchase mobile phones for boys, and boys may also be more likely to engage in paid work and gain income used to purchase digital devices (De Wet, 2013). We also find that higher maternal education and greater household wealth were associated with greater access to all forms of digital media and devices. This observation may be due to the higher socioeconomic status of the household, as wealthier families might be more likely to purchase mobile phones for adolescents in the household and install in-home internet. This finding is consistent with the survey among adolescents and young adults in Zimbabwe, which showed that internet access was higher among males, phone owners and those with a higher level of education (Doyle et al., 2021). In Guinea-Bissau, gender, educational institution, parental education and economic status were also associated with the use of digital technology among adolescents attending secondary schools (Gunnlaugsson et al., 2020). The lack of associations with paternal education in our study may be because many adolescents reside in female-headed households (with their mothers or maternal grandmothers) instead of living with their fathers, resulting in the disproportionately high impacts of maternal socioeconomic status. Future digital health and nutrition interventions in sub-Saharan Africa should avoid exacerbating inequalities as vulnerable groups (girls and those from disadvantaged households) are less likely to access digital technologies.

The strengths of this study are the large sample size, the coverage of multiple types of access to digital media and devices and the inclusion of multiple countries in sub-Saharan Africa. This study also has some limitations. First, due to the school-based sampling, our sample did not include out-of-school adolescents, for whom the use of digital media and devices needs further investigation. Exploration of digital delivery of nutrition interventions to out-of-school adolescents is needed, given that out-of-school adolescents are harder to reach through school settings, and the use of digital

TABLE 5 Associations between sociodemographic characteristics and access to digital media and devices (other than mobile phones) among adolescents in a school-based survey in five sub-Saharan African countries[a]

	Access to computer, laptop, or tablet		Social media		Internet at home	
	Univariate	Multivariate	Univariate	Multivariate	Univariate	Multivariate
Age of adolescent, years	1.02 (0.97, 1.07)	1.02 (0.97, 1.07)	1.39 (1.30, 1.49)	1.44 (1.33, 1.56)	1.04 (1.00, 1.08)	1.04 (0.99, 1.08)
Sex						
Boys	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Girls	0.82 (0.72, 0.94)	0.83 (0.70, 0.99)	0.68 (0.59, 0.79)	0.68 (0.56, 0.83)	0.92 (0.84, 1.02)	0.94 (0.84, 1.05)
Maternal education						
No education	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Primary education	1.93 (1.53, 2.42)	1.91 (1.52, 2.39)	1.18 (0.84, 1.66)	1.25 (0.89, 1.75)	1.29 (1.10, 1.52)	1.27 (1.08, 1.50)
Secondary education	2.88 (2.22, 3.74)	2.54 (1.94, 3.23)	2.34 (1.68, 3.26)	2.40 (1.73, 3.32)	1.76 (1.46, 2.12)	1.67 (1.39, 2.01)
Technical/vocational or university	4.75 (3.45, 6.53)	3.78(2.75, 5.19)	3.11 (2.15, 4.50)	3.10 (2.15, 4.46)	2.09(1.59, 2.74)	1.94 (1.46, 2.56)
Paternal education						
No education	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Primary education	1.02 (0.78, 1.32)	0.79 (0.59, 1.05)	0.77 (0.49, 1.20)	0.65 (0.40, 1.06)	1.08 (0.87, 1.33)	0.96 (0.76, 1.20)
Secondary education	1.76 (1.33, 2.33)	1.26 (0.93, 1.70)	1.12 (0.74, 1.69)	0.89 (0.57, 1.39)	1.34 (1.07, 1.69)	1.11 (0.88, 1.41)
Technical/vocational or university	2.87 (2.11, 3.91)	1.77 (1.28, 2.46)	1.90 (1.22, 2.97)	1.34 (0.81, 2.20)	1.55 (1.22, 1.97)	1.18 (0.91, 1.53)
Household wealth						
First quintile	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)	1.00 (Ref)
Second quintile	1.77 (1.41, 2.22)	1.86 (1.42, 2.43)	1.08 (0.82, 1.42)	1.07 (0.77, 1.50)	0.95 (0.86, 1.04)	0.92 (0.82, 1.02)
Third quintile	2.60 (1.99, 3.40)	2.70 (2.01, 3.63)	1.47 (1.09, 1.99)	1.53 (1.06, 2.20)	1.36 (1.19, 1.54)	1.32 (1.15, 1.50)
Fourth quintile	6.28 (4.90, 8.06)	6.24 (4.77, 8.18)	2.88 (2.10, 3.95)	2.82 (1.94, 4.10)	1.74 (1.46, 2.06)	1.62 (1.37, 1.93)
Fifth quintile	10.60 (7.99, 14.06)	9.98 (7.39, 13.49)	4.02 (2.83, 5.71)	3.68 (2.43, 5.58)	2.47(2.05, 2.97)	2.27 (1.90, 2.70)

[a]Values are odds ratios (95% confidence intervals) from logistic regression models and generalized estimating equations accounting for clustering by country and school. The multivariate analyses adjusted for other characteristics in the table; the multivariate analyses for maternal and paternal education did not adjust for household wealth as it could be a mediator. Missing data on maternal and paternal education were accounted for by using the missing indicator method.

channels will be even more critical. Second, this study was conducted in the more urbanized and economically developed settings in each country, so the reported access to digital media and devices may not be generalized to adolescents residing in rural areas. Third, due to disruptions by the COVID-19 pandemic, the analytical sample in South Africa included a smaller number of adolescents from fewer schools, which may have impacted the generalizability of the results for South Africa. Finally, our sample only included young adolescents aged 10–15. It is perceivable that older adolescents may have greater access to digital media and devices (Pfeiffer et al., 2014). Evidence from digital programs for adolescent sexual and reproductive health programs suggests that older adolescents may benefit more from digital interventions than young adolescents, which may be partially due to the lower access to digital devices among young adolescents (Ippoliti & L'Engle, 2017). While some previous studies have examined the use of digital media and devices among older adolescents, further research is still needed, especially on the access in different settings, out-of-school older adolescents, and the appropriate ways to connect with older adolescents digitally.

Digital interventions have great potential to contribute to the Sustainable Development Goals by improving health and education and reducing inequalities. Future work should assess the lower access to digital media and devices and the potentially poorer digital skills among girls and those from lower socioeconomic status. Digital media and devices present promising platforms for interventions in some settings in sub-Saharan Africa due to relatively high levels of access. The utility of digital platforms for delivering health and nutrition interventions to adolescents in these contexts should be further examined.

AUTHOR CONTRIBUTIONS

Till Bärnighausen, Deepika Sharma, and Wafaie W. Fawzi designed research; Roisin Drysdale, Alain Vandormael, Amare W. Tadesse, Huda Sherfi, Amani Tinkasimile, Mary Mwanyika-Sando, Mosa Moshabela, Till

Bärnighausen, Deepika Sharma, and Wafaie W. Fawzi conducted research; Dongqing Wang, Sachin Shinde, and Roisin Drysdale analyzed data; Dongqing Wang wrote the first draft of the paper; Dongqing Wang and Wafaie W. Fawzi had primary responsibility for final content. All authors have read and approved the final manuscript.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

DATA AVAILABILITY STATEMENT

Data described in the manuscript, code book, and analytic code will be made available upon request pending application and approval by the study team.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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