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Are out-of-school adolescents at higher risk of adverse health outcomes? Evidence from 9 diverse settings in sub-Saharan Africa

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Abstract

OBJECTIVES We analysed mutually comparable surveys on adolescent attitudes and behaviours from nine sites in seven sub-Saharan African countries, to determine the relationship between school enrolment and adolescent health outcomes.

METHODS Data from the Africa Research, Implementation Science, and Education Network cross-sectional adolescent health surveys were used to examine the associations of current school enrolment, self-reported general health and four major adolescent health domains: (i) sexual and reproductive health; (ii) nutrition and non-communicable diseases; (iii) mental health, violence and injury; and (iv) healthcare utilisation. We used multivariable Poisson regression models to calculate relative risk ratios with 95% confidence intervals (CI), controlling for demographic and socio-economic characteristics. We assessed heterogeneity by gender and study site.

RESULTS Across 7829 adolescents aged 10–19, 70.5% were in school at the time of interview. In-school adolescents were 14.3% more likely (95% CI: 6–22) to report that their life is going well; 51.2% less likely (95% CI: 45–67) to report ever having had sexual intercourse; 32.6% more likely (95% CI: 9–61) to report unmet need for health care; and 30.1% less likely (95% CI: 15–43) to report having visited a traditional healer. School enrolment was not significantly associated with malnutrition, low mood, violence or injury. Substantial heterogeneity was identified between genders for sexual and reproductive health, and in-school adolescents were particularly less likely to report adverse health outcomes in settings with high average school enrolment.

CONCLUSIONS School enrolment is strongly associated with sexual and reproductive health and healthcare utilisation outcomes across nine sites in sub-Saharan Africa. Keeping adolescents in school may improve key health outcomes, something that can be explored through future longitudinal, mixed-methods, and (quasi-)experimental studies.

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keywords school enrolment, education, adolescent health, child development, sub-Saharan Africa

Sustainable Development Goals (SDGs): SDG 2 (zero hunger), SDG 3 (good health and well-being), SDG 4 (quality education), SDG 5 (gender equity), SDG 10 (reduced inequalities), SDG 17 (partnerships for the goals)

Introduction

The period of adolescence, between 10 and 19 years of age, is critical: development and changes during adolescence have health consequences for the life course. Investments in adolescence often increase subsequent acquisition of human capital, multiplying the returns on investment in this period [1]. Adolescence is a critical period for several reasons: (i) adolescents develop new skills (e.g. complex reasoning and future-oriented thinking) with high returns in the labour market [2–4]; (ii) many adolescents are making their own decisions for the first time; and (iii) the decisions facing adolescents are important and have significant long-term effects, such as pregnancy [5–7], criminal activity [8], and planning around future schooling and a career path [9].

Schooling may have profound implications for the well-being of adolescents. The high number of out-of-school adolescents has been suggested to leave millions of young people trapped in a cycle of poverty with fewer opportunities. Young people who dropout of school are at higher risk for teenage parenthood [10,11], early marriage [12] and detrimental health outcomes over their life course [13,14]. School dropout shifts young people from a 'high human capital track' with deferred childbearing, improved health, economic independence, to a 'low human capital track' with high fertility, poor health, economic dependence and manifested through changes in health behaviours. Furthermore, investments in schooling may not only yield dividends for adolescents, but also for their offspring [6,15] and their parents [16].

While formal schooling has considerable intrinsic value, the role of school enrolment in improving adolescent health outcomes requires further study in resource-poor settings. The current literature has focused on length of schooling as opposed to enrolment itself [14,17,18]; young women and sexual and reproductive health (SRH) outcomes [19]; long-term health and economic outcomes [20,21]; and the effect of child health on school enrolment and participation [22,23], such as the recent 'worm wars' literature [24,25]. Major indicators of adolescent health, including risk factors for non-communicable diseases (NCDs) and mental health, disaggregated by age and gender, are missing [19,26], and most existing large-scale surveys do not gather information about very young adolescents (aged 10–14 years) [27].

In this paper, we analyse one of the largest mutually comparable surveys to date on the attitudes and behaviours of young people across sub-Saharan Africa (SSA) – where young people make up the greatest proportion of the population – to determine the relationship between school enrolment and adolescent health. Our novel, exploratory dataset includes data from nine diverse sites, collectively representing urban and rural communities across South, West and East Africa. We show results separately by study site and when pooling data across sites. When pooling data, we additionally take into account site-specific characteristics to estimate how school enrolment relates to adolescent health outcomes independent of study site context. Our overarching hypothesis is that school enrolment is crucial in helping young people attain the best health and develop to their full potential in the transition to adulthood [28].

Methods

Setting and study population

The African Research, Implementation Science, and Education (ARISE) Network Adolescent Health Study was conducted at nine sites in seven SSA countries. The Adolescent Health Study was performed in partnership between the Africa Academy of Public Health (Tanzania), Centre de Recherche en Santé de Nouna (Burkina Faso), Haramaya University (Ethiopia), Muhimbili University of Health and Allied Sciences (Tanzania), the University of Dodoma, the University of Ghana, the University of Ibadan, Makerere University, the University of Eswatini, as well as the Harvard T.H. Chan School of Public Health (United States), and Heidelberg Institute of Global Health (Germany). The selection procedure of sites is provided in detail elsewhere [29,30]. Briefly, sites were selected among ARISE Network members. The ARISE Network is comprised of over a dozen member institutions in SSA working to improve public health research and training. While all members of the ARISE Network were invited, site participation was based on budgetary constraints, existing data collection infrastructure, research team capacity and willingness of a site leader [30]. In terms of study population

selection, two criteria were used for heterogeneity of geography, including cross-regional geographic representation (South, West and East Africa) and within-country geographic representation (urbanicity). Three of the study sites were located in urban areas (Dar es Salaam [Tanzania], Harar [Ethiopia] and Ibadan [Nigeria]), and six were located in rural or semi-urban areas (Dodoma [Tanzania], Iganga/Mayuge [Uganda], Kersa [Ethiopia], Lubombo/Manzini [Eswatini], Ningo Prampram [Ghana] and Nouna [Burkina Faso]). At most sites, male and female residents aged 10–19 were recruited for the study through household-based sampling. In Burkina Faso, Ethiopia, Uganda and Tanzania, the study was supported by existing regional Health and Demographic Surveillance Systems (HDSS) to allow for potential future long-term follow-up. In Burkina Faso, adolescents aged 10–11 were not included, whereas in Dar es Salaam and Eswatini, children aged 10 were not included. In our analysis, we included only participants with full information on our exposure, outcome and covariates, yielding a total study population of 3937 female and 3892 male adolescents.

Sampling procedures

Sites within countries were not selected to be nationally or regionally representative, but age-eligible potential participants at all sites were selected to be representative of their communities and were randomly selected from the sampling frames derived from HDSS or other recent census records. All sampled adolescents were sought for interview at each site. Study sites used either simple random sampling (Tanzania, Uganda and Ethiopia) or two-stage random sampling (Burkina Faso, Eswatini, Ghana and Nigeria), with or without stratification by region, urbanicity and/or ethnicity. Data collection at each site took place during 1–2 months between July 2015 and December 2017. Site-specific sampling methodologies and participation rates are described in detail elsewhere [29,30].

Informed consent

Field staff visited selected households to recruit potential participants. Participants and their parents were first informed of the purpose and nature of the study and told that their participation was voluntary. Written informed consent was obtained from all adolescents aged 18 and 19 years as well as emancipated and mature minors according to country-specific ethical guidelines. Written parental consent and adolescent assent were obtained from those younger than 18 years. Interviews were held in privacy within the household or compound to facilitate confidentiality. Those who refused to participate, or were too sick to be interviewed, or were absent at the time of data collection, were excluded.

Data collection procedures

We used a standardised questionnaire that had been translated into local languages. The data collection tool was based on the WHO Global School-based Health Survey (GSHS) with some additional questions included primarily from other validated tools [30]. Modules covered by the questionnaire included demographic and socioeconomic characteristics, food security, dietary diversity, handwashing, physical activity, school and home activities, physical attacks, injuries, health care, general health status, life satisfaction, sexual practice, pregnancy, media use, sexual transmitted infection, cigarette and tobacco use, substance use and drug use. The instrument was reviewed and vetted by ARISE Network members to ensure its appropriateness for both in- and out-of-school adolescents, as well as local context in each community. Contextual edits, for instance, allowed for edits to indicate site-specific types of alcohol or substances. Height and weight were measured in all study sites using digital scales and stadiometers, except in Dar es Salaam, Uganda and Eswatini. Additional details on data collection procedures, including the study instrument, are described elsewhere [29,30].

Outcome measures

As a first step, we examined the relationship between school enrolment and two general measures of adolescent well-being, including self-reported general health ('Would you say that your health is excellent, good, fair, or bad?'), and life satisfaction ('Your life is going well' with agree/disagree responses) extracted from the Students' Life Satisfaction Scale [31].

Second, to examine specific indicators of health and well-being over and above the general measures, we examined four major adolescent health domains. These domains were chosen based on the burden of disease in the region [32]. The domains considered were as follows: (i) sexual and reproductive health (SRH); (ii) nutrition and risk factors for non-communicable diseases (NCDs); (iii) mental health, violence and injury; and (iv) healthcare utilisation. We selected four outcomes from each of the domains. We did not consider human rights applied to sexuality and reproduction.

For *SRH*, we included sexual debut (ever had sex), contraceptive use (did not use a condom at last sex), HIV testing (never tested for HIV) and frequency of communication with parents about SRH issues (never).

For *nutrition and NCDs*, we included underweight, overweight, soft drinks consumption (at least once a day in the past 30 days) and physical activity (less than one day of physical activity of more than one hour in the past week). Cut-offs for underweight and overweight in adolescents may vary by age and sex because of natural growth in adolescence [33]. Underweight and overweight were therefore defined by sex- and age-specific cut-offs based on a body-mass index (BMI) of 2 standard deviations (SD) below and more than 1 SD above the median of the WHO growth reference for adolescents [34], respectively. We used the WHO 2007 growth reference because it is considered statistically the most robust and has been recommended to facilitate comparability in SSA [35] (we show results when using alternative growth references in sensitivity analyses described below).

For *mental health, violence and injury*, we included low mood ('low mood, sadness, feeling blah or down, depressed, just couldn't be bothered' much, most or all of the time over the past week from the 6-item Kutcher Adolescent Depression Scale (KADS-6) questionnaire [36]), bullying (ever been bullied), physical fight (involved in a physical fight during the past 12 months) and injury (serious injury in the past 12 months). Since the KADS-6 questionnaire was not validated in the majority of the study sites, we avoided using cut-off points and did not examine depression as an outcome.

For *health service utilisation*, we included the unmet need for care in the past 12 months ('Did you wish to see a health provider or have needed to use healthcare services, but found yourself unable to use them?'), primary care clinic usage in the past 12 months (did not visit a primary care clinic), visiting a traditional healer in the past 12 months and any traditional or herbal medicine consumption in the past 12 months.

Third, to generate additional insight into potential pathways, we examined outcomes that are known to be linked to our health domains and likely to be affected by school attendance [37,38]. Specifically, we included a measure of pathogen awareness (never heard of HIV) and personal hygiene (frequency of handwashing after using a toilet or latrine, defined as sometimes or less vis-à-vis most of the time or always). To facilitate interpretation across outcome measures, all outcomes were coded as one in the case of an 'adverse' health outcome and zero otherwise. Additional information on our outcome measures is provided in Table S1 in the Appendix.

Exposure

Our exposure was self-reported school enrolment, defined as having responded with 'yes' to either the question 'Are you currently in school?' (all sites except Eswatini) or 'Does the respondent attend school?" (Eswatini). Length of schooling was not examined in our main analysis as most respondents did not have the opportunity to complete their formal education.

Covariates

We controlled flexibly for single-year age dummies to account for possible non-monotonic patterns of health outcomes across ages and lower expected schooling attainment for adolescents at younger ages. We also included indicators for site-specific household wealth quintile (with 1 being poorest, 5 being richest), gender, as well as study site indicators (i.e. 'fixed effects') [39]. The fixed effects in our pooled (multi-site) analyses control for community sources of heterogeneity by allowing each community to have its own intercept in the pooled regression. Wealth quintiles were based on principal components analysis of 26 household assets. Additional details on the construction of wealth quintiles are provided elsewhere [29,30].

Statistical analysis

For our main analyses, we used a pooled multi-site sample. First, we graphically described the proportion of adolescents in school at the time of the survey, separately by gender. To further examine the proportion of out-of-school youth that were *never* enrolled in school (defined as those having completed zero years of schooling), we assessed the distribution in length of schooling in descriptive statistics. Second, to determine the relationship between school enrolment and our outcome measures for adolescent health, we ran multivariable Poisson regression models to obtain the more easily interpretable relative risk ratios (RR) with 95% confidence intervals (CI). We modelled our data with a robust error structure [40]. We also tested for heterogeneity in associations by gender and show full regression results when interacting all independent variables with gender to obtain 'net effects' (parametrically identical to stratifying models by gender). We also examined heterogeneity by study site. We assessed effect modification by site-level mean school enrolment status. To do so, we categorised study sites by low, medium and high levels of site-level mean school enrolment. In our application, the study sites Kersa and Nouna had low (50–57%), Dar, Dodoma and Nigeria medium (71–76%), and Eswatini, Ghana, Harar and Uganda high mean school enrolment levels (79–95%). We also show site-specific results for all outcomes. Study site sample weights were used for all descriptive statistics while other estimates were unweighted.

Sensitivity analyses

We conducted several sensitivity analyses. First, we additionally controlled for maternal education, which was missing for a substantial proportion of our sample (19%). We used dummy coded variables indicating children of mothers with no education, primary education and secondary education or more, as well as a category for missing maternal education. Second, we used an alternative age specification of linear and quadratic terms (instead of single-year age indicators). Third, multiple internationally recognised standards exist to define underweight and overweight in adolescents [34,41–43]. We therefore assessed the sensitivity of our results to alternative cut-offs for malnutrition. We examined 'mild underweight' and obesity, defined as more than 1 SD below and more than 2 SD above the median WHO growth reference for adolescents [34]. We also used an alternative growth reference, which pools international data for BMI and links them to the WHO recommended adult cut-off points of <18.5 and >25 kg/m^2 at age 18 [41,42]. Fourth, we adjusted *P*-values for multiple comparisons by applying a Holm correction (assuming a total of 20 planned tests) [44].

Ethical clearance

Ethical approval for each study was provided by local ethical review boards. The overall study was approved by the Harvard T.H. Chan School of Public Health Institutional Review Board.

Results

Descriptive statistics

Across 7829 adolescents, 5551 (70.5%) reported being currently enrolled in school (Table 1). Average age was 14.5 years (standard deviation [SD]: 2.6). 1144 (14.9%) adolescents reported poor general health and 1466 (20.1%) reported that their life was not going well. With regard to key health domains, 1142 (15.1%) adolescents had ever had sexual intercourse by the time of the survey; and of those who ever had sexual intercourse, 651 (58.4%) did not use a condom at last sex encounter. A total of 874 (13.9%) were underweight and 375 (6.3%) overweight. A total of 382 (4.7%) adolescents reported frequently experiencing low mood, and bullying and physical fights were common (27.8% and 25.4%, respectively). Serious injury in the past 12 months had occurred in 949 (12.1%) adolescents. Female adolescents more commonly reported poor general health, physical inactivity and increased reliance on a traditional healer; whereas male adolescents more commonly reported never having tested for HIV, not communicating with parents about SRH issues, being involved in physical fights and having sustained serious injury.

Table 1 Selected characteristics of study participants (*N* = 7829)

Characteristic (%)	Pooled	Female	Male
Enrolled in school	70.5	71.9	68.9
Female	52.0	–	–
Age 10–14	50.4	50.6	50.1
Age 15–19	49.4	49.1	49.7
Maternal education: none	49.2	46.4	52.1
Maternal education: primary	31.1	32.0	30.2
Maternal education: secondary	14.8	16.7	12.7
Maternal education: higher	4.9	4.8	5.0
General health			
Poor self-rated health	14.9	16.6	13.0
Not satisfied with life	20.1	19.6	20.7
Sexual and reproductive health			
Sexual intercourse	15.1	14.8	15.3
Did not use a condom	58.4	58.8	58.0
Never tested for HIV	82.5	79.7	85.6
No communication with parents	71.9	64.8	79.6
Nutrition and non-communicable diseases			
Underweight	13.9	11.3	16.6
Overweight	6.3	7.8	4.7
Physically inactive	24.1	30.8	16.9
Drinks soft drinks	25.7	26.7	24.5
Mental health, violence and injury			
Low mood	4.7	5.2	4.1
Has been bullied	27.8	25.9	29.7
Physical fight	25.4	19.8	31.5
Serious injury	12.1	9.6	14.9
Health services utilization			
Unmet need for health care	8.4	9.1	7.7
Did not visit a primary care clinic	65.8	62.4	69.5
Traditional healer	6.1	7.4	4.8
Traditional or herbal medicine	21.3	21.7	20.8

Descriptive statistics were computed using survey-specific sampling weights.

School enrolment was on average somewhat higher among female adolescents in our sample (71.9% vs. 68.9% among male adolescents); although this gender gap only appears in mid-adolescence (Figure 1a). Large rates of school dropout occurred around ages 16 (male) and 17 (female). Average length of schooling was 5.9 years (SD: 3.4) among female adolescents and 5.6 years (SD: 3.4) among male adolescents. A considerable proportion of 9.0% of females and 8.9% of males had completed zero years of schooling and likely never enrolled in formal education (Figure 1b). School enrolment ranged from 50% in the study site Nouna, Burkina Faso, to 95% in Harar, Ethiopia. The study site Nouna, Burkina Faso, also had the highest proportion of adolescents with zero years of schooling (25.4%).

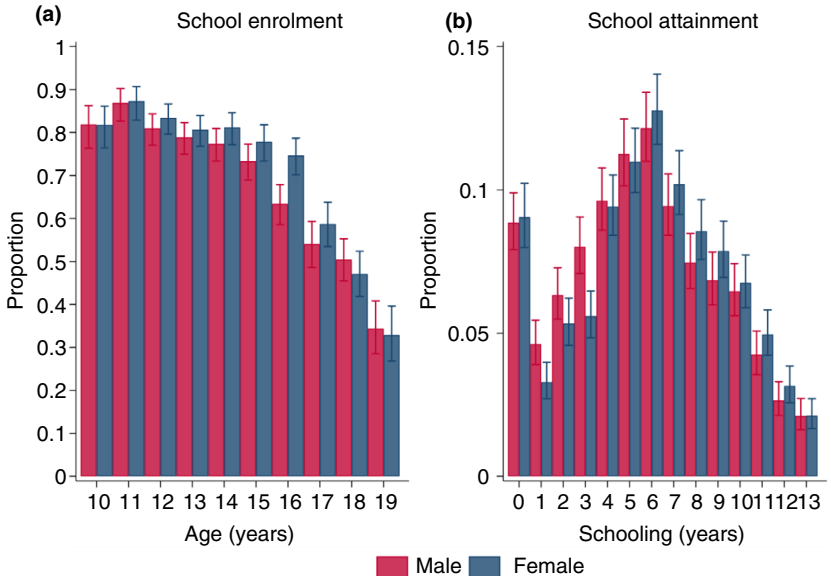

Figure 1 Schooling among adolescents across nine sites in sub-Saharan Africa. *Notes*: Figure 1 shows school enrolment (a) and educational attainment (b) in the pooled multi-site sample. Error bars represent 95% confidence intervals.

School enrolment and adolescent health

In adjusted models, school enrolment was positively associated with our measure of life satisfaction in the pooled multi-site sample (see Table S2 in the Appendix for full regression output). Those in school were 14.3% less likely (95% CI: 6–22) to report that their life is not going well. No relationship between school enrolment and self-rated general health, however, was identified.

School enrolment was also strongly associated with reported SRH outcomes. In-school adolescents were 51.2% less likely (95% CI: 45–67) than those out of school to report ever having had sexual intercourse. Those in school were also 20.5% more likely (95% CI: 11–29) to have used a condom at last sex, and 4.1% more likely (95% CI: 1–8) to communicate with their parents about SRH issues. School enrolment was also associated with all our healthcare utilisation outcomes. Those in school were 32.6% more likely (95% CI: 9–61) than those out of school to report unmet need for health care, 7.9% more likely (95% CI: 4–11) to have visited a primary care clinic, and 30.1% less likely (95% CI: 15–43) to have visited a traditional healer in the past 12 months.

Those in school were also 31.8% less likely (95% CI: 25–38) to be physically inactive, 57.6% more likely (95% CI: 52–63) to be aware of HIV, and more frequently washed their hands after using a toilet or latrine (14.6% [95% CI: 9–20]). No statistically significant relationship, however, was found with underweight, overweight or reported soft drink consumption. We also found no significant relationship between school enrolment and reported low mood, as well as our outcomes for violence and serious injury. Our results were generally consistent across sensitivity analyses, including controls for maternal education, alternative specifications of age and when using alternative definitions of malnutrition (Figures S1–S3 and Table S3).

Effect modification by gender and study site

In Table S4, we show full regression results for enrolment from models where all independent variables were interacted with gender. Three of our adolescent health outcomes were significantly associated with school enrolment but the association differed between females and males ($P < 0.1$ for interaction of school enrolment with gender). Specifically, we identified differences in sexual debut (67% less likely among girls vs. 43% less likely among boys), not testing for HIV (no association among girls vs. 4% less likely among boys) and being involved in a physical fight (16% more likely among girls vs. 10% less likely among boys). In Figure 2, we show results when stratifying our models by gender for all adolescent health outcomes.

Figure S4 shows effect modification by differences in site-level mean school enrolment. In-school adolescents were particularly less likely to report adverse health

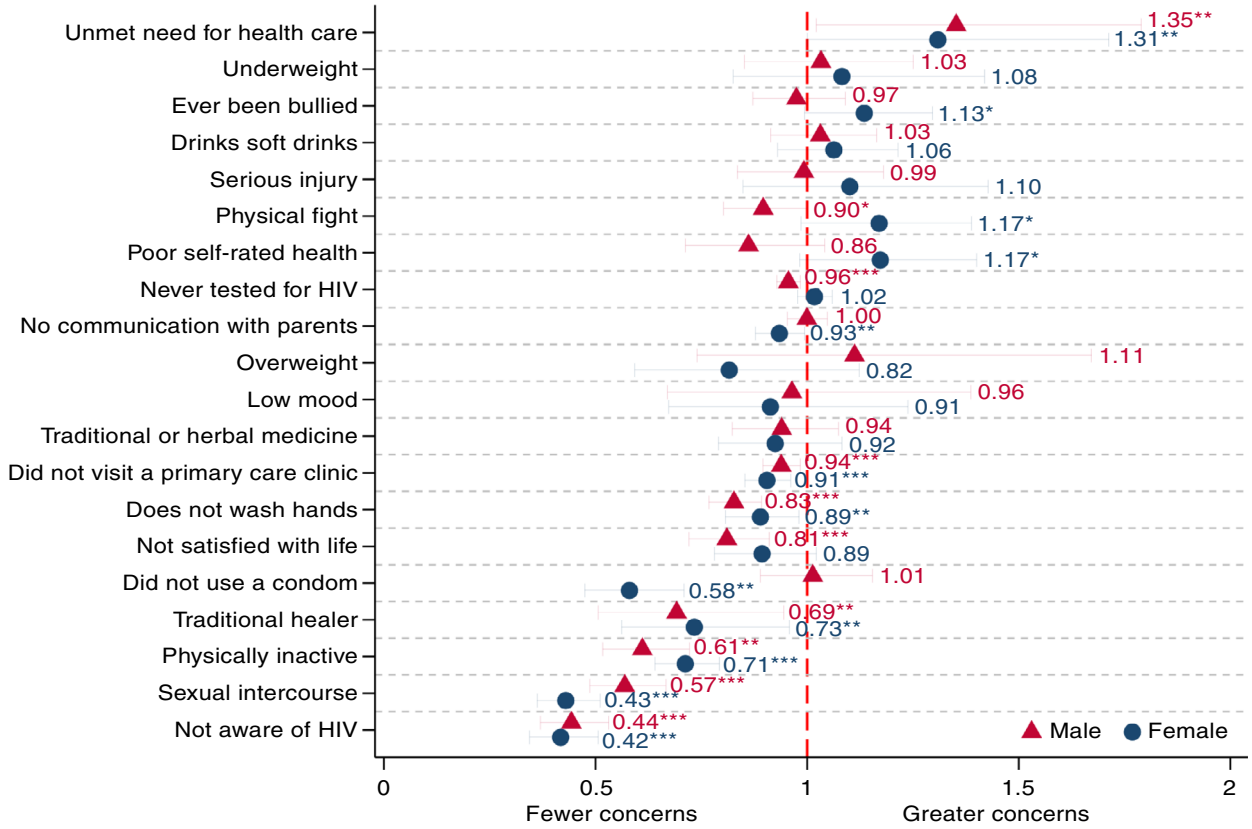

Figure 2 School enrolment and adolescent health across nine sites in sub-Saharan Africa. *Notes*: Figure 2 shows adjusted relative risk ratios from multivariable Poisson regression models in the pooled (multi-site) sample, separately by gender. Exposure was being either in- or out-of-school at the time of the survey. Descriptions of each outcome variable and full regression output are shown in Tables S1 and S2 in the Appendix. Error bars represent 95% confidence intervals. ***$P < 0.01$, **$P < 0.05$, *$P < 0.1$.

outcomes than those out of school in settings with high mean school enrolment. For instance, in study sites with high mean school enrolment (i.e. 79–95%), in-school adolescents were 48.0% less likely (95% CI: 39–69) to report not being satisfied with life; whereas in study sites with low mean school enrolment (i.e. 50–57%), no significant relationship was identified. Figure S5 displays results when stratifying our models by study site for all adolescent health outcomes.

Discussion

Using data on nearly 8000 adolescents from nine mutually comparable surveys across seven SSA countries, we show that school enrolment is variable and variably associated with a range of adolescent health outcomes. Despite the evidence on associations between these core dimensions of human capabilities, school enrolment remains relatively low in our sample, in particular after mid-adolescence. Moreover, a substantial proportion of adolescents were never enrolled in school (roughly 10%). Our outcomes for SRH and health service utilisation, in particular, were significantly associated with being in school. In-school adolescents were about twice more likely as those out of school to report having abstained from sexual intercourse. School enrolment was also positively linked to increased HIV awareness and openness to discussing SRH issues with parents, such as sexual partners and contraception, possibly reflecting increased demand for SRH knowledge. Adolescents in school were also substantially less likely to report having visited a traditional healer, used traditional or herbal medicine, and more likely to have visited primary care clinics. These relationships persisted after controlling for known confounders, including household wealth and maternal education, and net of study site differences.

The strong relationship between schooling and SRH outcomes has been observed in other settings [7,45–49], and schooling has been cited as a key policy lever in spurring the demographic transition from high to low fertility [50–53]. Formal schooling has also been proposed as a 'social vaccine' to reduce the spread of sexually transmitted infections (STIs), such as HIV [54]. Our findings complement evidence from prior studies, including randomised controlled trials, showing protective effects of schooling and school support against adverse SRH outcomes [55,56]. School enrolment was also strongly associated with our measures of health service utilisation. Schooling was associated with a shift away from traditional medicine towards utilisation of the formal healthcare system. This association may reflect in-school adolescents being more familiar with 'modern' society [57], and thus more receptive to allopathic medicine [58,59]. Adolescents in school may also have improved health literacy skills (such as reading medical brochures) [60], allowing them to engage more with the formal health system. They may also be more aware of their health status, possibly further increasing the unmet need for health care.

There was no significant association between school enrolment and our measure of self-reported general health. One reason may be that many of the benefits of schooling accrue later in life – long after the time spent in classrooms. Such benefits may include changing fertility preferences [7,11,46–48,61], fewer unhealthy behaviours such as smoking and alcohol consumption [8,62], and particularly for young women, increased bargaining power within relationships [63–65] and improved economic independence [16,49]. Another reason may be that adolescents in school have acquired higher standards for the meaning of 'good' health, which would attenuate our results towards the null if in fact schooling was associated with improved health. We did find a link between school enrolment and reported life satisfaction, suggesting that adolescents in school may have had a somewhat more positive outlook on life, perhaps reflecting increased future orientation. School enrolment was also not significantly associated with our outcomes for malnutrition (including underweight, overweight and obesity), risk factors for NCDs (with the exception of physical activity), as well as reported low mood, bullying, physical attacks and serious injury.

Policy implications of our findings include, first, the large number of adolescents identified who were likely to be never enrolled in school. In Nouna, Burkina Faso, approximately a quarter of adolescents had no formal education whatsoever. Policy interventions that are solely school-based risk missing this group of adolescents – a subpopulation that may be at particular risk of adverse health outcomes. Policy-makers should consider interventions that increase access to education for this vulnerable subpopulation, such as removing school fees, school feeding, remedial education and community-based programs [28,66]. Second, our findings complement existing research on the wide array of health and broader social benefits of school enrolment [14,20]. Late adolescence, in particular, appears a 'critical period' to promote enrolment or retention with implications for health across the life course [67]. During late adolescence, people develop new behavioural patterns; they acquire new skills [3]; they make their own decisions for the first time; and many of these decisions have particularly high path dependence, including pregnancy [68]. Investments in schooling during this period could improve health and engender adolescents' capabilities to lead fulfilling lives [69], especially since we see a substantial fall-off in school enrolment after age 15. Third, the role of schooling in adolescent health differed between genders and contexts, further highlighting the need for tailored interventions.

Strengths and limitations

Our study has the strengths of using a standardised questionnaire, administered to a large sample that was enrolled across a wide range of settings and countries. Much of the evidence pertaining to adolescent health has also been obtained from school settings, such as the GSHS [70]. Although school-based approaches have many advantages, they systematically exclude out-of-school adolescents. However, it also has some limitations. First, because study sites were not selected probabilistically, participants in this study are not representative of the overall adolescent population in these regions. We believe that the cross-community comparison of these results nonetheless provides insight into the links between school enrolment and health in these and similar contexts. Second, given the large number of potential factors (such as genetic traits) determining both school enrolment and adolescent health, residual confounding is likely to be present in our analyses – even after controlling for key potential confounders. The identified correlations are not likely to identify causal effects, particularly since our measurements are cross-sectional. Third, we assessed a limited number of health behaviours and outcomes, and it is quite possible that school enrolment affects other outcomes we have not yet considered. Fourth, almost all of our exposure and outcome measures were self-reported, opening the possibility of social desirability or recall biases that may lead to differential reporting of outcomes by school enrolment status [71]. Self-reported health, however, has been suggested to be a strong indicator of objective and

subjective health, including in low-resource settings [72,73]. We also adjusted for socio-economic differences to focus on variation in adolescent health outcomes net of socio-economic status. Fifth, we were limited by the data at hand. We did not have complete data, for instance, on frequency of school attendance or quality of schooling. Additional limitations, including those related to data collection, have been reported elsewhere [29,30].

Conclusion

This paper is among the first to determine the relationship between school enrolment and adolescent health across multiple communities in SSA. A large proportion of adolescents had completed no formal schooling whatsoever, and the proportions of those in school decreased substantially after ages 15. Further promoting school enrolment may improve a wide range of adolescent health outcomes in similar contexts, in particular SRH and health service utilisation outcomes. Further research is needed on these associations, including longitudinal, mixed-methods and (quasi-)experimental studies, to inform context-specific interventions to improve the health and well-being of adolescents in the region.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Figure S1. Controlling for maternal education.
Figure S2. Alternative functional form for age.
Figure S3. Alternative definitions of malnutrition.
Figure S4. Results by site-level school enrolment.
Figure S5. Full site-specific regression results.
Table S1. Descriptions of outcome measures.
Table S2. Full regression output for pooled models.
Table S3. Holm corrected significance levels.
Table S4. Models fully interacted with gender.

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