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Two are Better Than One but Three is Best: Fast-Tracking the Attainment of the Sustainable Development Goals (SDGs) Among In-School Adolescents in Nigeria

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Abstract

Background With 60% of Africa's population under the age of 25 years, investing in youth will accelerate progress towards achieving the Sustainable Development Goals (SDGs). The United Nations concept of 'Development Accelerators' is operationalized by examining factors associated with multiple SDGs among adolescents in Nigeria.

Methodology Through data collected on the health of 1800 adolescents in Southwest Nigeria (Ibadan), ten SDG targets were identified. Accelerator protective factors that could lead to the attainment of two or more SDG targets were identified. Associations were assessed using multivariable logistic regression adjusting for sociodemographic covariates and multiple testing. Cumulative effects were tested by marginal effects modelling.

Results Participants' mean age was 15.02 years (SD = 2.27). Family (parenting support), environmental (no survival work and food security) and school (safe schools) related factors emerged as development accelerators. For seven of the identified SDG-aligned targets, a combination of two or more accelerator factors showed cumulative positive associations, suggesting accelerator synergies with a combination of three accelerators showing the greatest increase. For instance, perceiving the school environment as safe, being food secure and having optimal mental health was associated with an 67% chance of not using psychoactive substances. While with safe school alone it was 39% (29%-51%), with food security alone it was 42% (31%-54%) and with optimal mental health alone it was 54% (42%-66%).

Conclusion Several development accelerators related to family, environmental and school factors can have additive effects on the attainment of the SDGs amongst adolescents in Nigeria. This has practical and policy utility in the fastest growing economy in Africa.

Extended author information available on the last page of the article

Keywords Nigeria · Adolescents · Attainment · Development Accelerators · SDGs

1 Introduction

Eight time-bound targets to be achieved by the year 2015, named the Millennium Development Goals (MDGs) (United Nations, 2015), were adopted by leaders around the world in 2000. The aim of this eight-goal initiative was to liberate communities of men, women, youth and children from conditions of dehumanizing poverty through global partnerships. Some remarkable gains were made during the MDG era, such as a reduction in the number of people living in extreme poverty, the number of out-of-school children of primary school age and considerable strides were made in combating HIV/AIDs and other communicable diseases (United Nations, 2015). Unfortunately, there were inequalities in these gains and the progress made across countries was very uneven. By 2015, most low and middle-income countries (LMIC) were still lagging behind in meeting the MDG targets particularly with regards to maternal and child health (Oleribe & Taylor-Robinson, 2016). Thus, a sustainable path that could guarantee an end to hunger, achieve optimal child health, and get every child into school was adopted in the last quarter of 2015 by the United Nations. These 17 goals (the Sustainable Development Goals) were to be implemented and achieved by every country by 2030. However, countries would need to first identify areas of need and incorporate lessons learned from the MDG era into feasible, cost-effective and cost-efficient interventions (Oleribe & Taylor-Robinson, 2016). This is especially important for LMIC countries such as Nigeria where more than 60% are children and youth.

Adolescents (aged 10–19 years) represent 23% of Nigeria's 200 million population (UNFPA, 2021) and have the potential to play a significant role in the country's growth and development if given the right circumstances. Unfortunately adolescents in Nigeria live in extremely difficult circumstances evidenced by poor access to education, low quality of life (one of the lowest in the world), high poverty rates, and serious security challenges (Idoko & Dasuma, 2014; The World Bank, 2019). Despite these adversities many adolescents living in these contexts remain resilient and possess enormous potential to drive national development and transformation (UNICEF, 2020) given the right opportunities. Successful navigation through the period of adolescence has the potential to break the cycle of poverty and could result in long term benefits for individuals, communities and nations at large (UNFPA, 2012). Investing in interventions which can build resilience among adolescents and help them make the right transition into adulthood may be directly related to achieving the SDGs and other national development goals especially in Sub-Saharan Africa (UNFPA, 2012; UNICEF, 2011). For example, studies reveal that investing in young people's sexual and reproductive health will not only improve their current well-being, but will also help them make informed decisions about childbearing and/or marriage thus preparing them to become better parents in the future (Sully et al., 2020).

The United Nations Development Programme (UNDP) has taken the lead in supporting countries in achieving the SDGs by proposing the "Mainstreaming, Acceleration, and Policy Support" approach (MAPS) (UNDG, 2015). The MAPS is

an integrated approach that is aimed at moving the SDGs from theory to practice (UNDP, 2018). The acceleration component of MAPS entails identifying country-specific interventions and/or services that can boost progress across several SDGs. Development accelerators can therefore be viewed as key interventions, provisions and services that simultaneously reach across the three aspects of sustainable development: economic, social and environmental (UNDG, 2015). So far, virtually all the emerging evidence on the accelerator concept has been from Southern and Eastern Africa (with only one known study being from West Africa— Ghana) and none yet from Nigeria (Sherr et al., 2022). This is particularly noteworthy since UNICEF currently reports that Nigeria still requires "high effort" to achieve most child-related SDG targets in the domains of *survive+thrive*, *environment*, *protection*, and *poverty*, by year 2023 (UNICEF, 2024). Therefore, given the limited time left before the year 2030 mark, solid evidence is urgently needed to give direction to governmental and non-governmental efforts at ensuring that adolescent-relevant SDG targets are optimally attained in Nigeria. This study is therefore deemed a critical attempt at meeting this urgent need— of identifying priority areas for policy and programmatic activities vis-à-vis adolescents in Nigeria and identifying potential accelerators (protective factors) which can be implemented as "simple combinations rather than complex packages" to produce optimal outcomes (Sherr et al., 2022).

Over the years stand-alone programmes have been shown to be effective in addressing specific problems such as adolescent depression and childhood learning difficulties in LMICS. Emerging evidence now points to the fact that a combination of services and programmes better complement each other to have additive and/or synergistic effects on accelerating progress towards the SDGs (Blattman et al., 2017; Cluver et al., 2019). For example Blatmann et al., in Liberia showed that, cognitive therapy or cash transfers alone had no long-term effects on criminally engaged male youths, but the combination of both resulted in sustained reduction in crime and violence (Blattman et al., 2017). This combination of interventions to attain synergistic or additive effects might be a more cost-effective way of improving the quality of life for youth especially in resource-limited settings in Africa (UNDG, 2015) where problems are pervasive and multiple. However, employing a one-size-fits-all model may not be practical, as programmes that have been shown to be effective in a specific context might be ineffective in another setting. Therefore, there is a need to empirically identify what interventions or policies would combine to yield the most rewards for adolescents across various SDG targets in low- and middle-income settings such as Nigeria.

Previous univariable analysis from an existing dataset drawn from in-school adolescents in Southwest rural and urban Nigeria, showed that six factors: safe schools, parenting support, not doing paid work before or after school, food security, optimal mental health and stable childhood were associated with the attainment of two or more SDGs targets (Tamambang et al., 2024). This paper, therefore, aims to subject this preliminary finding to additional analyses using multivariable regressions and marginal effect modelling. These further analyses would help to test the UNDP development accelerator concept by quantifying the individual and synergistic contributions of the accelerators to the attainment of SDG outcomes.

2 Methods

2.1 Data source

The data used for this study was extracted from an existing data set (the Ibadan school health study). The study targeted 2100 young persons aged 9 to 24 years at all levels (JSS1-SSS3 corresponding to grade 7 to 12) in twenty-two secondary schools in rural and urban districts of Ibadan. Detailed information on the procedure and instruments used for this study has been reported by Omigbodun et al., (2010).

2.2 Procedure

The procedure employed for this study can be summed up into the following steps (1) mapping of SDG targets; (2) mapping of potential accelerators; (3) identification of accelerators; multivariable logistic regression and marginal effect modelling. The first 3 stages have been explained in detail in a preliminary paper published from this dataset (Tamambang et al., 2024).

2.2.1 Mapping of SDG targets

The study instruments were reviewed and items that were deemed suitable as proxies for the measurement for the different SDG targets were identified. This was achieved by consensus of team members on items on the questionnaire that were found to be similar in construct to individual SDG targets. (see Tables 1 and 2).

2.2.2 Identification of potential accelerators

Questions that closely represented practices for which interventions can be implemented were identified from the study instruments**.** After carrying out bivariate analysis (chi square analysis and t-test), seven out of eight accelerators initially identified from a prior literature search were associated with at least two SDG targets, details of which have been reported in Tamambang et al., (2024). The seven potential accelerators, their questions and categorisation are shown in Tables 3 and 4.

2.2.3 Ethical considerations

Ethical approval for the study was obtained from the Oyo State Ministry of Health, Ethical Review and during data collection, ethical principles were observed in line with internationally and located accepted standards. This had been described in detail in the original study by Omigbodun et al., (2005).

2.2.4 Statistical analysis

The statistical analysis was carried out in four (4) stages in Statistical Package for Social Sciences (SPSS) version 24 and R studio.

Table 1 Mapped SDG targets and measures

SDG Target	Measure	Operationalized measure	Instrument
2.2 End all forms of malnutrition	Anthropometry measurements: Height and weight	BMI for Age Stunting	Height and weight measured using standardized methods by clinicians
3.5 Prevention of substance use	-During the last 30 days how many times days did you have at least one drink containing alcohol? -During the past 30 days, on how many days did you smoke any other form of tobacco, such as snuff?	No self-reported use of alcohol, or tobacco within the past 30 days	Global School Health Questionnaire: Measures behavioural risk and protective factors across 10 key areas: Alcohol use Dietary behaviour Drug use Hygiene and sanitation Physical activity Sexual behaviour Dietary behaviour Parenting support and supervision Violence and unintentional injury (WHO & CDC, 2003)
4.1 All girls and boys' complete primary education	Age and class	Appropriate age for class based on the Nigerian ministry of education recommendations	Sociodemographic Questionnaire: Collects information on sex, age, family structure and school related issues (Omigbodun et al., 2010)
4.4 Increase relevant skills for employment	During the past 30 days, on how many days did you miss class or school without permission? Have you often had trouble concentrating or keeping your mind on what you are doing for more than a short time?	No self-reported school absenteeism within the past 30 days No self-reported history of not being able to concentrate (in the past 12 months)	Global School Health Questionnaire Global School Health Questionnaire

In step 1, we checked for collinearity between predictors and/or outcomes.

In step 2, a single outcome multivariable logistic regression was carried out simultaneously while adjusting for similar covariates identified from previous studies. Each Model included all hypothesized accelerators, all covariates against one SDG-target.

Step 4 entailed controlling for test multiplicity using the Benjamini-Hockberg correction, checking for associations between predictors and outcomes for a false-positive rate of 10%.

In step 5, we tested for possible cumulative effects between developmental accelerators that emerged using marginal effects model. This entailed a series of regression analyses which provided us with the probabilities of achieving an SDG target when an accelerator is present and when all accelerators are present versus when the accelerator is absent, and this was done while holding all significant covariates constant.

Table 2 Mapped SDG targets and measures

SDG Target	Measure	Operationalized Measure	Instrument
5.2 Universal access to sexual and reproductive health	i) Age at onset of sexual intercourse ii) The last time you had sexual intercourse did you or your partner use a condom?	No self-reported onset of sexual intercourse on or before the age of 14 and/or use condom during last sexual encounter	Global School Health Questionnaire
16.1 Reduce all forms of violence and related deaths 16.1a No violence perpetration	i) Have you shoplifted, that is, stolen from a shop when you thought no one was looking? ii) Have you snatched someone else's purse iii) Have you broken or spoilt some place on purpose? iv) Have you stolen from someone when they were not looking? v) Have you broken into a building, house or car?	No self-reported history of shoplifted or snatching someone's purse or vandalizing or burglary (in the last 12 months)	Global School Health Questionnaire
16.1b No community violence	In the past 12 months how many times you were physically attacked?	No self-reported history of being physically attacked in the past 12 months	Global School Health Questionnaire
16.2 End violence against children	i) Has an adult ever forced you to have sexual intercourse with them? ii) Has an adult ever touched breast, private parts or made you touched parts of their private parts?	No self-reported history of rape and/or fondling with body parts	Global School Health Questionnaire

3 Results

3.1 Sociodemographic characteristics of respondents

Information pertaining to 1800 adolescents was extracted from the data source. The mean age of participants was 15.02 ± 2.27 years. Almost half (48.6%) of the participants were females, and a third of the participants (75.2%) were from urban areas. Majority of the participants (89.2%) were not orphans and 67.0% were from families with a low socioeconomic status. See Table 5

3.2 Frequency distribution of SDG targets and accelerator protective factors

Seventy-nine percent (79.4%) of the participants had normal BMI for age, while 82.2% had normal height for age (not stunted). The majority (79.6%) of the participants, reported that they had not used substances in the month prior to data collection (See Table 5). Missing data for variables was less than 4.5%.

The mean score for parenting support was 10.31 ± SD3.08, with a range of 1 to 15. The majority of participants (68.4%) were classified as being food secure, while slightly above half (50.5%) reported not having any mental health condition. Also, about 8 out of 10 participants (81.8%) were not engaged in survival work. Missing values for variables was less than 3.5%. See Table 6.

Table 3 Mapped Accelerators and Measures

Accelerator	Measure	Operationalized measure	Instrument
Food Security	During the past 30 days how often did you go hungry because there was not enough food at home? This was rated as (never, rarely, sometimes, most of the time, always)	'Never' and 'rarely' were classified as food secure security while 'sometimes', 'most of the time' and 'always' were classified as food insecure insecurity	Global School Health Questionnaire
No Mental Health Issues	Not meeting the criteria for mental health condition on the Diagnostic Interview Schedule for Children (DISC) Predictive scales and Culture Free Inventory	The absence of diagnosable mental health disorder like depression, oppositional defiant disorder, low self-esteem, and suicidal attempts	1) Diagnostic Interview Schedule for Children (DISC) Predictive scales: Structured diagnostic interview which assesses common mental health disorders in children and adolescents such as depression, anxiety, eating disorders, suicidal behaviours and conduct disorders (Shaffer et al., 2000) 2) Culture free Inventory: 30-item questionnaire used to identify problems with self-esteem in adolescence 10 items were selected for use during the data collection (Battle, 1992)
Safe Schools	How often the participant was bullied in the last 30 days	The absence of a self-reported history of bullying within the last 30 days	Global School Health Questionnaire
No survival work[a]	Doing any kind of work to earn money before or after school	No self-reported involvement in work to earn money before or after school	Socio-demographic questionnaire

[a]'Survival work' [referred to as 'Paid work' in Omigbodun et al. (Olayinka Omigbodun et al., 2008)] includes both adolescents doing work which may be termed "economic activities" as well as those doing more harmful work which may be termed "child labour"— as differentiated in NBC & UNICEF (2021)

3.3 Multivariable regression analysis of associations between accelerator provision and SDG aligned targets

Before performing the multivariate logistic regressions, collinearity between accelerators was assessed using Spearman's correlation. Table 7 shows correlations between the hypothesized accelerators. All associations between the accelerators were small (Spearman's correlation coefficient less than 0.2) indicating no collinearity.

Table 8 shows the results of the overall multivariate path analysis spanning the seven (7) hypothesized accelerators and ten (10) SDG aligned targets while simultaneously controlling for three (3) covariates. After correcting for multiple comparisons using the Benjamin Hochberg, six of the factors were deemed to be potential accelerators (predictors significantly associated with two or more SDG outcomes). These predictors were: no survival work, small family size, safe schools, good mental health, parenting support, and food security.

Table 4 Mapped Accelerators and Measures

Accelerator	Measure	Operationalised Measure	Instrument
Parenting Support	a) During the past 30 days how often did your parents or guardians check to see if your homework was done? (Never, rarely, sometimes, most of the times, always) b) During the past 30 days how often do your parents or guardians understand your worries and problems? (Never, rarely, sometimes, most of the times, always) c) During the past 30 days, how often did your parents or guardians really know you were doing with your free time? (Never, rarely, sometimes, most of the time, always)	The responses were translated to a Likert scale of 1 to 5 with 'never' accorded the lowest value (1) and always accorded the highest value (5). An additive scale was then derived by summing up the responses for the three (3) questions. The maximum score a participant could record on the scale was fifteen (15) while the minimum was three (3)	Global School Health Questionnaire

No survival work was significantly associated with no stunting (SDG 3.4) and school progression (SDG 4.1).

Safe school was associated with 6 (six) SDG targets: no substance use (SDG 3.4), optimal school attendance (SDG 4.4), ability to concentrate in school (SDG 4.4), no risky sexual behavior (SDG 5.6), no self-perpetration of violence (SDG 16.1) and no community violence (SDG 16.1).

Good mental health was associated with 7 (seven) SDG targets: no substance use (SDG 3.4), optimal school attendance (SDG 4.4), no risky sexual behavior (SDG 5.6), no self-perpetration of violence (SDG 16.1), no community violence (SDG 16.1) and no sexual abuse (SDG16.5).

Parenting support was associated with 4 (four) SDG targets: no substance use (SDG 3.4), optimal school attendance (SDG 4.4), no self-perpetration of violence (SDG 16.1) and no community violence (SDG 16.1).

While food security was associated with 5 (five) optimal school attendance (SDG 4.4), ability to concentrate in school (SDG 4.4), no risky sexual Behavior (SDG 5.6), no community violence (SDG 16.1) and no sexual abuse (SDG16.5).

In all, after correcting for multiple comparisons, the five potential accelerators provided association across seven (7) SDG aligned targets spanning four goals. See Table 8.

Table 5 Sociodemographic characteristics of respondents (N = 1800)

Characteristics	Categories	Number (%)
Age (years)	10–14	746 (41.6)
	15–19	1051 (58.4)
Gender	Male	925 (51.4)
	Female	875 (48.6)
Residence	Rural	446 (24.8)
	Urban	1354 (75.2)
Socioeconomic status[a]	Low	1209 (67.0)
	High	593 (33.0)
Orphaned	Yes	173 (9.7)
	No	1605 (90.3)
Father's highest level of education	No formal/ Quranic Education	96 (5.3)
	Primary Education	255 (14.2)
	Secondary/ Tertiary Education	1081 (56.7)
	Don't know	426 (23.7)
Mother's highest level of education	No formal / Quranic education	179 (10.1)
	Primary Education	315 (17.7)
	Secondary/Tertiary Education	952 (53.5)
	Don't Know	334 (18.8)

[a]Participants' socioeconomic status (SES) was derived using a modified version of the Oyedeji socio-economic classification (Oyedeji, 1985) in which the parents' occupational status and educational status were graded on a scale of 1 to 4 (that is highly skilled and highly educated = 4; unemployed/don't know and uneducated/don't know = 1). The average of the sum of both parents' score was obtained, and the mean score (2.97) was used as the cut-off. Participants who scored below the mean were categorised as having high SES and those who had the mean score and above were categorised as having low SES

3.4 Associations of individual accelerator and combined accelerator synergy provisions with SDG-aligned targets

Accelerator synergies were encountered for eight of the SDG aligned targets: no substance use, no stunting, optimal school attendance, ability to concentrate, no risky sexual behavior, no self-perpetration of violence, no community violence, and no sexual abuse— in that the probability of reporting the achievement of the SDG targets was increased when two or more accelerators were combined compared to a scenario where just one accelerator was present. We demonstrate this by employing marginal effect models which identify the probability of achieving the SDGs in three scenarios: (i) when the participant is not exposed to the accelerator (ii) when the participant is exposed to the accelerator and (iii) when the participant is exposed to all six accelerators combined.

The results showed that:

Whereas adolescents who had none of the accelerators had 70% likelihood of not engaging in substance use, those who had all six accelerators (that is had optimal parenting support, lived in a small family, did not engage in paid work before or after school, perceived school as safe, had good mental health and had enough food to eat) had 88% likelihood (an 18% increase) of not engaging in substance use. Also,

Table 6 Frequency distribution of SDG Targets (N = 1800)

Variables	N(%)
SDG Targets	
SDG 2.2 Adequate BMI for Age	1389 (79.4)
SDG 2.2 No Stunting	1438 (82.2)
SDG 3.5 No substance use	1428 (79.6)
SDG 4.1 Optimal school progression	927 (51.5)
SDG 4.4 Ability to concentrate in class	978 (55.2)
SDG 4.4 Optimal school attendance	1238 (69.8)
SGD 5.2 No risky sexual behaviours	1463 (83.1)
SDG 16.1a No self-perpetration of violence	1230 (71.4)
SDG 16.1b No community violence	1202 (32.0)
SDG16.2 No sexual abuse	1573 (89.6)
Accelerator Protective Factors	
No survival work	1472 (81.8)
Stable childhood	1301 (73.3)
Food security	1221 (68.4)
Safe Schools	1163 (66.8)
Good Mental Health	890 (50.5)

N < 1800 = missing data

Table 7 Bivariate correlation with predictor variables

Accelerators	Parenting Support	No survival Work	Good mental health	Safe Schools	Food security	Stable childhood
Parenting support	1.00					
No survival work	-0.01	1.00				
Good mental health	0.07	0.07	1.00			
Safe schools	0.01	-0.01	0.12	1.00		
Food security	0.07	0.06	0.13	0.14	1.00	
Stable childhood	0.07	0.09	0.09	0.01	0.09	1.00

adolescents who had none of the accelerators had 51% likelihood of not perpetrating violence while those who had all six accelerators (that is had optimal parenting support, lived in a small family, did not work to earn money, perceived school as safe, had good mental health and had enough food to eat) had 87% likelihood of not perpetrating violence, amounting to a 36% difference. See Table 9.

Figure 1 summarises and shows the probability differences comparing adjusted probability of achieving the sustainable development goals in the absence and presence of a combination of a combination of accelerator protective factors with the

Table 8 Multivariable Association between Accelerator Protective Factors and SDG aligned targets

SDG outcomes / **Hypothesised Accelerators**	3.4 No Substance Use	2.2 No Underweight	2.2 No Stunting	4.1 School progression	4.4 Optimal school attendance	4.4 Ability to concentrate	5.6 No risky sexual behaviour	16.1 No self-perpetration of violence	16.1 No community violence	16.5 No sexual Abuse
No survival work	0.85 (0.60–1.20; 0.382)	1.15 (0.83–1.57; 0.380)	**1.55 (1.11–2.15; 0.009)**	**1.79 (1.30–2.47; <0.001)**	0.94 (0.69–1.25; 0.673)	1.15 (0.87–1.51; 0.320)	1.28 (0.91–1.78; 0.144)	1.16 (0.89–1.65; 0.357)	1.31 (0.98–1.73; 0.066)	0.89 (0.56–1.38; 0.627)
Stable childhood	**1.38[a] (1.04–1.82; 0.025)**	1.06 (0.80–1.41;0.660)	1.26 (0.93–1.70; 0.134)	**1.40[a] (1.07–1.85; 0.015)**	1.02 (0.79–1.31; 0.891)	0.99 (0.78–1.26; 0.951)	1.18 (0.87–1.61; 0.275)	0.93 (0.71–1.22; 0.615)	0.91 (0.70–1.18; 0.467)	1.08 (0.74–1.56; 0.678)
Food security	1.28 (0.97–1.66; 0.071)	1.01 (0.76–1.32;0.964)	0.75 (0.55–1.02; 0.073)	0.99 (0.76–1.29; 0.966)	**1.51 (1.20–1.91; <0.001)**	**1.45 (1.16–1.81; 0.001)**	**1.42 (1.06–1.91; 0.017)**	1.21 (0.94–1.55; 0.129)	**1.61 (1.28–2.03; <0.001)**	**1.44 (1.01–2.00; 0.041)**
Safe schools	1.59 (1.23–2.05; <0.001)	0.89 (0.69–1.18;0.440)	0.97 (0.72–1.30; 0.841)	0.95 (0.74–1.25; 0.715)	**1.47 (1.16–1.85; 0.001)**	**1.28 (1.03–1.60; 0.026)**	**1.43 (1.07–1.92; 0.017)**	**1.61 (1.26–2.05; <0.001)**	**2.18 (1.75–2.74; <0.001)**	1.42 (1.00–2.00; 0.050)
Parenting support	1.04 (1.00–1.08; 0.030)	0.99 (0.95–1.03;0.787)	1.00 (0.96–1.04; 0.898)	0.98 (0.95–1.02; 0.470)	**1.05 (1.02–1.09; 0.003)**	1.02 (0.99–1.05; 0.257)	0.99 (0.95–1.04; 0.937)	**1.08 (1.04–1.12; <0.001)**	**1.04 (1.01–1.08; 0.015)**	1.02 (0.97–1.08; 0.360)
Good mental health	1.62 (1.25–2.10; <0.001)	1.04 (0.80–1.34;0.761)	1.00 (0.75–1.32; 0.999)	1.07 (0.84–1.35; 0.631)	1.24 (0.99–1.56; 0.059)	**2.37 (1.93–2.92; <0.001)**	**1.36 (1.03–1.81; 0.032)**	**2.22 (1.75–2.83; <0.001)**	**1.57 (1.25–1.96; <0.001)**	**1.81 (1.28–2.60; <0.001)**
Covariates										
Orphanhood	1.68 (1.08–2.72; 0.027)	1.33 (0.87–2.09;0.193)	1.51 (0.95–2.58; 0.089)	0.96 (0.64–1.44; 0.844)	0.74 (0.52–1.06; 0.093)	0.92 (0.65–1.30; 0.611)	0.68 (0.45–1.43; 0.061)	0.82 (0.56–1.21; 0.312)	1.16 (0.79–1.70; 0.444)	0.98 (0.58–1.69; 0.940)
Mother's educational level	1.14 (0.85–1.55; 0.385)	0.92 (0.69–1.24;0.585)	0.98 (0.71–1.34; 0.886)	1.30 (0.98–1.73; 0.069)	1.44 (1.10–1.88; 0.007)	1.17 (0.91–0.50; 0.229)	1.23 (0.88–1.70; 0.212)	0.83 (0.62–1.09; 0.174)	0.90 (0.69–1.18; 0.459)	1.19 (0.78–1.80; 0.413)
Father's educational level	1.20 (0.88–1.64; 0.252)	0.97 (0.72–1.31;0.852)	0.98 0.71–1.35; 0.905)	0.97 (0.72–1.30; 0.859)	0.86 (0.65–1.13; 0.274)	0.98 (0.76–1.27; 0.875)	0.85 (0.61–1.18; 0.328)	0.90 (0.67–1.20; 0.470)	1.07 (0.82–1.40; 0.641)	0.97 (0.64–1.49; 0.919)

Table 8 (continued)

SDG outcomes / **Hypothesised Accelerators**	3.4 No Substance Use	2.2 No Underweight	2.2 No Stunting	4.1 School progression	4.4 Optimal school attendance	4.4 Ability to concentrate	5.6 No risky sexual behaviour	16.1 No self-perpetration of violence	16.1 No community violence	16.5 No sexual Abuse
Gender	1.71 (1.33–2.21; <0.001)	1.66 (1.29–2.14;<0.001)	3.00 (2.26–4.03; <0.001)	1.09 (0.86–1.39; 0.466)	0.97 (0.77–1.21; 0.79)	0.89 (0.72–1.10; 0.271)	2.28 (1.72–3.06; <0.001)	1.67 (1.33–2.11; <0.001)	1.26 (1.10–1.56; 0.040)	0.74 (0.53–1.04; 0.088)
Location	0.81 (0.59–1.11; 0.196)	1.28 (0.95–1.72; 0.091)	2.23 (1,65–3.02; <0.001)	2.10 (1.57–2.82;<0.001)	1.15 (0.88–1.50; 0.29)	0.72 (0.55–0.93; 0.011)	1.78 (1.31–2.43; <0.001)	0.51 (0.37–0.68; <0.001)	0.94 (0.71–1.23; 0.654)	1.26 (0.82–1.88; 0.274)
Age	1.16 (0.89–1.52; 0.270)	1.06 (0.81–1.38; 0.652)	0.75 (0.56–0.99; 0.046)	6.25 (0.12–0.21; <0.001)	1.11 (0.88–1.50; 0.389)	1.02 (0.82–1.27; 0.842)	3.17 (2.27–4.51; <0.001)	0.78 (0.99–1.62; 0.057)	1.04 (0.76–1.22; 0.757)	2.93 (0.23–0.51; <0.001)
Socioeconomic status	0.85 (0.59–1.22; 0.385)	1.68 (1.17–2.42; 0.004)	1.91 (1.27–2.90; 0.002)	3.85 (2.77–5.39; <0.001)	1.14 (0.82–1.56; 0.427)	0.70 (0.52–0.93; 0.019)	1.51 (0.99–2.31; 0.052)	1.60 (1.15–2.22; 0.005)	1.05 (0.76–1.43; 0.764)	0.625 (0.38–1.00; 0.053)
Small family size	0.99 (0.76–1.28; 0.938)	1.24 (0.95–1.60;0.105)	1.41 (1.06–1.87; 0.016)	1.67 (1.32–2.13; <0.001)	1.36 (1.08–1.71; 0.008)	1.02 (0.82–1.26; 0.834)	1.13 (0.85–1.51; 0.397)	0.93 (0.73–1.18; 0.549)	1.10 (0.87–1.37; <0.001)	0.90 (0.64–1.27; 0.555)

Data are adjusted odds ratio (95% C.I, *p*-values). Potential accelerators were defined as predictors that were significantly associated with two or more SDG targets. [a]SDG targets that were no longer significant after corrections for multiple comparison using the Benjamin Hochberg corrections

Table 9 Adjusted probability of SDG outcomes considering different combinations of identified accelerator protective factors

SDG outcomes / **Hypothesised Accelerators**	3.4 No Substance Use	3.4 No Stunting	3.4 No underweight	4.1 School progression	4.4 Optimal school attendance	4.4 Ability to concentrate	5.6 No risky sexual behaviour	16.1 No self-perpetration of violence	16.1 No community violence	16.5 No sexual Abuse
No accelerator	0.70 0.58–0.79	0.77 0.67–0.85	0.76 0.66–0.85	0.39 0.30–0.49	0.60 0.48–0.70	0.33 0.23–0.47	0.74 0.64–0.82	0.51 0.41–0.63	0.37 0.27–0.48	0.83 0.73–0.91
No survival work	0.58 0.44–0.70	0.83 0.75–0.90	0.79 0.69–0.87	0.49 0.41–0.57	0.58 0.48–0.67	0.37 0.27–0.47	0.77 0.69–0.85	0.55 0.45–0.65	0.43 0.34–0.53	0.82 0.72–0.89
Food security	0.67 0.52–0.79	0.73 0.59–0.82	0.77 0.65–0.86	0.39 0.30–0.48	0.68 0.59–0.78	0.42 0.31–54	0.79 0.71–0.86	0.57 0.45–0.67	0.49 0.38–0.60	0.88 0.79–0.94
Safe schools	0.71 0.57–0.82	0.77 0.64–0.85	0.75 0.63–0.84	0.38 0.31–0.48	0.59 0.49–0.69	0.39 0.29–0.51	0.74 0.63–0.82	0.63 0.52–0.73	0.56 0.45–0.67	0.88 0.78–94
Parenting support	0.74 0.62–0.83	0.77 0.67–0.86	0.76 0.66–0.84	0.37 0.29–0.47	0.65 0.53–0.75	0.36 0.25–0.47	0.74 0.63–0.83	0.61 0.48–0.72	0.42 0.31–0.54	0.85 0.74–0.92
Good mental health	0.72 0.57–0.83	0.77 0.65–0.85	0.78 0.65–0.87	0.40 0.31–0.49	0.64 0.54–0.74	0.54 0.42–0.66	0.78 0.69–0.86	0.70 0.59–0.79	0.42 0.31–0.54	0.85 0.74–0.92
All accelerators	0.88 0.83–0.93	0.84 0.77–0.89	0.80 0.73–0.86	0.57 0.49–0.65	0.81 0.74–0.87	0.71 0.62–0.79	0.87 0.81–0.92	0.87 0.81–0.91	0.70 0.59–0.79	0.94 0.90–0.96
Marginal effect	0.18 0.18–0.19	0.07 0.06–0.07	0.04 0.04–0.05	0.18 0.16–0.20	0.22 0.21–0.22	0.37 0.37–0.38	0.14 0.13–0.15	0.35 0.34–0.35	0.34 0.33–0.34	0.10 0.10–0.11

Marginal effects models with covariates held at their individual values. Data are fitted probabilities (95% CI)

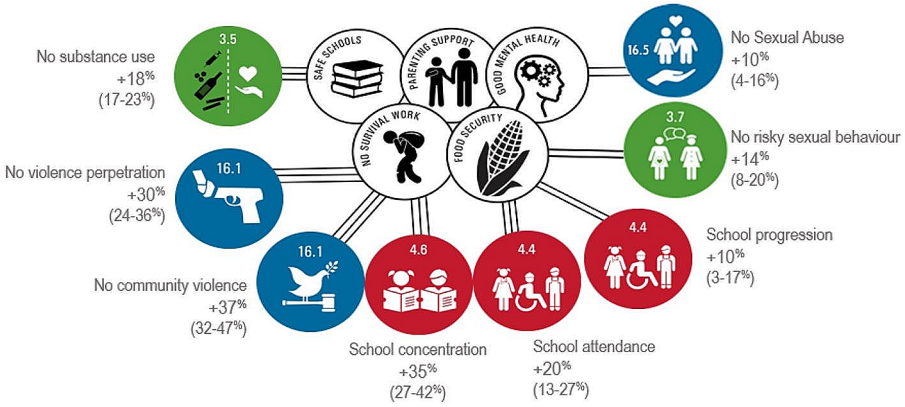

Fig. 1 Probability differences comparing adjusted probability of achieving the sustainable development goals in the absence and presence of a combination of a combination of accelerator protective factors with the number of lines indicating the number of accelerator protective factor combination. Data are point improvements (95% CI) in percentage probabilities. Double lines indicate where two protective factors are associated with outcomes and triple lines indicate when three protective factors are associated with outcomes

number of lines indicating the number of accelerator protective factor combination. Double lines indicate where two protective factors are associated with outcomes and triple lines indicate when three protective factors are associated with outcomes. The diagram shows that combining three protective accelerators led to greater percentage gains than combination of two (2) accelerator protective factors for example a combination of three accelerators lead to 37% increase in in likelihood of not engaging in substance use, 36% increase in the likelihood of not being engaged in community violence and 30% increase in not being involved in violence perpertration. The detials of how the percentage increase were measured have been detailed in Tamambang et al. (Tamambang et al., 2024).

4 Discussion

In this study, after controlling for socio-demographic correlates and multiple testing, five accelerators for achieving the SDG targets were identified in a sample of adolescents in Southwest, Nigeria. These accelerators included being in a safe school, not doing survival work, having good mental health, food security and parenting support. Safe schools, good mental health and parenting support had the strongest associations as they were associated with achieving 4 or more SDG targets after controlling for confounders. We also demonstrated the concept of accelerator synergies— a concept that posits that combinations of accelerators will have improved effects across breath (number of targets achieved) and depth (likelihood of achieving a target) of SDG targets.

Good mental health was one of the strongest accelerators identified in the current study (it was linked to the achievement of six out of the 10 SDG targets, spanning four goals with p-values < 0.001). Children who had good mental health were less

likely: to use psychoactive substances (SDG3.4), engage in risky sexual behaviours (SDG 5.6) and violence perpetration (SDG16.1a), experience community violence (SDG 16.a) and sexual abuse (SDG 16.b) and were more likely to concentrate in school (SDG 4.4). The World Health Organisation, defines Youth Mental Health as "state of well-being, allowing young people to manage their thoughts and emotions, learn and acquire an education, have a positive sense of identity, fulfilling social life, and fully participate in society" (Maenhout et al., 2020; WHO, 2018). This definition of mental health cuts across different domains that are essential for young people to function at the optimal capacity in society and this can explain why mental healthconditions can be highly disabling. Evidence has shown that, the onset of mental health conditions such as anxiety and depression predicts other indirect negative outcomes in different areas of students' lives such as low educational attainment, increased exposure to violence, and involvement in sexual acts, and negatively impacts adolescents relationships with support systems (Agnafors et al., 2020; Bennett & Bauman, 2000; Juma et al., 2020). Mental health conditions like depression are characterised by both the inability to concentrate and intrusive ruminative thoughts which likely reduce cognitive functioning (American Psychiatric Association, 2000). A reduction in cognitive functioning implies disturbance in learning, thinking, reasoning, decision-making and problem-solving abilities. These qualities are imperative for achieving educational outcomes and optimal interaction in society (Khadija et al., 2018; Wascher et al., 2018). The relationship between cognitive function, learning, decision-making and problem-solving could explain why participants in the current study who had good mental health had better outcomes in terms of substance use, education, violence, and sexual and reproductive health.

In 2006, Nigeria adopted a five-component national school health policy (Federal Ministry of Education, 2016). One of the aims of the policy was the creation of school health services consisting of pre-entry medical screening, routine health screening, first aid, and provision of counselling services. Critical analysis of this policy 13 years after it was enacted revealed that, the policy had not been implemented and the guidelines on how to improve school psychological environment and running of counselling services were not listed (Dania & Adebayo, 2019). With increasing school enrolment in Nigeria and other LMICS, school mental health programmes provide a scalable opportunity to improve the mental well-being of adolescents (Shinde et al., 2018). Schools are recommended as a setting for promoting health and well-being by the 2016 Lancet Commission of Adolescent health and well-being (Patton et al., 2016). The incorporation of mental health into existing school health programmes is cost-effective as it has been shown to improve different domains of adolescent health. Evidence of the effectiveness of small-scale mental health interventions such as school group-based cognitive psychotherapy, problem-solving, social skills interventions has been established in Nigeria (Abdumalik et al., 2016; Adeniyi & Omigbodun, 2016; Bella-Awusah et al., 2016). Expanding on and incorporating these small-scale interventions into already existing school health programmes/policies could be an efficient way of improving the mental well-being of adolescents in Nigeria (Bella-Awusah & Omigbodun, 2020).

A proof-of-concept study identified "safe school" as an accelerator that helps achieve 5 SDG targets among adolescents living with HIV/AIDS in South Africa. These targets include good mental health, school progression, non-perpetration of

violence, no community violence, and no emotional or physical abuse (Cluver et al., 2019). This result is consistent with the current study which showed that adolescents who perceived their school as safe were less likely to use psychoactive substances, more likely to have good educational outcomes (optimal school attendance and good concentration in school), and more likely to achieve all the SDG targets under the protection dimension of the United Nations Convention of the Rights of the Child (that is, no risky sexual behaviours, no self-perpetration of violence, no community violence, and no sexual abuse). According to USAID (2016), a safe learning environment is a place where structured learning is free from environmental, internal and external threats to learners and educators (USAID, 2016). Internal threats to safe learning environments identified in literature include bullying, corporal punishment, and gang recruitment. The operational definition of safe school in the current dataset was self-report of not having experienced bullying in school. A growing body of evidence indicates that a safe and healthy learning environment is essential for students to maximize academic performance and learning (USAID, 2016). Studies carried out in Ghana and other developed countries have shown that students who perceive their schools as being unsafe suffer from inability to concentrate and low self-esteem which could affect school attendance, engagement and motivation (Barrett et al., 2012; Dunne et al., 2013; Ripski & Gregory, 2009). Children who engage fully in school by not skipping classes may have less unstructured free time and are consequently less likely to engage in risky behaviours like substance use and self-perpetration of violence as seen in the current study.

Evidence from high resource settings and some parts of Africa have shown that school-based violence prevention interventions are effective in reducing violence against children from their peers and teachers. A social inclusion programme in Australia called the "Gatehouse project" reduced interpersonal violence and antisocial behaviours among students in secondary school. In the elementary schools in Hawaii and US, "Positive Action" project which is a multiple risk behaviour intervention resulted in reduced violent behaviours after 3 to 6 years (Beets et al., 2009; Flay et al., 2004). Recently in Uganda, a case control study was carried out to assess impact of the "Good School toolkit" among adolescents aged 11–14 years in 42 primary schools in Uganda (Devries et al., 2015). The results showed that prevalence of past week physical violence was 16% lower in the intervention group (Devries et al., 2015). Adaptation of some of these school violence prevention programs in Nigeria could have a ripple effect on different areas of adolescent health as predicted by the results of the current study.

In the current study, adolescents who had higher scores on the parenting support scale were less likely to use psychoactive substances, had optimal class attendance and had better violence related outcomes (self-perpetration of violence and community violence). Previous studies have shown that poor parental support of adolescent is associated with engagement in risky behaviours such as skipping school, drug/alcohol use, stealing and hurting someone. This evidence is consistent with findings of the current study. During the developmental period of adolescence, the pre-frontal cortex (an area associated with inhibition and decision-making) is under-developed (Pharo et al., 2011). Due to the impairment in decision making, the likelihood of engaging in risky sexual behaviour during adolescence is higher compared to the

period of adulthood (Steinberg, 2007). For most children, the family is the central sphere of influence as it is the everyday environment, they contact. Parents are a crucial part of this social environment (WHO, 2007). Parental monitoring aimed at tracking adolescents activities or location is one factor that serves as a "check" for adolescent risky behaviour (Villarreal & Nelson, 2018).

Family support programmes can provide parents with the resources and skills they need to effectively interact with adolescents and perform their parenting responsibilities. The Governments and non-governmental organisations (NGOs) in LMICs are increasingly recognising the critical role of families in the development of adolescents. Parenting programmes in LMICs were initially focused on parents of young children but new programmes have now included parents of adolescents (Marcus et al., 2019). A review of parenting programmes for adolescents in LMICs revealed that majority of the programmes in this setting not only improve communication between adolescents and their parents but had a positive impact on psychoactive substance use psychosocial well-being, experience of violence and sexual and reproductive health (Marcus et al., 2019). Examples of the programmes included in the review were Families Matter, Strengthening Families programme and Parenting for lifelong health (Kumpfer & Magalhães, 2018; Vandenhoudt et al., 2010; WHO, 2024). All are group-based and have been implemented in Sub-Saharan Africa.

The current study showed that combination of factors relating to the family/caregiver (parenting support), environmental (no survival work and food security) and school (safe schools) showed additive effects across the SDG targets. The social ecology theory of resilience proffers that, amid extreme risk, children's success results from a combination of personal capacities, environmental supports such as helpful parenting, enabling school environments, and improved socioeconomic conditions for the family (Ungar, 2011). Therefore, in order to achieve optimal outcomes for adolescents, public health interventions need to adopt a multidimensional approach involving adolescents, parents, school systems as well as the community (Ikorok et al., 2015). For example, in a sample of adolescents living with HIV in South Africa, a combination of cash transfers, parenting support and safe schools increased the probability of progressing in school by 33% compared to when an adolescent had none of those factors (Cluver et al., 2019). Though the current study did not identify specific interventions, the results form a foundation on which resource-limited countries like Nigeria could formulate integrated interventions and policies geared towards SDG attainment among adolescents.

5 Implications of the study

Up to three quarters of African countries (including Nigeria) either have insufficient data or are lagging behind in meeting global targets for child-related SDGs by the year 2030 (UNICEF, 2018). Our study, therefore, suggests ways to achieve the 2030 agenda especially in resource-constrained settings, by identifying factors that could simultaneously lead to attainment of multiple SDG targets. Armed with these findings, therefore, relevant stakeholders may prioritise interventions and policies which incorporate these identified accelerators viz; safe school, good mental health, no sur-

vival work, and parenting, towards improving the outcomes of adolescents in low- and middle-income countries vis-à-vis the sustainable development goals.

6 Limitations and strengths

A major limitation of this study is that out-of-school adolescents who are known to have poorer outcomes (Manzuma-Ndaaba Ndanusa et al., 2021) were not included. Consequently, our results may not be generalizable to out-of-school children who are usually the most disadvantaged (Manzuma-Ndaaba Ndanusa et al., 2021). Nevertheless, our study sample consisted of a relatively large and representative number of adolescents from both urban and rural parts of Ibadan. The fact that information was obtained by self-report might have posed another limitation to our findings. Although this limitation is inherent in cross-sectional studies, we expect that the rigour of questioning by the study interviewers— who also assured participants of utmost confidentiality— would have helped to reduce the impact of self-reporting bias.

Also, our findings are based on data from about 20 years ago, which makes it somewhat of a historical data and, as such, may be deemed non-relevant to the current situation in Nigeria. However, findings from more recent national surveys such as the Nigeria Multidimensional Poverty Index (2022) and the National Bureau of Statistics (NBS) and United Nations Children's Fund (UNICEF) Multiple Indicator Cluster Survey 2021 (NBS, UNICEF., 2022) show that our data is quite reflective of the current situation. For instance, the Food and Agricultural Organisation (FAO) reported a rise in the prevalence of undernourishment in Nigeria from 7.1% in 2005 to 14.6% in 2019 (FAO, 2021); experience of "security shocks" which includes sexual and community violence has been estimated to be 15.7% (Nigeria Multidimensional Poverty Index, 2022) compared to 10.4% for sexual violence found in our study; prevalence of food insecurity has been reported to be 50.9% (Nigeria Multidimensional Poverty Index, 2022) compared to 31.6% found in our study; 21.3% of children aged 7–14 years were reported to have parental assistance with their homework in 2021 (NBS, UNICEF., 2022); and 20.6% of children aged 5–17 years have been reported to be involved in economic activities (NBS, UNICEF., 2022) compared to the 18.2% prevalence of engagement in survival work found in our study. Although these surveys were not restricted to adolescents, adolescents were included, thus giving some room for extrapolation of the overall findings to adolescents. In addition, our findings are concurrent with recent accelerator evidence emerging from other countries in Africa (Cluver et al., 2019; Mebrahtu et al., 2021). For example, a study carried out by Lucie et al., on a group of adolescents living with HIV in South Africa showed that safe school was a protective factor increasing the probability of achieving violence-related, educational and health outcomes like what was recorded in the current study.

7 Conclusion

This study aimed at identifying potential drivers for the attainment of the SDGs among in-school adolescents in Nigeria using the UN accelerator concept. Absence of a mental health problem, perceiving school as safe, not doing survival work, food security, and parenting support, were each associated with increased odds of attaining least 2 SDG targets. Also, combination of these six (6) accelerators resulted both in increased likelihood of attaining an SDG target as well as the number of SDG targets attained with three combinations showing the highest increase. These findings provide valuable evidence upon which policy makers and other relevant stakeholders can base the design of cost-effective interventions tailored towards the attainment of the SDGs among adolescents in sub-Saharan Africa and other LMIC settings.

Authors' contributions All authors contributed to the study conception and design. Data collection and entry was coordinated by Olayinka Omigbodun; material preparation, and analysis were performed by Olayinka Omigbodun, Rita Tamambang, Kwabena Kusi-Mensah, Tolulope Bella-Awusah, Olusegun Ogunmola, Adeola Afolayan, Elona Toska, Lucas Hertzog, William Rudgard, Robin Evans, Heidi Stoeckl, and Lucie Cluver. The first draft of the manuscript was written by Rita Tamambang and Olayinka Omigbodun and all authors commented on the manuscript. All authors read and approved the final manuscript.

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Availability of data and materials The data used for this study is available upon reasonable request.

Declarations

Statement Regarding Informed Consent In the original study that produced the data for this current study, parents of study participants who were less than 18 years provided informed consent while their children provided assent; participants who were 18 years and above also gave their informed consent.

Statement Regarding Ethical Approval Ethical approval (for the original study that produced the data used for this current study) was received from the Ethical Committee on Research of the Ministry of Health, Oyo state, Nigeria.

Statement Regarding Research Involving Human Participants and/or Animals The original research that produced the data used for these secondary analyses complied with the principles of the Helsinki Report guiding research involving human participants.

Competing Interests No potential conflict of interest was reported by the authors.

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