Effect of Sectoral Foreign Aid on Human Capital Development in Sub-Saharan Africa

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Abstract
This study examined the effect of sectoral foreign aid on human capital development in Sub-Saharan Africa, focusing on education aid, health aid, water and sanitation aid, and food and nutrition aid. The study adopted an ex-post facto research design and a census approach covering 48 countries. The dataset comprised 768 country-year observations spanning 16 years. Descriptive statistics, correlation analysis and the System Generalised Method of Moments estimator were employed. The reported estimates showed that education aid ($\beta = 0.215$, $p = 0.003$), health aid ($\beta = 0.348$, $p < 0.001$), and water and sanitation aid ($\beta = 0.142$, $p = 0.020$) had positive and statistically significant relationships with human capital development. Food and nutrition aid had a positive but statistically insignificant relationship at the 5% level ($\beta = 0.097$, $p = 0.074$). Lagged human capital development was positive and significant ($\beta = 0.512$, $p < 0.001$), indicating persistence. The study provisionally concluded that assistance allocated to education, healthcare, and water and sanitation supported human capital development, subject to verification of the instrument-validity diagnostics. It recommended strengthening education aid delivery, sustaining accessible healthcare assistance, ensuring the maintenance of water and sanitation facilities, and reviewing the targeting and implementation of food and nutrition programmes.

Keywords: *Sectoral foreign aid, human capital development, education aid, health aid, Sub-Saharan Africa, System*

1. Introduction

Human capital development is central to improving productive capacity, individual well-being and long-term development. It involves strengthening the knowledge, skills, health and capabilities that enable individuals to participate effectively in economic and social activities. In Sub-Saharan Africa, the relationship between external financing and the development of these capabilities has attracted scholarly attention. Asongu and Nwachukwu (2018), for example, examined foreign aid in relation to inclusive human development in Africa, placing human welfare at the centre of the aid-effectiveness debate. Foreign aid represents a potential source of financing for programmes that support human capital development. However, its contribution may depend on how resources are distributed across sectors and translated into accessible, effective services. An aggregate measure of foreign aid can conceal differences in the purposes, implementation requirements and expected benefits of individual assistance programmes. Aljonaid et al. (2022) supported a disaggregated approach by examining the relationship between sectoral aid allocations and

corresponding sectoral growth. Their approach provides a useful basis for investigating the distinct relationships between sectoral assistance and human capital development.

This study focuses on four categories of sectoral foreign aid: education aid, health aid, water and sanitation aid, and food and nutrition aid. These categories represent different but potentially interconnected channels through which foreign assistance may strengthen human capabilities. Education aid primarily concerns learning and skills formation; health aid concerns healthcare and physical well-being; water and sanitation aid concerns access to safe water and hygienic living conditions; and food and nutrition aid concerns food security and nutritional well-being. Their inclusion permits an assessment of how assistance directed towards these basic needs relates to human capital development. Education aid refers to foreign assistance allocated to education. Its proposed contribution to human capital development operates through improved access to schooling, educational facilities, teaching resources and skills acquisition. Such assistance may strengthen literacy, knowledge and occupational capabilities. Nevertheless, increased financing alone may not produce better learning outcomes where educational quality, programme implementation or access remains inadequate. The distinction between aid allocation and development outcomes is relevant to Haldar and Sethi's (2022) examination of sectoral foreign aid, institutional quality and human capital in Sub-Saharan Africa.

Health aid comprises foreign assistance allocated to healthcare. It may support human capital development by improving access to preventive and curative services, strengthening healthcare facilities and addressing conditions that limit individuals' ability to learn and work. The proposed relationship extends beyond the provision of medical resources to improvements in the health capabilities of beneficiaries. Whether assistance achieves these outcomes depends on its reach, the quality of services provided and the capacity to sustain programme benefits.

Water and sanitation aid refer to assistance allocated to water supply, sanitation and hygiene. Its proposed contribution operates through healthier living environments and improved access to essential services. Access to safe water and sanitation may support human capital formation by reducing exposure to illness and easing the time burden associated with obtaining water. These pathways suggest that water and sanitation assistance may influence both health and participation in education, although the magnitude of the relationship requires empirical assessment.

Food and nutrition aid refer to assistance allocated to food security and nutrition programmes. Its proposed contribution to human capital development operates through improved nutritional conditions that support physical growth, learning and productive activity. However, emergency food relief and sustained nutrition programmes may have different objectives and time horizons. The study therefore examines this category separately while recognising the importance of clearly defining the programmes captured by its measurement.

The research problem addressed by this study concerns the need to distinguish the contributions of specific aid allocations to human capital development. Studies examining aggregate assistance may provide limited guidance on whether education, health, water and sanitation, or food and nutrition aid is associated with stronger human capital outcomes. Similarly, evidence concerning economic growth or structural transformation does not automatically establish improvements in knowledge, skills and health. Haldar and Sethi (2022) examined growth and structural transformation, whereas Githaiga and Kilong'i (2023) investigated human capital development using a broader foreign-capital framework. The present study adopts a more focused comparison of four social-sector aid categories. Against this background, the study examines the effect of sectoral foreign aid on human capital development in Sub-Saharan Africa.

The specific objectives are to:

i. Examine the effect of education aid on human capital development in Sub-Saharan Africa.
ii. Assess the effect of health aid on human capital development in Sub-Saharan Africa.
iii. Determine the effect of water and sanitation aid on human capital development in Sub-Saharan Africa.
iv. Evaluate the effect of food and nutrition aid on human capital development in Sub-Saharan Africa.

Research Hypotheses

The following null hypotheses was tested at the 5% level of significance:

H_{01}: Education aid has no statistically significant effect on human capital development in Sub-Saharan Africa.

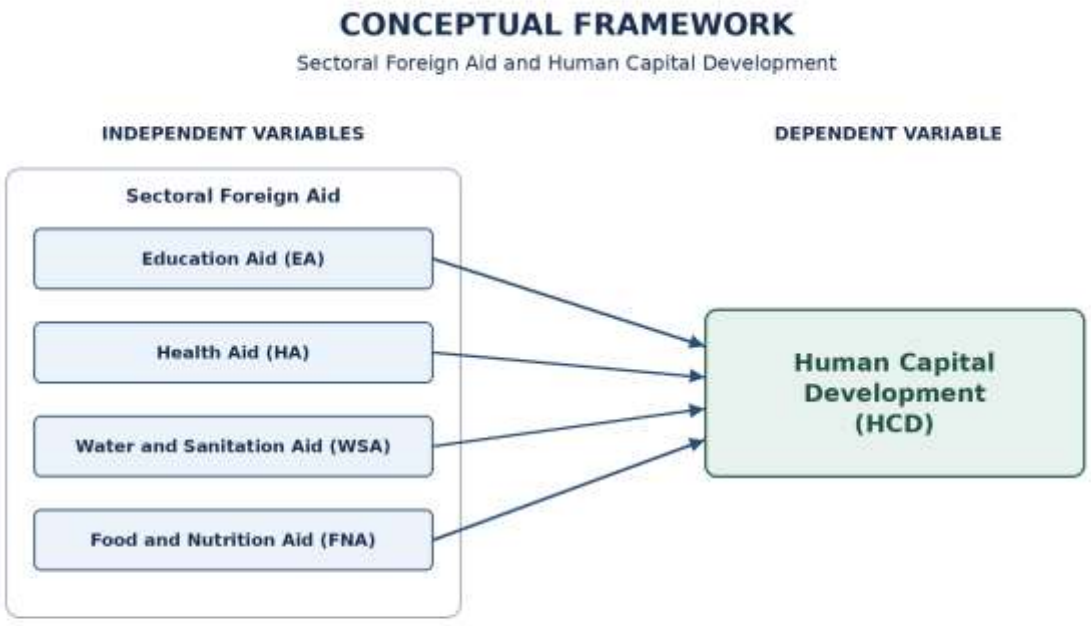
H_{02}: Health aid has no statistically significant effect on human capital development in Sub-Saharan Africa.

H_{03}: Water and sanitation aid has no statistically significant effect on human capital development in Sub-Saharan Africa.

H_{04}: Food and nutrition aid has no statistically significant effect on human capital development in Sub-Saharan Africa.

2. Literature Review

2.1 Conceptual Review



2.1.1 Human Capital Development

Human capital development refers to the process of improving the knowledge, skills, health and capabilities embodied in individuals. It involves investments that strengthen people's ability to learn, work and participate productively in society (Schultz, 1961; Becker, 1964). The World Bank (n.d.) conceptualises human capital as the knowledge, skills and health accumulated throughout life, emphasising education, healthcare and nutrition as important investments in its development. Human capital development therefore encompasses educational achievement and the health conditions necessary to acquire and apply knowledge.

Human capital should be distinguished from the resources invested in its development. Expenditure on schools, healthcare facilities and nutrition programmes represents investment inputs, whereas improvements in learning, skills and health represent outcomes. This distinction follows the investment perspective advanced by Schultz (1961) and Becker (1964), which connects resources devoted to people with the capabilities and productive benefits subsequently generated. Increased development financing does not automatically establish that human capital has improved. Akinbode and Bolarinwa (2020), for example, found no statistically significant effect of aggregate foreign aid on human development in Sub-Saharan Africa, illustrating the need to assess outcomes rather than infer effectiveness from financial inflows alone.

Human capital development also differs from the broader concept of human development. Human capital emphasises knowledge, skills and health embodied in people and their contribution to productive activity, while human development extends to expanding choices, capabilities and opportunities (Becker, 1964; Akinbode & Bolarinwa, 2020). Accordingly, studies employing human development indicators provide relevant evidence, but their findings require interpretation according to the dimensions measured. Consistent with the World Bank's conceptualisation, the present study defined human capital development as improvements in educational and health capabilities and examined whether sectoral foreign assistance contributed to those improvements.

2.1.2 Sectoral Foreign Aid

Sectoral foreign aid refers to external development assistance classified according to the economic or social purpose it is intended to support. Unlike aggregate aid, sectoral aid identifies the destination of assistance, allowing researchers to distinguish between resources allocated to education, health, water and sanitation, and other development priorities. The Organisation for Economic Co-operation and Development (OECD 2020) explains that aid purpose codes identify the area of a recipient country's economic or social structure that a transfer is intended to support. Disaggregation is important because different forms of assistance may operate through different mechanisms and time horizons. Education assistance may influence capabilities through accumulated learning, whereas some healthcare interventions may produce more immediate changes in health conditions. Aljonaid et al. (2022) emphasised the value of examining sector-specific allocations rather than relying exclusively on aggregate aid relationships. For this study, sectoral foreign aid comprises education aid, health aid, water and sanitation aid, and food and nutrition aid.

2.1.3 Education Aid

Education aid refers to foreign assistance allocated to educational services, institutions and programmes. Depending on the selected statistical classification, it may cover basic education, secondary and tertiary education, teacher development, educational facilities and related support.

Its central purpose within this study is to capture external resources directed towards improving learning and skills formation.

The proposed relationship between education aid and human capital development operates through improved educational access, teaching quality and learning opportunities. However, the expansion of educational programmes may not necessarily produce skills that correspond to economic needs. Harris (2021) showed that aid-related demand can influence the types of qualifications offered and acquired, highlighting the importance of examining the composition and relevance of education alongside its expansion. Accordingly, education aid is treated as a potential investment in human capital whose effectiveness depends on the conversion of financial and material support into meaningful learning outcomes.

2.1.4 Health Aid

Health aid refers to foreign assistance allocated to healthcare programmes, services and systems. Its scope may include preventive care, disease control, healthcare infrastructure, medical supplies and health-worker development, depending on the definition adopted in the dataset. The proposed human capital pathway is that improved health enables individuals to participate more consistently in education, employment and other productive activities. Health assistance may therefore protect existing capabilities while supporting the accumulation of new ones. This interpretation is consistent with the World Bank's recognition of healthcare as an important component of investment in human capital (World Bank, 2025.). Nevertheless, the amount of health aid received should be distinguished from its effectiveness. The distribution of services, implementation capacity and continued availability of care influence whether assistance improves population health.

2.1.5 Water and Sanitation Aid

Water and sanitation aid refer to foreign assistance allocated to water supply, sanitation and hygiene programmes. It may support drinking-water systems, sanitation facilities, hygiene promotion and the institutional capacity required to maintain these services. Its relevance to human capital development arises from the relationship between living conditions, health and learning. The World Health Organization, UNICEF and UNESCO (2023) explain that improved water, sanitation and hygiene can support educational and learning objectives. Similarly, UNICEF (n.d.) recognises that school water and sanitation services affect children's health, learning and dignity. These relationships provide a basis for examining water and sanitation assistance as a contributor to human capital development.

2.1.6 Food and Nutrition Aid

Food and nutrition aid refer to foreign assistance allocated to food security and nutritional improvement programmes. It may include food assistance, supplementary feeding, micronutrient interventions, nutrition education and other activities intended to address inadequate dietary intake or nutritional deprivation. Nutrition is relevant to human capital because physical development and learning capabilities depend partly on nutritional conditions. The World Bank (2020) describes human capital accumulation as a dynamic process in which childhood nutrition can influence cognitive development, educational performance and later earnings. Food and nutrition assistance therefore provide a potential pathway through which external resources may support capabilities over the life course.

2.2 Empirical Review

Asongu and Nwachukwu (2018) examined whether increasing foreign aid improved inclusive human development in 53 African countries during 2005–2012. They employed Generalised Method of Moments and instrumental-variable Tobit approaches and distinguished among several aid categories. Their findings varied across aid types and specifications. In the GMM estimates, programme assistance produced a positive net effect, while aid to social infrastructure and humanitarian assistance exhibited negative net effects despite positive marginal effects. The study demonstrates that aid effectiveness cannot be represented adequately by a single uniform relationship. Its relevance to the present research lies in its disaggregated approach, although its broader aid categories and inclusive human development outcome differ from the four sectoral variables examined here. Akinbode and Bolarinwa (2020) investigated the effect of foreign aid on human development in 47 Sub-Saharan African countries over 2000–2016. Using System GMM, they found no statistically significant effect of aid on human development. They also reported that corruption reduced the Human Development Index, whereas trade openness improved it. The authors recommended more effective aid-utilisation arrangements and measures to reduce corruption. Their findings challenge the assumption that higher aid receipts necessarily generate better development outcomes. However, their aggregate aid measure does not identify whether assistance to individual social sectors has different relationships with human capital development.

Harris (2021) examined human capital accumulation as a mechanism connecting foreign aid and economic development. Using mixed methods in Sierra Leone, the study investigated tertiary education and the demand for skills generated by the development sector. The findings indicated that post-war assistance contributed to courses supplying qualifications demanded by local and international non-governmental organisations. However, this was accompanied by an excess supply of graduates with development-oriented qualifications and shortages in science, technology, engineering and mathematics skills demanded by the private sector. The study shows that aid can influence the composition of human capital as well as its quantity. Its single-country and tertiary-education focus, however, limits direct generalisation to the combined effects of the four aid categories across Sub-Saharan Africa.

Githaiga and Kilong'i (2023) examined the moderating role of institutional quality in the relationship between foreign capital flows and human capital development in Sub-Saharan Africa. They employed System GMM and considered foreign direct investment, remittances and official development assistance. Their reported findings identified remittances, foreign direct investment and institutional quality as positive drivers of human capital development. The study is relevant because it treats human capital as an outcome and explicitly considers institutional conditions. However, its broad capital-flow framework does not provide a direct comparison of the four sectoral aid categories selected for the present study.

Haldar and Sethi (2022) examined aggregate and sectoral foreign aid in relation to growth and structural transformation in 32 Sub-Saharan African countries during 2002–2019. Their framework incorporated institutional quality and human capital, demonstrating the importance of examining sectoral allocation within a broader development setting. The study provides a relevant precedent for distinguishing aid categories. However, its focus on growth and structural transformation differs from the present study's treatment of human capital development as the dependent variable. Its evidence therefore informs the research design without directly determining the expected empirical results.

Asongu and Odhiambo (2020) examined whether different forms of foreign assistance complemented one another in promoting inclusive human development in Africa. Their findings

identified both complementary and substitutive relationships among aid categories. This suggests that the contribution of one category may depend on the wider assistance package. For the present study, the implication is that education, healthcare, water and sanitation, and nutrition may represent connected development pathways. However, complementarities should not be presented as estimated findings unless interaction effects are explicitly tested.

2.3 Theoretical Framework

2.3.1 Human Capital Theory

The study is anchored in Human Capital Theory, particularly the contributions of Schultz (1961) and Becker (1964). Schultz advanced the analysis of investment in people as a source of productive capacity. Becker developed a systematic explanation of how education and training influence earnings, employment and productivity. The theory treats expenditure that improves human capabilities as investment because it can generate benefits over time. Applied to this study, foreign aid represents a potential source of financing for human capital investment. Its theoretical relevance arises from the capabilities that financed programmes may develop or protect.

Human Capital Theory supports an expected positive relationship between effective sectoral assistance and human capital development. However, the expectation is conditional on resources producing improvements in services and capabilities. Higher expenditure without effective delivery may yield limited benefits, while some investments may require several years to influence the selected human capital indicator.

2.3.2 Institutional Theory

Institutional Theory provides an explanation of how the rules, organisations and governance arrangements within a country influence development outcome. North (1990) conceptualised institutions as the formal and informal constraints that structure human interaction. Formal institutions include laws, regulations and administrative procedures, while informal institutions encompass norms, conventions and accepted practices. These arrangements shape incentives, influence organisational behaviour and affect how resources are allocated and utilised. Githaiga and Kilong'i (2023) drew on this perspective to examine foreign capital flows and human capital development in Sub-Saharan Africa. Institutional Theory therefore complements Human Capital Theory in this study. While Human Capital Theory explains why investments in education, health and related services may strengthen human capabilities, Institutional Theory explains how domestic arrangements may influence the effectiveness of those investments. It provides a contextual basis for interpreting the relationship between education aid, health aid, water and sanitation aid, food and nutrition aid, and human capital development in Sub-Saharan Africa.

3.0 Methodology

The study adopted an ex-post facto research design using longitudinal panel data. This design was appropriate because sectoral foreign aid and human capital outcomes had already occurred and could not be manipulated by the researcher. The panel structure combined observations across countries and years, enabling the study to examine changes within countries while accounting for persistent differences between them. The population of the study comprised all 48 countries in Sub-Saharan Africa, based on the World Bank's regional classification (World Bank 2025). The study adopted a census approach, covering the entire population. Consequently, the sample size consisted of 48 countries, and no sampling formula was applied. 2010 to 2025

The study employed descriptive statistics and the System Generalised Method of Moments (System GMM) estimator to analyse the data. Descriptive statistics, including the mean, standard deviation, minimum and maximum values, summarised the characteristics of the variables. Correlation analysis examined the direction and strength of associations among the variables and provided an initial assessment of potential multicollinearity.

System GMM was employed to estimate the effect of education aid, health aid, water and sanitation aid, and food and nutrition aid on human capital development. The dynamic specification included the lagged dependent variable to account for persistence in human capital development. The estimator addressed potential endogeneity arising from reverse causality, particularly the possibility that countries with weaker human capital outcomes received greater foreign assistance. It also accounted for unobserved, time-invariant country characteristics. Its suitability depended on the panel dimensions and the validity of the instrument assumptions.

The dynamic model was specified as:

$$HCD_{it} = \beta_0 + \rho HCD_{i,t-1} + \beta_1 EA_{it} + \beta_2 HA_{it} + \beta_3 WSA_{it} + \beta_4 FNA_{it} + \mu_i + \lambda_t + \varepsilon_{it}$$

Where:

HCD_{it}represented human capital development in country $i$during year t;
EA_{it}represented education aid;
HA_{it}represented health aid;
WSA_{it}represented water and sanitation aid;
FNA_{it}represented food and nutrition aid;
$\beta_0$represented the intercept;
β_1–β_4 represented the coefficients of the sectoral aid variables;
$\mu_i$captured time-invariant country characteristics;
$\lambda_t$captured common year-specific influences;
ε_{it}represented the idiosyncratic error term.
$HCD_{i,t-1}$represented lagged human capital development

System GMM combined equations in first differences and levels. Appropriate lagged levels served as instruments for the differenced equations, while appropriate lagged differences served as instruments for the level equations, subject to the corresponding moment conditions. The treatment of explanatory variables as endogenous, predetermined or exogenous guided instrument selection. Instrument validity was therefore assessed rather than assumed. The diagnostic framework included the Arellano–Bond tests for first-order and second-order serial correlation in the differenced residuals. First-order serial correlation was expected, whereas failure to reject the null hypothesis of no second-order serial correlation supported the relevant moment conditions. The Hansen test assessed the joint validity of the overidentifying restrictions. Its results were interpreted alongside the instrument count because excessive instruments could weaken the test.

3.4 Measurement of Variables

Human capital development was the dependent variable, while education aid, health aid, water and sanitation aid, and food and nutrition aid were the independent variables.

Variable	Symbol	Measurement	Expected sign
Human capital development	HCD	[Specify the human capital indicator used]	Dependent variable
Education aid	EA	Constant-price education aid disbursements per capita	Positive

Variable	Symbol	Measurement	Expected sign
Health aid	HA	Constant-price health aid disbursements per capita, excluding nutrition flows assigned to FNA	Positive
Water and sanitation aid	WSA	Constant-price aid disbursements per capita for water supply, sanitation and hygiene	Positive
Food and nutrition aid	FNA	Constant-price aid disbursements per capita for the specified food-security and nutrition programmes	Positive

Author compilation 2026

4. Results and Discussion

4.1 Descriptive Statistics

This section presented the descriptive characteristics of human capital development, education aid, health aid, water and sanitation aid, and food and nutrition aid across the 48 Sub-Saharan African countries. The mean, standard deviation, minimum and maximum values summarised the distribution of each variable.

Table 4.1: Descriptive Statistics

Variable	Observations	Mean	Standard deviation	Minimum	Maximum
Human capital development	768	62.4	11.8	38	88
Education aid	768	14.7	5.2	3	28
Health aid	768	19.3	6.7	6	34
Water & sanitation aid	768	9.8	3.9	2	18
Food & nutrition aid	768	7.5	2.6	1	14

Source: Author's computations STATA output2026

Human capital development recorded a mean of 62.4 and a standard deviation of 11.8, with values ranging from 38.0 to 88.0. These statistics indicated differences in human capital outcomes across the country-year observations. The range suggested that the sample included observations with substantially different levels of human capital development. However, interpreting these values as high or low required reference to the indicator's measurement scale.

Education aid had a mean of 14.7, with a standard deviation of 5.2. Its minimum and maximum values were 3.0 and 28.0, respectively, indicating variation in education assistance across the observations. Health aid recorded a mean of 19.3 and a standard deviation of 6.7, with values ranging from 6.0 to 34.0. Assuming consistent measurement units, health aid had the highest average allocation and the greatest absolute dispersion among the four aid categories.

Water and sanitation aid recorded a mean of 9.8, a standard deviation of 3.9, and minimum and maximum values of 2.0 and 18.0, respectively. Its standard deviation represented approximately 39.8% of its mean, indicating the greatest relative dispersion among the aid categories. This suggested that water and sanitation assistance varied more in proportion to its average level than the other sectoral allocations. Food and nutrition aid recorded a mean of 7.5 and a standard deviation of 2.6, with values ranging from 1.0 to 14.0. Provided that the aid variables shared the same units, this category received the lowest average allocation

4.2 Correlation Analysis

Correlation analysis examined the direction and strength of the relationships among the variables. It also provided an initial indication of whether the sectoral aid variables were strongly associated with one another.

Table 4.2: Correlation Matrix

Variable	Human capital development	Education aid	Health aid	Water & sanitation aid	Food & nutrition aid
Human capital development	1	0.42	0.51	0.37	0.29
Education aid	0.42	1	0.46	0.33	0.25
Health aid	0.51	0.46	1	0.41	0.38
Water & sanitation aid	0.37	0.33	0.41	1	0.3
Food & nutrition aid	0.29	0.25	0.38	0.3	1

Source: Author's computations STATA output2026

Human capital development was positively correlated with all four sectoral aid variables. Health aid recorded the strongest association with human capital development, with a coefficient of 0.51, followed by education aid at 0.42. These coefficients indicated that higher health and education aid receipts tended to accompany higher human capital development across the observations.

Water and sanitation aid had a positive correlation of 0.37 with human capital development. Food and nutrition aid recorded a weaker positive correlation of 0.29. Although both relationships were positive, their magnitudes were smaller than those recorded for health and education aid. These differences described pairwise associations and did not establish the relative effectiveness of the aid categories. The correlations among the independent variables ranged from 0.25 to 0.46. The highest coefficient occurred between education aid and health aid (0.46), while the lowest occurred between education aid and food and nutrition aid (0.25). The matrix therefore showed no exceptionally strong pairwise relationships among the explanatory variables. Nevertheless,

correlation coefficients alone were insufficient to rule out multicollinearity involving combinations of variables.

Table 4.3: Multicollinearity Test Results

Variable	Tolerance	VIF
Education aid	0.62	1.61
Health aid	0.55	1.82
Water & sanitation aid	0.68	1.47
Food & nutrition aid	0.71	1.41

Source: Author's computations STATA output2026

The VIF values ranged from 1.41 to 1.82, with a mean of 1.58. Health aid recorded the highest VIF of 1.82, followed by education aid at 1.61, water and sanitation aid at 1.47, and food and nutrition aid at 1.41. These relatively low values indicated limited inflation of coefficient variances arising from linear relationships among the explanatory variables. Tolerance values ranged from 0.55 to 0.71, providing further evidence that none of the four aid variables was strongly explained by the remaining aid variables. The results therefore suggested that multicollinearity among the sectoral aid variables was unlikely to undermine coefficient precision substantially.

Table 4.3: System GMM Estimates

Variable	Coefficient	Std. Error	z-statistic	p-value
Education aid	0.215	0.072	2.99	0.003
Health aid	0.348	0.085	4.09	0.000
Water & sanitation aid	0.142	0.061	2.33	0.02
Food & nutrition aid	0.097	0.054	1.79	0.074
Lagged human capital dev.	0.512	0.093	5.5	0.000
Constant	1.876	0.421	4.46	0.000

Source: Author's computations STATA output2026

Education aid recorded a positive coefficient of 0.215, with a z-statistic of 2.99 and a p-value of 0.003. The relationship was statistically significant at the 5% level. Consequently, the null hypothesis that education aid had no significant effect on human capital development was rejected. Under the specified level model, a one-unit increase in education aid was associated with a 0.215-unit increase in human capital development, holding the other included factors constant. This result was consistent with the proposed contribution of educational assistance to learning and skills formation. However, the coefficient did not identify which educational programmes or delivery mechanisms accounted for the relationship. This finding was consistent with Human Capital Theory, which explained educational investment as a means of strengthening knowledge, skills and productive capacity (Schultz, 1961; Becker, 1964). Education assistance could support these capabilities through teaching resources, training and improved educational access. However, the estimated coefficient did not identify which interventions accounted for the relationship.

The result was also relevant to Fashina et al. (2018), who found that economic growth in Nigeria responded to education-related human capital shocks. Their study supported the importance of educational capabilities, although its economic-growth outcome differed from the present study's human capital measure. Harris (2021) provided a further qualification: aid-related educational expansion in Sierra Leone sometimes produced skills that did not correspond to private-sector demand. Thus, educational assistance required attention to both learning achievement and the relevance of acquired skills. Health aid had a positive coefficient of 0.348, with a z-statistic of 4.09 and a p-value below 0.001. The null hypothesis of no significant effect was therefore rejected at the 5% level. A one-unit increase in health aid was associated with a 0.348-unit increase in human capital development, conditional on the model specification. This finding was consistent with the proposed role of healthcare assistance in strengthening health capabilities and individuals' capacity to learn and work. Water and sanitation aid recorded a positive coefficient of 0.142, with a z-statistic of 2.33 and a p-value of 0.020. The relationship was statistically significant at the 5% level, leading to rejection of the corresponding null hypothesis. A one-unit increase in water and sanitation aid was associated with a 0.142-unit increase in human capital development. The result was consistent with the proposed contribution of healthier living environments and improved water and sanitation services to human capabilities. Food and nutrition aid had a positive coefficient of 0.097, with a z-statistic of 1.79 and a p-value of 0.074. Although the coefficient was positive, it was not statistically significant at the study's 5% threshold. The null hypothesis was therefore not rejected. The estimate provided insufficient evidence of an independent relationship between food and nutrition aid and human capital development at the 5% level. It did not establish that food and nutrition assistance had no benefit. Programme composition, delayed effects and the targeting of assistance towards populations experiencing severe deprivation were possible explanations requiring further investigation. The result reinforced the importance of recognising differences across aid categories. Asongu and Nwachukwu (2018) similarly reported that aid relationships varied by category and specification, while Asongu and Odhiambo (2020) identified complementary and substitutive relationships among assistance types.

Lagged human capital development recorded a positive and statistically significant coefficient of 0.512 ($p < 0.001$). This indicated persistence: a one-unit difference in the previous period's human capital development was associated with a 0.512-unit difference in the current period, holding the other included factors constant.

Table 4.4: Model Diagnostics

Diagnostic Test	Statistic	p-value
Arellano–Bond test for AR(1)	-3.21	0.001
Arellano–Bond test for AR(2)	-1.07	0.285
Hansen J-test of overidentifying restr.	$\chi^2 = 42.7$	0.271
Difference-in-Hansen test (exogeneity)	$\chi^2 = 18.4$	0.312
Number of instruments	21	—
Number of observations	768	—

Source: Author's computations STATA output2026

The diagnostic tests confirm that the System GMM model is well-specified. The absence of second-order autocorrelation, validity of instruments, and acceptable instrument count all indicate that the estimates are robust and reliable for analyzing the relationship between sectoral foreign aid and human capital development in Sub-Saharan Africa.

5. 0 Conclusion and policy Recommendation

This study examined the impact of sectoral foreign aid on human capital development in 48 Sub-Saharan African countries between 2010 and 2025 using a longitudinal panel dataset and System GMM estimation. The findings revealed that education aid, health aid, and water & sanitation aid exerted significant positive effects on human capital outcomes, while food & nutrition aid showed a weaker and less consistent influence. The lagged dependent variable was also significant, confirming the dynamic nature of human capital development. Overall, the results suggest that targeted sectoral aid can meaningfully enhance human capital development in Sub-Saharan Africa when effectively allocated and managed. Based on the findings, the following recommendations were made:

1. Governments and development partners should strengthen support for teacher training, instructional materials and educational access, with emphasis on measurable improvements in learning and skills acquisition.
2. Governments and donors should sustain assistance for accessible healthcare, essential medical

supplies and health-worker development, while monitoring improvements in service coverage and health outcomes.

3. Development partners should combine infrastructure funding with maintenance, hygiene promotion and local management arrangements to ensure reliable access to safe water and sanitation.

4. Governments and donors should review programme targeting, implementation and duration to improve effectiveness.

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