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Governance Quality and Productivity Growth: Empirical Evidence from Uganda's Manufacturing Sector

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ABSTRACT

This paper examined the relationship between governance quality and productivity growth in Uganda's manufacturing sector. Drawing on Institutional Economic Theory, the study used a longitudinal design based on secondary panel data for the period 2010–2024. Governance quality was captured by five dimensions of the World Bank's Worldwide Governance Indicators (WGI): control of corruption, rule of law, political stability, government effectiveness, and regulatory quality. Firm-level data on output, labour, capital, and raw materials for domestic manufacturing firms were obtained from Uganda Revenue Authority (URA) tax returns, yielding 4,471 firm-year observations for 1,229 firms. Firm-level total factor productivity (TFP) was first derived from a Cobb-Douglas production function using Wooldridge's (2009) approach and then related to the governance indicators using a dynamic two-step System Generalized Method of Moments (System GMM) estimator, which addresses endogeneity and productivity persistence while controlling for region, industry, and year effects. The findings show that none of the five governance indicators had a significant direct effect on firm productivity. Regulatory quality had the strongest positive association, while rule of law, political stability, and government effectiveness carried negative but insignificant signs. Productivity depended mainly on firms' own past productivity, reflecting accumulated learning, technology, and organisational capability. The paper concludes that governance reforms, while important for a stable business climate, are not sufficient on their own to raise manufacturing productivity in Uganda, and recommends pairing them with firm-level industrial policies targeting technology adoption, workforce skills, access to finance, and infrastructure.

1. Introduction

Manufacturing plays a pivotal role in economic growth, structural transformation, employment generation, and poverty reduction by enabling countries to add value to raw materials, integrate into global value chains, and increase productivity. However, these benefits often depend on governance quality, including political stability, regulatory quality, control of corruption, the rule of law, and government effectiveness (Rodrik, 2022; Acemoglu & Robinson, 2020). In Uganda, the manufacturing sector has been prioritised in national development frameworks, including Uganda Vision 2040, the National Industrial Policy (2020), and the Third National Development Plan (NDP III), which identify industrialisation as a key strategy for structural transformation (Government of Uganda, 2020; UNDP, 2024). Despite this policy emphasis, the sector's contribution to GDP has stagnated at approximately 15% over the past decade, and firms operate at a low average capacity utilisation rate of around 54.4%, signalling persistent production inefficiencies and substantial underuse of installed resources (World Bank, 2023; Uganda Bureau of Statistics [UBOS], 2023).

These structural weaknesses coincide with, and are largely attributed to, governance-related constraints. Uganda's manufacturing firms continue to face unreliable electricity supply, high production costs, and weak infrastructure (African Development Bank [AfDB], 2024), as well as institutional and regulatory weaknesses, including inconsistent standards enforcement, bureaucratic hurdles, and inadequate innovation support systems. Lax enforcement of product quality standards also allows substandard goods to dominate domestic and export markets (Uganda National Bureau of Standards, 2023). Effective governance, transparency, accountability, sound regulation, and anti-corruption measures are expected to create a stable policy environment that encourages investment, improves operational efficiency, and ensures the fair enforcement of industrial laws (Kaufmann, Kraay, & Mastruzzi, 2010; Ali & Ahmed, 2023). However, empirical evidence specifically linking governance quality to productivity in Uganda's manufacturing sector remains limited (Mogaka & Musila, 2024).

From a theoretical perspective, the link between governance and productivity rests on Institutional Economic Theory, which views institutions as the rules that shape the incentives and costs facing firms (North, 1990). Where corruption is contained, contracts are enforced, regulation is predictable, and government delivers public services effectively, firms face lower transaction costs and less uncertainty, and can therefore commit resources to investment, technology, and organisational improvement (Acemoglu, Johnson, & Robinson, 2005). Because governance does not enter production as a physical input, its influence is expected to appear in total factor productivity (TFP), the efficiency with which firms convert labour, capital, and materials into output. Weak institutions, by contrast, raise the cost of doing business, distort resource allocation, and discourage long-term investment (Méon & Weill, 2010).

This paper makes three contributions. First, it moves the analysis from aggregate manufacturing output and national economic growth, the focus of most existing studies, to the productivity of individual manufacturing firms. Second, rather than treating governance as a single composite index, it separates governance into five Worldwide Governance Indicators, making it possible to establish whether particular dimensions matter more than others. Third, it combines firm-level URA tax return data with a dynamic System GMM estimator that accounts for productivity persistence and endogeneity, providing new evidence for Uganda, where such firm-level analysis has been scarce. The findings are directly relevant to policymakers seeking to align governance reforms with the industrialisation goals of Uganda Vision 2040 and the National Industrial Policy (Government of Uganda, 2020).

Against this background, this paper examines the effect of governance quality on the productivity growth of Uganda's manufacturing sector over the period 2010–2024. The rest of the paper is organised as follows. Section 2 reviews the theoretical and empirical literature, Section 3 describes the approach and methodology, Section 4 presents the results, Section 5 discusses the findings, and Section 6 concludes with policy implications and recommendations.

2. Theoretical and Empirical Review

2.1 Theoretical Review

The paper is anchored on Institutional Economic Theory, particularly its modern variant, New Institutional Economics, associated with Douglass C. North. North (1990) defines institutions as the formal rules (laws, regulations, and property rights) and informal constraints (norms and conventions) that structure human interaction. By making the behaviour of others more predictable, institutions reduce the uncertainty and transaction costs involved in exchange, protect property rights, and encourage productive investment. From this perspective, economic performance depends not only on physical resources such as capital and labour but also on the institutional environment in which economic activity takes place, including the organisational structures and shared expectations that give rules their force (Scott, 2014).

The theory identifies clear channels through which each dimension of governance can affect firms. Kaufmann, Kraay, and Mastruzzi (2010) group governance quality into political stability, government effectiveness, regulatory quality, rule of law, and control of corruption. Corruption raises the cost of permits, licences, and public services, diverts managerial time, and misallocates resources, thereby lowering efficiency and investment (Mauro, 1995; Fisman & Svensson, 2007). A strong rule of law protects property rights and makes contracts enforceable, allowing firms to capture the returns on their investments (La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 1999). Political instability creates uncertainty that deters long-term commitments and disrupts production (Acemoglu, Johnson, Robinson, & Thaicharoen, 2003), while effective government and sound regulation reduce bureaucratic delays and compliance costs and support competition and the provision of infrastructure.

The theory is relevant to this paper in three respects. First, it identifies governance as a determinant of productivity rather than as a factor of production: institutions do not add to the stock of machines or workers, but they shape how efficiently those inputs are used (Hall & Jones, 1999; Acemoglu et al., 2005). The paper therefore models the governance indicators as determinants of firm-level TFP, and uses the Cobb-Douglas production function only as an empirical tool for measuring TFP, as explained in Section 3. Second, the theory guided the selection of the five governance dimensions examined and generates the expectation that each will be positively associated with productivity. Third, it offers a lens for interpreting weak or insignificant effects: because institutions change slowly and firms can adapt to their institutional environment through internal capabilities and informal networks, the productivity gains from governance reform may take time to emerge or may be conditional on complementary factors such as infrastructure, finance, and skills.

2.2 Empirical Review

Studies on governance and manufacturing performance have produced mixed findings. Khanna and Sharma (2018) examined manufacturing productivity across Indian states between 2008 and 2011 using panel data and a benefit-of-the-doubt index of governance quality, and found that good governance significantly raised manufacturing TFP, although law and order had no notable effect; however, governance was treated as a single index. Nnyanzi, Kavuma, Sseruyange, and Nanyiti (2022) studied 30 Sub-Saharan African countries between 2003 and 2018 using a panel-corrected standard errors estimator and found that infrastructure development and institutional quality significantly raised manufacturing output in the long run, but governance was combined with infrastructure rather than assessed separately.

Evidence from studies that disaggregate governance is also inconsistent. Using a dynamic System GMM for BRICS countries over 2010–2021, Musiita, Turyareeba, Mugambe, Wamala, Jeke, and Boyi (2023) found that only government effectiveness significantly boosted manufacturing growth, while regulatory quality, control of corruption, and voice and accountability were insignificant. Misi Lopes, Packham, and Walther (2023) analysed emerging and developed economies between 1996 and 2018 and found that regulatory quality had a positive and significant effect on GDP growth, especially in emerging markets, whereas rule of law had a weak and sometimes negative association. Siyakiya (2017) found that institutional quality improved gross value added per capita across European Union members and candidate countries, while at the firm level, Inah, Magam, Ubi, Amos, and Johnson (2024) showed that corporate governance features such as board composition and audit committee size improved the performance of Nigerian manufacturing firms. These studies, however, examine aggregate growth, developed economies, or internal corporate governance rather than national governance and firm productivity in a developing economy.

In East Africa and Uganda, the evidence is thinner. Manyinsa (2014) studied five East African Community countries, including Uganda, over 1999–2012 using a random-effects model and found that political stability, regulatory quality, and control of corruption significantly affected economic growth, with political stability and regulatory quality negatively associated with growth and control of corruption positively associated. In Uganda, Tayebwa, Musiita, and Nuwabimpa (2023) applied an Autoregressive Distributed Lag model to data for 2000–2023 and found that regulatory quality, control of corruption, and government effectiveness had significant positive effects on the growth of the agro-processing industry. Other Ugandan studies have focused on exports, linking institutional quality (Vundru Drazi, 2023) and regulatory quality (Abirimu, 2024) to aggregate export growth.

Taken together, existing Ugandan studies examine aggregate economic growth, a single sub-sector, or total exports, typically using time-series data and broad or composite governance measures. None estimates firm-level TFP for Uganda's manufacturing sector and relates it to the individual Worldwide Governance Indicators while accounting for productivity persistence and endogeneity. This gap leaves policymakers without firm-level evidence on whether, and which, governance improvements translate into productivity gains in manufacturing, and it is this gap that the present paper addresses.

3. Approach and Methodology

The paper employed a longitudinal research design covering the period 2010 to 2024. The design was appropriate for tracking changes in governance quality and firm performance over time and for assessing the direction and sustainability of the relationship between governance and productivity, which cross-sectional designs observing firms at a single point in time cannot do (Saunders, Lewis, & Thornhill, 2019; Creswell & Creswell, 2018).

3.1 Theoretical Framework

Following Institutional Economic Theory, governance was treated as a factor that shapes the efficiency of production rather than as a production input. To operationalise this idea, the paper used the Cobb-Douglas production function (Cobb & Douglas, 1928), expressed as:

$$Y_{it} = A_{it}K_{it}^{\beta}L_{it}^{\alpha} \quad (1)$$

where Y_{it} is the output of firm i at time t, A_{it} is total factor productivity, K_{it} is capital input, L_{it} is labour input, and β and α are the output elasticities of capital and labour, respectively. In the empirical estimation, raw materials were included as an additional input. TFP captures the portion of output not explained by the physical inputs, and it is through TFP that governance is expected to operate: better governance lowers transaction costs, improves regulatory processes, and strengthens contract enforcement, allowing firms to obtain more output from the same inputs (Acemoglu et al., 2005).

3.2 Model Specification

The relationship between governance quality and productivity was specified as:

$$TFP_{it} = \beta_0 + \beta_1 PS + \beta_2 GE + \beta_3 RQ + \beta_4 CC + \beta_5 RL + \varepsilon_{it} \quad (2)$$

where TFP_{it} is the total factor productivity of firm i at time t, PS is political stability, GE is government effectiveness, RQ is regulatory quality, CC is control of corruption, RL is rule of law, β_0 is the intercept, β_1 to β_5 are the coefficients measuring the effect of each governance indicator on productivity, and ε_{it} is the error term. Because productivity tends to persist over time, the estimated version of Equation (2) included the one-period lag of TFP as an additional regressor, together with region, industry, and year fixed effects to control for heterogeneity across locations, sectors, and time.

3.3 Definition and Measurement of Variables

The variables used in the analysis are defined in Table 1.

Table 1: Definition and Measurement of Variables

Variable	Definition	Measurement and source
TFP	Total factor productivity: the efficiency with which a firm converts inputs into output	Estimated from a Cobb-Douglas production function (output on labour, capital, and raw materials) using Wooldridge's (2009) approach; URA tax returns
CC	Control of corruption	Dummy variable (investment incentive = 1, 0 otherwise); World Bank Worldwide Governance Indicators (WGI)
GE	Government effectiveness	Dummy variable (investment incentive = 1, 0 otherwise); World Bank Worldwide Governance Indicators (WGI)
PS	Political stability and absence of violence	Dummy variable (investment incentive = 1, 0 otherwise); World Bank Worldwide Governance Indicators (WGI)
RL	Rule of law	Dummy variable (investment incentive = 1, 0 otherwise); World Bank Worldwide Governance Indicators (WGI)
RQ	Regulatory quality	Dummy variable (investment incentive = 1, 0 otherwise); World Bank Worldwide Governance Indicators (WGI)

Source: Authors' compilation, 2026.

3.4 Estimation Procedure and Econometric Issues

Estimation proceeded in two stages. In the first stage, a Cobb-Douglas production function was estimated following Wooldridge's (2009) proxy-variable approach, with firm output as the dependent variable and labour, capital, and raw materials as inputs. This approach controls for the unobserved productivity shocks that influence firms' input choices, and the resulting residual provided the firm-level TFP measure used as the dependent variable in the second stage.

In the second stage, TFP was regressed on its own lag and the five governance indicators using a dynamic two-step System GMM estimator with region, industry, and year fixed effects. This estimator was chosen to address three econometric problems common in dynamic panel data: the correlation between the lagged dependent variable and the error term, possible reverse causality between governance and productivity, and omitted-variable bias. It does so by using internal instruments drawn from lagged levels and differences of the endogenous variables. The validity of these instruments was assessed with the Hansen J test of over-identifying restrictions, and robust standard errors were used throughout to correct for heteroskedasticity.

Several diagnostic tests were conducted to check the reliability of the regression results. Multicollinearity among the governance indicators was assessed using the Variance Inflation Factor (VIF), with values above 10 taken to indicate a problem, supported by a correlation matrix. Heteroskedasticity was tested using the Breusch-Pagan and White tests, and the normality of residuals was assessed using the Jarque-Bera test.

3.5 Data Type and Source

The paper used secondary panel data from two sources. Governance data were drawn from the World Bank's Worldwide Governance Indicators (WGI) database, covering political stability, government effectiveness, regulatory quality, rule of law, and control of corruption. Firm-level data on output, capital, labour, and raw material inputs were drawn from the annual tax returns filed with the Uganda Revenue Authority (URA) by domestic manufacturing firms, defined as enterprises producing goods within Uganda with less than 10% foreign ownership. The two data sets were harmonised and matched by year, yielding an unbalanced panel of 4,471 firm-year observations for 1,229 firms over the period 2010–2024.

3.6 Ethical Considerations

Ethical approval was obtained from the Bishop Stuart University Research Ethics Committee (BSU-REC) before data collection, and an introductory letter from the Directorate of Graduate Studies, Research and Innovations of Bishop Stuart University was used to access the firm-level data from the Uganda Revenue Authority. The researchers adhered to all conditions relating to the use of secondary data, including data-sharing agreements and institutional data access protocols. The confidentiality and anonymity of firms were preserved throughout, with no identifiable firm or taxpayer information revealed in the analysis or reporting, and the data were used solely for academic purposes.

4. Results

This section presents the estimation of firm-level total factor productivity and the effect of governance indicators on that productivity in Uganda's manufacturing sector.

4.1 Estimation of Firm-Level Total Factor Productivity

The production function was estimated with firm-level output as the dependent variable and labour, capital, and raw materials as inputs, following Wooldridge's (2009) approach. Table 2 presents the results.

Table 2: Estimation of Total Factor Productivity (Two-Step SGMM)

Output	Two-step SGMM	Std. Err.	P>|t|
Labour	0.159	0.008	.000
Capital	0.036	0.009	.000
Raw materials	0.769	0.008	.000
Constant	1.324	0.196	.000

Note. Sigma_u = 0.637; Sigma_e = 0.437; Rho = 0.680. Source: Authors' estimations, 2026.

Table 2 shows that the coefficients of all three production inputs are positive and highly significant ($p < .001$). Raw materials have by far the largest output elasticity (0.769), followed by labour (0.159) and capital (0.036), indicating that output in Uganda's manufacturing firms responds most strongly to the use of materials. Together, the elasticities sum to about 0.96. These estimates confirm that the inputs are important determinants of output and provide a sound basis for the firm-level TFP measure used in the governance analysis that follows.

4.2 Governance Indicators and Total Factor Productivity

Using the firm-level TFP, a dynamic two-step System GMM model was estimated with TFP as the dependent variable, lagged TFP and the five governance indicators as explanatory variables, and region, industry, and year fixed effects. Table 3 presents the results.

Table 3: Governance Indicators and Total Factor Productivity (A Two-Step SGMM Approach)

TFP	Coeff.	Std. Err.	P>|t|
L1_TFP	0.619	0.127	.000
Control of corruption	0.012	0.188	.947
Rule of law	-0.150	0.190	.431
Political stability	-0.071	0.088	.422
Government effectiveness	-0.284	0.318	.373
Regulatory quality	0.306	0.218	.162
Region	Yes		
Industry	Yes		
Year	Yes		
Constant	1.587	0.512	.002

Note. Observations = 4,471; Number of groups = 1,229; Prob > F = .000; Hansen J test: $\chi^2(9) = 7.29$, Prob > χ^2 = .607. Robust standard errors. Source: Authors' estimations, 2026.

Table 3 shows that past productivity is the strongest determinant of current productivity. The coefficient of lagged TFP is positive and highly significant (0.619, $p < .001$), meaning that firms that were more productive in one year tended to remain more productive in the next. This persistence reflects the cumulative nature of productivity: knowledge gained through experience, adopted technologies, management practices, and organisational routines carry over from one period to the next. It also implies that measures which raise a firm's productivity today are likely to produce benefits that last.

By contrast, none of the governance indicators has a statistically significant effect on firm productivity. Control of corruption has a positive but negligible coefficient (0.012, $p = .947$), and rule of law has a negative coefficient (-0.150, $p = .431$). Neither the containment of corruption nor the strength of legal institutions and contract enforcement, as captured by these indicators, was associated with measurable differences in firm productivity over the study period. One plausible explanation is that firms had adapted their operations to the prevailing institutional environment, so that marginal changes in these indicators did little to alter how efficiently they produced.

Political stability (-0.071, $p = .422$) and government effectiveness (-0.284, $p = .373$) also have negative but insignificant coefficients. Because these estimates are not statistically different from zero, they do not indicate that stability or effective government harms productivity; rather, they suggest that year-to-year changes in political conditions and public administration were not large enough, or not direct enough, to shift firm efficiency. In a setting where firms rely on internal capabilities and informal arrangements to cope with institutional uncertainty, such changes may have little immediate effect unless they are accompanied by improvements in infrastructure, finance, technology, and skills.

Regulatory quality has the largest positive coefficient among the governance indicators (0.306), consistent with the expectation that sound regulation lowers compliance costs, encourages competition, and supports investment and innovation. However, the coefficient is not statistically significant ($p = .162$), so the data do not allow the conclusion that regulatory quality on its own raises productivity. Overall, the results indicate that, within Uganda's manufacturing sector, firm productivity was driven mainly by firms' own accumulated capabilities rather than by short-term changes in national governance.

5. Discussion

The results show that, over the study period, the quality of national governance did not translate into measurable differences in the productivity of Uganda's manufacturing firms, while firms' past productivity did. None of the five governance indicators, control of corruption, rule of law, political stability, government effectiveness, and regulatory quality, had a statistically significant effect on firm-level TFP, and productivity persistence, captured by the lagged TFP coefficient, emerged as the most influential factor.

These findings contrast with Khanna and Sharma (2018), who found that good governance substantially enhanced manufacturing productivity across Indian states, and with Nnyanzi et al. (2022), who identified institutional quality as a crucial driver of manufacturing output across Sub-Saharan Africa. The difference may be methodological and contextual. Both comparator studies examined aggregate manufacturing performance at regional or national level, whereas the present paper centres on firm-level productivity in Uganda, where firms may rely more on internal capabilities and strategic adaptation than on institutional factors. Nnyanzi et al. (2022) also combined governance measures with infrastructure indicators, making it harder to isolate the standalone effect of governance, whereas the present paper assesses individual governance indicators directly.

The findings partially align with studies showing that different governance dimensions have varying effects on manufacturing performance. Musiita et al. (2023) found that only government effectiveness significantly boosted manufacturing growth in BRICS countries; the present paper finds that even government effectiveness does not significantly influence firm productivity in Uganda, although regulatory quality shows the strongest positive, if insignificant, association. Similarly, Misi Lopes et al. (2023) found that regulatory quality improved economic growth while rule of law had weak or negative effects; the present paper likewise reports a negative coefficient for rule of law and a positive one for regulatory quality, though neither reaches statistical significance. The results also diverge from Tayebwa et al. (2023), who found significant positive effects of regulatory quality, control of corruption, and government effectiveness on the growth of Uganda's agro-processing industry. That study, however, used aggregate time-series data for one sub-sector, whereas the present paper examines the productivity of individual firms across the manufacturing sector.

The results also differ from broader governance research emphasising the macroeconomic impacts of institutional quality. Siyakiya (2017) and Manyinsa (2014) found that institutional quality significantly affects economic performance, though Manyinsa (2014) reported mixed effects across governance dimensions. At the corporate level, Inah et al. (2024) found that board structure and audit committee size improved the performance of Nigerian manufacturing firms, a finding about internal corporate governance that is distinct from the national governance indicators examined here. Taken together, these comparisons suggest that governance influences economic outcomes through different pathways depending on the scope and level of analysis.

Interpreted through Institutional Economic Theory, the absence of significant effects does not mean that institutions are unimportant. The theory expects institutions to shape productivity over long horizons, and national governance indicators change slowly and uniformly across firms, which limits their ability to explain differences in productivity from one year to the next. The results are consistent with a setting in which Ugandan firms face binding structural constraints, such as limited access to finance, poor infrastructure, technological gaps, and shortages of skilled labour, that must be relaxed before better governance can show up as higher productivity. The paper therefore extends the literature by showing that, within Uganda's manufacturing sector, firm productivity depends chiefly on firm-specific capabilities rather than short-term changes in national governance, underscoring the importance of pairing governance reform with investment in innovation, technology, human capital, and industrial infrastructure.

6. Conclusion and Recommendations

6.1 Conclusion

The paper concludes that the governance indicators examined, control of corruption, rule of law, political stability, government effectiveness, and regulatory quality, did not directly influence the total factor productivity of manufacturing firms in Uganda in a

statistically significant way. Productivity was instead driven mainly by productivity persistence, as shown by the significant positive effect of past TFP, indicating that earlier productivity gains carry forward through learning, technological progress, and organisational development. Although regulatory quality showed the strongest positive association among the governance indicators, its effect remained insignificant, suggesting that institutional improvements alone are not sufficient to raise firm productivity in the short term.

6.2 Policy Implications

The results indicate that improving national governance alone is unlikely to produce immediate productivity gains in Uganda's manufacturing sector. While governance reforms remain important for establishing a stable and transparent business climate, the absence of significant links between the governance indicators and firm productivity suggests that policymakers should place more direct emphasis on strengthening firms' productive capabilities. Because productivity was found to persist strongly over time, investments that build firm capacity now are likely to generate lasting gains.

6.3 Recommendations

The Government of Uganda and related bodies, including the Ministry of Trade, Industry and Cooperatives, should pursue an integrated policy approach that combines institutional governance reforms with targeted industrial support, prioritising firms' access to modern technology, technical and vocational skills development, affordable financing, and dependable industrial infrastructure such as energy and transport. Regulatory reforms should continue to reduce administrative hurdles and improve the predictability of the business environment, since this can still support investment and innovation even where it does not, by itself, produce a statistically detectable productivity effect in the short term.

6.4 Limitations and Areas for Further Research

The paper has two main limitations. First, governance was measured using national-level indicators, which may not fully capture the experiences of individual firms or regional differences in the business climate. Second, the analysis examined only the direct effect of governance on productivity, and the results may not extend to sectors other than manufacturing. Future research should examine the indirect channels, such as infrastructure, financial development, technology adoption, digitalisation, and innovation, through which governance quality may influence firm productivity, and should use firm-level governance measures, longer panels, and comparative designs across sectors and countries.

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Availability of Data and Materials

The governance data are publicly available from the World Bank's Worldwide Governance Indicators database. The firm-level manufacturing data are available from the corresponding author upon reasonable request, subject to Uganda Revenue Authority data-sharing agreements.

Competing Interests

The authors declare no competing interests.

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Authors' Contributions

Musiimenta Ritah conceptualised the study, collected and analysed the data, and prepared the original draft of the manuscript. Milton Rwiita Nuwabimpa and Betrum Namanya supervised the study and reviewed and edited the manuscript. All authors read and approved the final manuscript.

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