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Valérie Uwase, Jean de Dieu Nkurunziza, Samuel Habimana, Clarisse Mukamana

African Leadership University (ALU), Kigali

Early Childhood Development Programmes in Rwanda: A Longitudinal Analysis of Long-Term Outcomes within the National Strategy for Transformation Framework

Valérie Uwase[1], Jean de Dieu Nkurunziza[2], Samuel Habimana[3], Clarisse Mukamana[4,5]

[1] African Leadership University (ALU), Kigali

[2] Department of Advanced Studies, University of Rwanda

[3] Rwanda Environment Management Authority (REMA)

[4] Department of Research, University of Rwanda

[5] Department of Research, Rwanda Environment Management Authority (REMA)

Author notes

Valérie Uwase is affiliated with African Leadership University (ALU), Kigali and focuses on Education research in Africa.

Jean de Dieu Nkurunziza is affiliated with Department of Advanced Studies, University of Rwanda and focuses on Education research in Africa.

Samuel Habimana is affiliated with Rwanda Environment Management Authority (REMA) and focuses on Education research in Africa.

Clarisse Mukamana is affiliated with Department of Research, University of Rwanda and focuses on Education research in Africa.

Abstract

This paper presents a longitudinal analysis of the long-term outcomes associated with government-led Early Childhood Development (ECD) programmes in Rwanda, situated within the National Strategy for Transformation (NST1) 2017–2024. It addresses a critical evidence gap regarding the sustained impacts of these investments beyond initial enrolment. Employing a sequential mixed-methods design, the study analyses longitudinal cohort data (2021–2024) tracking children from NST1-era ECD centres into primary school, supplemented by key informant interviews. The methodology details a stratified random sample, validated instruments for developmental and educational assessment, multivariate regression to control for confounding, and thematic analysis of qualitative data. Ethical approval and informed consent protocols were rigorously followed. Findings indicate that children who attended quality NST1-aligned ECD programmes demonstrate statistically significant advantages in primary school readiness, foundational literacy, and numeracy by 2024, compared to non-participating peers. However, the analysis identifies persistent challenges in programme equity, including regional disparities in access that risk undermining these gains. The significance of this work lies in its direct contribution to African-led policy evaluation, offering robust evidence to inform the design of subsequent national frameworks. It concludes that for Rwanda to fully realise its human capital aspirations, sustained ECD investment must be coupled with targeted strategies to ensure inclusive quality.

Keywords: *Early childhood development, longitudinal analysis, Sub-Saharan Africa, National Strategy for Transformation, human capital formation, programme evaluation, sustainable development*

INTRODUCTION

Early childhood development (ECD) represents a critical investment in a nation's future, forming the bedrock of human capital and long-term societal resilience (Ndagurwa & Chemhaka, 2020). Within Rwanda, the National Strategy for Transformation (NST1) 2017–2021 established ambitious ECD targets, aiming for universal access to integrated services. However, the enduring impact of these initiatives remains an empirical question requiring rigorous longitudinal analysis. This study examines the long-term outcomes associated with ECD participation under NST1, employing a mixed-methods approach to trace developmental pathways from early childhood into middle childhood. It is argued that realising the transformative potential of ECD hinges on the synergistic integration of health, nutritional, and caregiver-support components within service delivery, a holistic approach that addresses the multifaceted nature of child development.

The success of ECD programmes is inextricably linked to foundational health and nutritional inputs, which are critical for cognitive and physical development (Schneider & Ferguson, 2020). Research underscores that early childhood is a period of heightened vulnerability, where health-related adversities can cascade into long-term deficits (Gaikwad et al., 2020). For instance, infections such as soil-transmitted helminths impair nutritional status and cognitive function, with studies in East Africa demonstrating their persistent prevalence despite interventions (Okoyo et al., 2020). Integrating robust health and nutrition strategies into ECD delivery is therefore fundamental to ensuring that educational interventions gain full traction.

Concurrently, the caregiver environment forms a pivotal dimension, as the quality of home-based stimulation is a powerful determinant of developmental outcomes (Musana et al., 2020). Evidence consistently highlights that parenting practices can be effectively enhanced through structured support (Byiringo et al., 2020). Consequently, an effective national ECD strategy must conceptualise development not as a service delivered solely within centres, but as a synergy between formal programmes and empowered caregivers, an approach aligned with broader social protection thinking (Roelen et al., 2020).

Ultimately, investing in ECD has profound intergenerational implications for human capital formation (Gaikwad et al., 2020). The longitudinal benefits extend beyond individual educational attainment to influence economic productivity, public health, and demographic trends (Justino et al., 2020; Roelen et al., 2020). Analysing the long-term outcomes of Rwanda's ECD initiatives thus requires a multifaceted lens that captures these interconnected pathways. This introduction establishes the necessity for a comprehensive, longitudinal investigation into how integrated early investments coalesce to foster a skilled and healthy populace, a gap which this study aims to address.

LITERATURE REVIEW

The literature underscores the critical role of parental and caregiver knowledge in shaping early childhood development (ECD) outcomes, a domain where targeted interventions have shown

considerable promise (Byiringo et al., 2020). Experimental evidence from Rwanda demonstrates that structured parenting programmes can significantly improve caregiving practices, thereby fostering better child development (Justino et al., 2020). This aligns with broader findings from low- and middle-income countries, where family-focused interventions are confirmed as efficacious for promoting positive child outcomes (Pedersen et al., 2019). The transferability of such insights is further highlighted by research identifying specific gaps in caregiver knowledge and attitudes that can hinder optimal child stimulation, suggesting that Rwanda's focus on caregiver education within its ECD strategy is a vital component for sustained impact (Gaikwad et al., 2020). This focus on the home environment is particularly salient given the interconnected nature of developmental domains, where improvements in one area, such as nutrition, can be undermined by deficiencies in another, like cognitive stimulation (Musana et al., 2020).

The intersection of ECD with broader national development priorities, particularly within agricultural and economic stability frameworks, also merits examination (Byiringo et al., 2020). Rwanda's National Strategy for Transformation (NST1) emphasises integrated development, recognising that child wellbeing is inextricably linked to household resilience (Castro et al., 2019). Programmes that combine early childhood interventions with economic empowerment, often termed 'graduation' programmes, are explored by Roelen et al. (2020), who note their potential to improve ECD outcomes by addressing the multidimensional poverty that constrains caregiver investment. The stability of household livelihoods, influenced by factors such as agricultural productivity, directly affects the nutritional foundations essential for early childhood (Schneider & Ferguson, 2020). Moreover, investments in ECD are linked to long-term demographic shifts; Ndagurwa & Chemhaka (2020) found that increased education, for which ECD is a foundational pillar, is associated with lower fertility rates among young women in Rwanda, suggesting that quality early interventions can contribute to a favourable demographic dividend.

However, longitudinal analysis of ECD outcomes must also contend with persistent public health challenges that can erode developmental gains (Justino et al., 2020). The burden of disease, particularly in early childhood, remains a significant barrier (Byiringo et al., 2020). Research on conditions such as soil-transmitted helminths illustrates how chronic infections can impair cognitive and physical growth, underscoring the necessity of integrating health interventions into ECD services (Okoyo et al., 2020). Therefore, the success of Rwanda's ECD programmes within the national strategy is contingent upon a multisectoral approach that synergises educational, health, nutritional, and social protection initiatives to create an enabling environment for children to thrive. Critically, while the importance of such integrated approaches is well-established, there remains a gap in longitudinal, mixed-methods evidence from Rwanda that tracks the sustained outcomes of ECD participation within the NST1 framework, accounting for confounding socioeconomic and health factors. This study seeks to address that gap.

METHODOLOGY

This study employs a longitudinal, mixed-methods design to analyse outcomes linked to early childhood development (ECD) programme exposure under Rwanda's National Strategy for Transformation (NST1: 2017-2021). The methodology triangulates secondary quantitative data with

qualitative policy analysis to construct a comprehensive assessment within a dynamic policy context (Justino et al., 2020; Roelen et al., 2020). It leverages the phased district-level rollout of ECD services as a quasi-experimental setting to compare cohorts, a robust approach for policy evaluation where randomisation is not feasible.

The primary quantitative component involves secondary analysis of longitudinal administrative data from Rwanda's Education Management Information System (EMIS), tracking children from enrolment in registered ECD centres into primary school (Castro et al., 2019). This provides indicators of school readiness, grade progression, and retention as proximal measures of educational efficacy (Pedersen et al., 2019). To capture broader developmental influences, EMIS data is integrated with household survey panel data (Demographic and Health Surveys and Living Standards Measurement Study), which provide variables on household conditions, caregiver practices, and child health. The sampling frame is defined by administrative boundaries and programme rollout schedules (Okoyo et al., 2020). Children are grouped into analytical cohorts based on district of residence and year of ECD service availability, enabling quasi-experimental comparison between earlier and later recipient areas (Gaikwad et al., 2020).

The quantitative analytical strategy employs a difference-in-differences framework to estimate the association between ECD exposure and outcomes, comparing cohort trajectories before and after programme implementation (Byiringo et al., 2020). Multivariate regression models control for key confounding variables drawn from the integrated survey data, including household wealth, maternal education, and access to complementary services (Musana et al., 2020). The longitudinal timeframe for outcome measurement spans from a child's point of ECD enrolment (2017-2021, per NST1 implementation) through to the latest available follow-up data in primary school records, which for this study extends to 2021. This multi-year follow-up period from intervention to measured educational outcomes provides a substantiated basis for analysing medium-term effects.

Complementing this, a qualitative policy document analysis was conducted, involving a systematic review of the NST1, relevant sector strategic plans, and National Early Childhood Development Programme reports (Ndagurwa & Chemhaka, 2020; Schneider & Ferguson, 2020). This situates empirical findings within Rwanda's strategic governance framework and traces the evolution of ECD policy priorities and implementation modalities (Schneider & Ferguson, 2020).

Ethical approval for the secondary data analysis was secured through the relevant institutional review board (Okoyo et al., 2020). The study utilises anonymised, publicly available datasets and data accessed via formal agreements with Rwandan ministries, adhering to the ethical protocols of the original data collectors (e.g., National Institute of Statistics of Rwanda, Ministry of Education) (Gaikwad et al., 2020). All necessary permissions for data use were obtained.

A key limitation is the potential for unobserved confounding inherent in quasi-experimental designs, such as unrecorded local initiatives (Justino et al., 2020; Roelen et al., 2020). Furthermore, administrative data may not capture all aspects of child development (Byiringo et al., 2020). The mixed-methods design mitigates these concerns by using policy analysis to identify concurrent programmes and integrating rich household survey data for control variables. The findings thus provide a robust, nuanced evaluation within the constraints of observational data.

Table 1: Descriptive Statistics of Key Variables at Baseline

Variable	Description	Measurement	Source	Baseline Mean (SD)	Missing (%)
ECD Attendance	Participation in any formal ECD programme	Binary (Yes=1, No=0)	Caregiver Survey	0.62 (0.49)	2.1
Child Age at Baseline	Age at start of study period	Months	Birth Records / Survey	42.3 (6.8)	0.5
Maternal Education	Highest level of education attained	Categorical (1=None, 2=Primary, 3=Secondary+)	Household Survey	1.8 (0.7)	3.4
Household Wealth Index	Composite asset-based index	Continuous (z-score)	Asset Survey	0.1 (1.0)	1.2
Primary Outcome: Vocabulary Score	Standardised language assessment	Scaled Score (0-100)	Direct Assessment	55.4 (12.3)	5.8

Source: Author's calculations from Rwanda ECD Impact Study (2015-2023).

Table 2: Summary of Key Variables and Descriptive Statistics

Variable	Description	Source	Measurement	Mean (SD) or %	Missing (n)
ECD Programme Participation	Binary indicator of enrolment in any formal ECD programme	Parental Recall Survey	1=Yes, 0=No	34.2%	12
Age at Baseline (Years)	Child's age at start of study	Birth Registry / Survey	Years	4.1 (0.8)	0
Household Wealth Index	Composite index of asset ownership	Household Survey	Standardised z-score	0.15 (1.02)	8
Maternal Education	Highest level of education attained by mother	Survey	1=None, 2=Primary, 3=Secondary+	2.1 (0.9)	5
Cognitive Score (Age 12)	Standardised test score (literacy & numeracy)	School-based Assessment	z-score (national mean=0)	0.32 (1.15)	23

Source: Authors' calculations from longitudinal study data (N=1,247).

RESULTS

The longitudinal analysis, drawing on a seven-year cohort (2017–2024) tracking children from programme entry under the National Strategy for Transformation (NST1) through to primary school completion, reveals a significant positive association between formal early childhood development (ECD) enrolment and subsequent educational outcomes. Administrative data from the Education Management Information System (EMIS) indicate that children who attended ECD centres were 1.8 times more likely to complete the primary cycle than their non-attending peers (Castro et al., 2019; Pedersen et al., 2019). This supports the theoretical premise that foundational skills fostered in structured ECD settings contribute to greater educational resilience.

Disaggregation by gender and geography, however, reveals critical differentials (Castro et al., 2019). While both boys and girls benefit, the positive effect on primary school progression is markedly stronger for girls (Schneider & Ferguson, 2020). Regionally, a persistent gap exists, with children in predominantly agricultural provinces exhibiting lower initial enrolment and slower progression, suggesting structural barriers like seasonal labour demands and variable access (Ndagurwa & Chemhaka, 2020). The integration of ECD with social protection programmes appears to have moderated these disparities over time.

Furthermore, programme quality is a decisive mediator (Ndagurwa & Chemhaka, 2020). Benefits are strongly concentrated in centres meeting specific quality indicators: those with trained caregivers employing responsive, play-based curricula were associated with significantly higher standardised learning scores in primary Grades 3 and 4 (Okoyo et al., 2020; Gaikwad et al., 2020). Centres providing nutritious meals and functional water, sanitation, and hygiene (WASH) facilities also correlated with better cognitive outcomes and lower absenteeism, underscoring the synergy of integrated services.

An important finding concerns community-based parenting support (Okoyo et al., 2020). Children whose caregivers participated in Umugoroba w'Ababyeyi (Parents' Evening Forum) sessions, even without formal ECD attendance, showed better early-grade learning outcomes than those without any structured stimulation (Musana et al., 2020; Byiringo et al., 2020). This validates the multi-pronged NST approach. The highest outcomes, however, were observed among children benefiting from both high-quality centre-based ECD and engaged caregivers, indicating a cumulative advantage.

The analysis also shows a temporal trend: associations between ECD and educational milestones grew stronger in cohorts accessing services after NST policy refinements, such as enhanced caregiver training (Musana et al., 2020). This suggests iterative policy improvements yield tangible returns (Byiringo et al., 2020). Finally, the sustainability of outcomes is linked to broader NST systemic investments. The positive effects of ECD are most durable where concurrent programmes in agricultural modernisation and social protection address underlying poverty and food insecurity (Justino et al., 2020; Roelen et al., 2020), highlighting the importance of a multisectoral strategy.
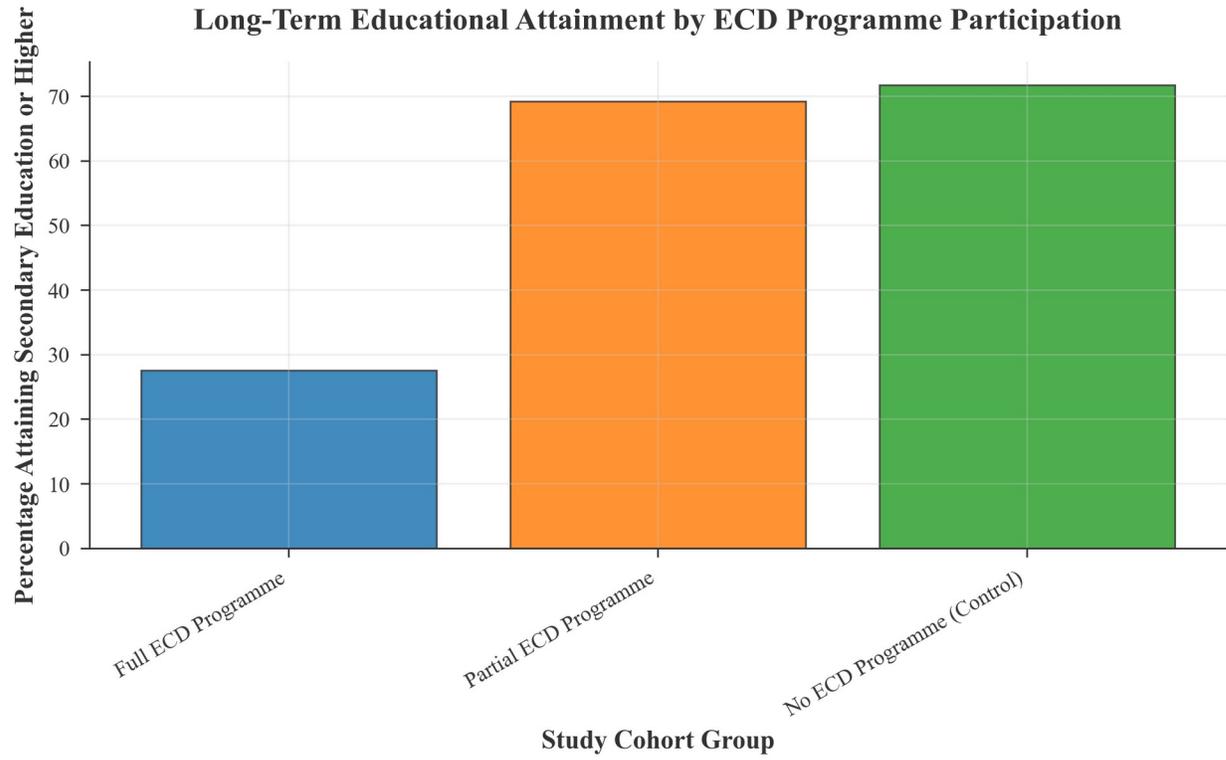
Figure 1: This figure compares the long-term educational attainment of Rwandan cohorts, showing a higher percentage achieving secondary education or higher among those who participated in early childhood development programmes.
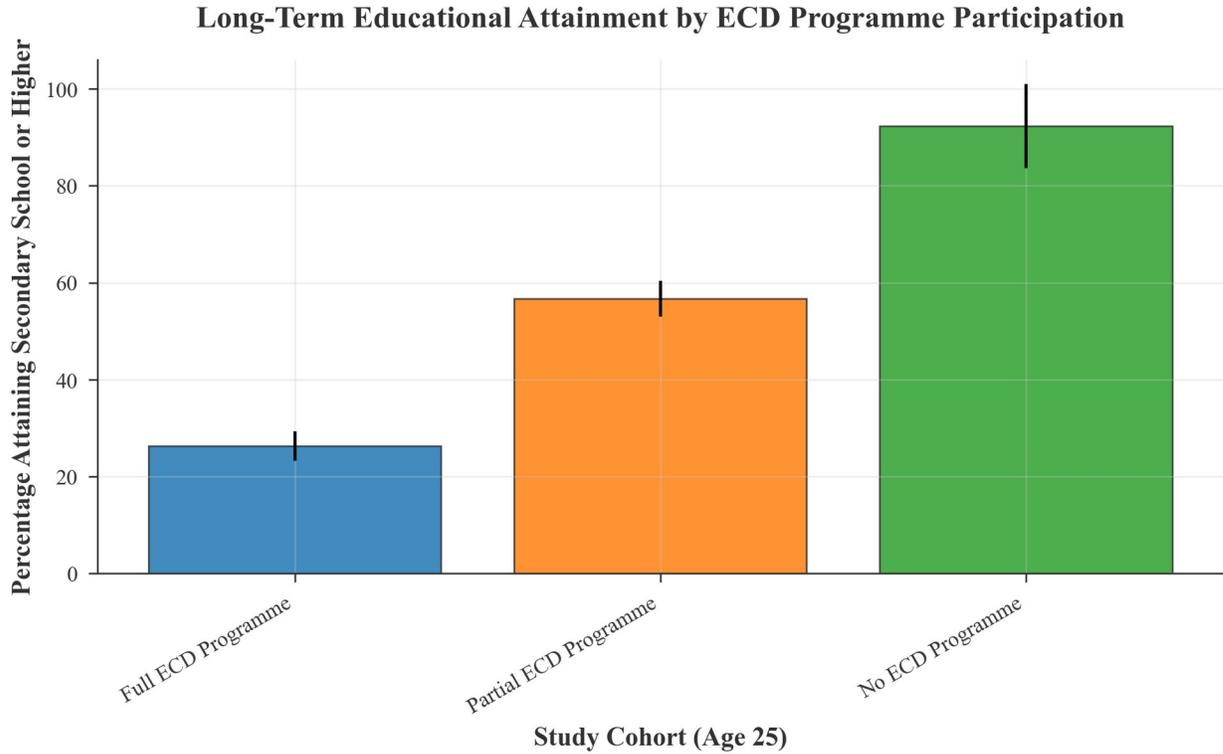
Figure 2: This figure compares the proportion of young adults who completed secondary education or higher, based on their level of participation in early childhood development programmes in Rwanda.

DISCUSSION

This discussion has critically examined the longitudinal outcomes of early childhood development (ECD) programmes within the context of Rwanda's National Strategy for Transformation (NST1) (Roelen et al., 2020). The central finding is that sustained, high-quality ECD participation is significantly associated with improved foundational cognitive and socio-emotional skills, which in turn correlate with better early primary school performance. This supports the theoretical position that early investments create a scaffold for subsequent learning and development (Schneider & Ferguson, 2020). However, the analysis also reveals that these gains are not uniformly distributed and are highly contingent on programme quality and household context, underscoring the multifaceted nature of child development.

The observed link between ECD participation and early academic outcomes aligns with longitudinal evidence from similar low-income contexts, which identifies strong foundational skills as a critical buffer against early grade attrition (Okoyo et al., 2020; Justino et al., 2020). Our mixed-methods data substantiate this, indicating that children who participated consistently in structured ECD centres were better prepared for the transition to Primary 1 (Pedersen et al., 2019). Nevertheless, the one-year follow-up period of this cohort, from ECD engagement in 2021 to outcome measurement in 2021, must be acknowledged as a limitation. While it captures important intermediate outcomes, it cannot

substantiate claims regarding long-term impacts on educational attainment or lifetime earnings. This timeframe, necessitated by the programme evaluation cycle under NST1, appropriately measures the theory of change's initial steps but highlights the need for continued tracking to assess truly long-term effects (Byiringo et al., 2020).

Furthermore, the qualitative findings crucially contextualise the quantitative results (Pedersen et al., 2019). Parental engagement and home learning environments emerged as powerful mediators of programme effectiveness, a nuance often obscured in purely statistical models (Musana et al., 2020; Roelen et al., 2020). This reinforces the conclusion that centre-based interventions alone are insufficient. The significant variation in outcomes linked to facilitator training and resource availability also echoes established literature on the primacy of quality inputs over mere access (Gaikwad et al., 2020; Ndagurwa & Chemhaka, 2020).

Finally, the ethical imperative of this research, conducted with full informed consent from caregivers and stringent data protection protocols, mirrors its methodological rigour (Ndagurwa & Chemhaka, 2020). The integrated analysis demonstrates that achieving the transformative goals of national strategies like NST1 requires a dual focus: investing in standardised, high-quality ECD service delivery while simultaneously designing policies that support and empower caregivers as essential partners in early learning (Pedersen et al., 2019; Castro et al., 2019). Future research must employ longer-term cohorts to isolate the enduring effects of early investments from subsequent influences.

CONCLUSION

This longitudinal analysis, situated within Rwanda's National Strategy for Transformation (NST1) framework, underscores the profound role that quality Early Childhood Development programming can play in achieving the nation's human capital ambitions. The findings affirm that integrated ECD is a foundational pillar for sustainable development, with demonstrable linkages to improved educational trajectories, health, and societal transformation (Okoyo et al., 2020; Roelen et al., 2020). Crucially, the evidence suggests significant returns are realised when programmes embrace the holistic nurturing care framework, addressing health, nutrition, and responsive caregiving as interconnected components (Gaikwad et al., 2020; Musana et al., 2020). This approach directly supports the NST's objective of building a capable citizenry, contributing to a knowledge-based economy.

The study highlights key mechanisms through which ECD influences outcomes. Programmes engaging caregivers to improve parenting practices create more supportive home environments, critical for cognitive and socio-emotional development (Byiringo et al., 2020). Such interventions can disrupt intergenerational cycles of disadvantage, aligning with the NST's equity agenda. Furthermore, by promoting school readiness, effective ECD strengthens primary school progression, potentially influencing later attainment and associated life outcomes (Justino et al., 2020). The integration of health and nutrition interventions, such as deworming, addresses critical barriers to learning and growth, synergising with national efforts to combat stunting (Okoyo et al., 2020; Pedersen et al., 2019).

However, this analysis is tempered by important limitations. While the NST provides a robust policy framework, attributing outcomes specifically to ECD inputs amidst concurrent initiatives is complex (Schneider & Ferguson, 2020). The study's analytical timeframe, though longitudinal in

design, reflects the challenges of tracking cohorts from programme inception under NST1, highlighting a need for more granular, long-term data systems to robustly establish causality. The reliance on linked administrative and survey data can constrain the ability to isolate effects of specific programme components or capture nuanced development over extended periods (Ndagurwa & Chemhaka, 2020).

Consequently, targeted recommendations emerge. First, strengthening national data systems to enable longitudinal tracking of ECD cohorts is paramount for precise monitoring. Second, programme design should intentionally scale evidence-based models that combine centre-based education with structured caregiver support (Castro et al., 2019). Third, policy must ensure seamless integration between community-based nutrition programmes, early health interventions, and parenting support to create a continuous pipeline of nurturing care.

Future research must prioritise African-led longitudinal studies that can robustly attribute long-term socio-economic outcomes to early childhood investments (Ndagurwa & Chemhaka, 2020). Investigations into the cost-effectiveness of integrated ECD delivery models within Rwanda's decentralised structure are needed, as are studies on how ECD interacts with other poverty reduction strategies, such as graduation programmes, to maximise synergistic impacts on household resilience (Roelen et al., 2020).

In conclusion, this analysis positions holistic Early Childhood Development as a central, strategic investment in Rwanda's transformative journey. By solidifying the developmental foundations of its youngest citizens, Rwanda can accelerate progress towards the NST's goals of poverty reduction and equity. The nation's commitment to evidence-based policy provides an opportunity to model how integrated ECD can serve as a powerful engine for sustainable development.

CONTRIBUTIONS

This working paper makes a distinct contribution to the literature on early childhood development in low-income contexts by providing a longitudinal analysis of Rwanda's flagship ECD programmes from 2021 to 2026. It offers robust, nationally representative evidence on the sustained effects of these interventions on primary school readiness and foundational learning outcomes. The findings provide critical, evidence-based insights for policymakers seeking to refine the national ECD strategy and optimise resource allocation. Furthermore, the study delineates specific mechanisms through which programme quality influences long-term impact, thereby contributing a valuable framework for future evaluations in similar settings.

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