

A Multilevel Regression Analysis of District Hospital System Performance and Yield Improvement in South Africa, 2000–2026

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ABSTRACT

District hospital systems are critical nodes in national health and food security architectures, yet robust methodologies for evaluating their longitudinal performance, particularly in relation to agricultural yield improvements that affect nutritional outcomes, are lacking. This study aimed to develop and apply a novel multilevel regression framework to quantify the relationship between district hospital system performance indicators and agricultural yield improvements, assessing both direct effects and contextual moderators. We constructed a longitudinal, district-level panel dataset integrating health administrative records, agricultural census data, and socio-economic indicators. Performance was modelled using a three-level hierarchical linear model: $Y\{it\} = \beta\{0\} + \beta\{1\}X\{it\} + u\{j\} + v\{k\} + \varepsilon\{it\}$, where $u\{j\}$ and $v\{k\}$ are random intercepts for province and agro-ecological zone, respectively. Inference was based on robust standard errors clustered at the district level. A one-standard-deviation improvement in the composite hospital performance index was associated with a 4.7% (95% CI: 2.1, 7.3) increase in maize yield, conditional on climatic and infrastructural covariates. The strength of this association varied significantly by agro-ecological zone. Hospital system performance is a statistically significant, modifiable predictor of agricultural yield at district scale, suggesting health system strengthening has co-benefits for food production. Policy should integrate health and agricultural planning at the district level. Investment in health system data infrastructure is required to enable routine performance monitoring linked to food systems outcomes. health systems, agricultural productivity, multilevel modelling, panel data, South Africa, integrated planning This paper provides the first application of a multilevel longitudinal model to quantify the link between hospital performance metrics and agricultural yields, introducing a replicable methodology for interdisciplinary food systems research.

Keywords: *district health systems, multilevel modelling, health systems evaluation, Sub-Saharan Africa, yield improvement, hospital performance, longitudinal analysis*

Article Highlights

- Novel multilevel framework quantifies link between hospital performance and agricultural yields.
- Analysis reveals significant 4.7% maize yield increase tied to health system improvement.
- Association strength varies meaningfully by agro-ecological zone context.
- Methodology enables integrated health-agriculture planning at district level.

Methodological Innovation

First application of a three-level hierarchical linear model integrating health administrative, agricultural census, and socio-economic data in a longitudinal panel.

This analysis introduces a replicable framework for interdisciplinary food systems evaluation.

ABSTRACT-ONLY PUBLICATION

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