

Replication of a Field Trial for Pathogen Reduction Diagnostics in Tanzanian Water Treatment Systems

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Juma Mwakalinga^{1,2} | Neema Mwambene^{1,2}

¹ Muhimbili University of Health and Allied Sciences (MUHAS), Dar es Salaam

² Mkwawa University College of Education

Correspondence: jmwakalinga@hotmail.com

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ABSTRACT

Pathogen reduction in decentralised water treatment is a persistent challenge in sub-Saharan Africa. Previous research proposed a diagnostic protocol for evaluating treatment efficacy, but its robustness across varied operational conditions required independent validation. This study aimed to replicate a field trial of a diagnostic protocol for assessing pathogen reduction in decentralised water treatment systems, with the objective of evaluating its methodological consistency and practical applicability in a real-world setting. A randomised field trial was conducted across multiple small-scale treatment facilities. The replication employed the original diagnostic protocol, measuring log-reduction values (LRVs) for key microbial indicators. Statistical analysis used a mixed-effects model: $LRV\{ij\} = \beta_0 + \beta_1 X\{ij\} + u_j + \varepsilon\{ij\}$, where u_j represents facility-level random effects. Robust standard errors were calculated to account for heteroskedasticity. The replication confirmed the protocol's utility but revealed a 15% lower mean LRV for *Escherichia coli* compared to the original study, with a 95% confidence interval for the difference ranging from -0.8 to -0.3 log units. Operational variability, particularly in coagulant dosing, was identified as a critical factor influencing diagnostic outcomes. The diagnostic protocol is a viable tool, but its results are sensitive to site-specific operational practices, indicating a need for contextual interpretation beyond standardised application. Future applications of the protocol should incorporate real-time monitoring of operational parameters. Practitioners should use its findings as part of a broader risk assessment framework, not as a standalone performance metric.

water treatment, pathogen reduction, field trial, replication study, diagnostic protocol, Tanzania This replication provides an independent, empirical evaluation of a previously proposed diagnostic method, offering a critical assessment of its reliability and generating a novel dataset on treatment performance under typical operational conditions.

Keywords: Pathogen reduction, Decentralised water treatment, Sub-Saharan Africa, Field trial replication, Water treatment diagnostics, Randomised controlled trial

Article Highlights

• Replication revealed a 15% lower mean LRV for *E. coli*

Methodological Note

Statistical analysis employed a mixed-effects model with

<p>versus original study.</p> <ul style="list-style-type: none">• Operational variability, particularly in coagulant dosing, critically influences outcomes.• Protocol is viable but results require contextual interpretation beyond standardised application.• Future applications should incorporate real-time monitoring of operational parameters.	<p>facility-level random effects and robust standard errors to account for heteroskedasticity.</p> <p><i>This replication offers an independent evaluation of a diagnostic method's reliability under typical operational conditions.</i></p>
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