AN INTERRUPTED TIME SERIES ANALYSIS USING SEGMENTED REGRESSION IN EVALUATING THE EFFICACY OF PCV10 VACCINATION IN KILIFI COUNTY HOSPITAL

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A THESIS SUBMITTED TO THE SCHOOL OF APPLIED AND HEALTH SCIENCES IN THE DEPARTMENT OF MATHEMATICS AND PHYSICS IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF A DEGREE OF MASTER OF SCIENCE IN APPLIED STATISTICS OF TECHNICAL UNIVERSITY OF MOMBASA

2025

DECLARATION

This thesis is my original work and has not been presented for award of a degree in any other university.

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To my late beloved parents Mary and Albert, loving wife and kids: Risper Neema, Anthony Junior and Ashley Marie.

ACKNOWLEDGEMENT

First and foremost, I would like to thank the Lord Almighty for His never-ending graces in enabling me to reach this stage of my educational life. It has not been easy, but God walked with me through every stage.

Special gratitude goes to my supervisors who provided invaluable and unmatched guidance throughout this thesis development. Your sincerity, vision, thoroughness, and motivation have deeply inspired me. It was a great privilege and honor to work and study under your guidance.

I am extremely grateful to my wife and kids for their love, prayers, understanding and unending support to complete this thesis.

To my colleagues, friends and fellow classmates, Martin, Chiro, Galgalo and Steve, you were there for me in many ways. I have a special gratitude to all of you for sharing your knowledge and ideas in helping me construct this research thesis.

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LIST OF ABBREVIATIONS

CITS	Controlled Interrupted Time Series
ITS	Interrupted Time Series
PCV10	Pneumococcal Conjugate Vaccine, 10-valent
SITS	Single Interrupted Time Series
KWTRP	Kemri Wellcome Trust Research Program
RCT	Randomized Control Trials
SLR	Segmented Linear Regression
SPC	Statistical Process Control
QED	Quasi Experimental Design
ARIMA	Auto Regressive Integrated Moving Average
GLM	Generalized Linear Models
PCVIS	Pneumococcal conjugate Impact Study
SIR	Standardized Incidence Ratio
ZIP	Zero Inflated Poisson
GAM	Generalized Additive Model

DEFINITION OF TERMS

Interrupted Time Series (ITS) This is a statistical technique, also referred to quasi-experimental time series analysis, employed for statistical analysis of public health interventions, and other fitting interventions. The technique entails keeping track of a phenomenon over an extended period of time including tracing changes before (pre) and after (post) a point of intervention to determine the effects of the intervention, if any.

Pneumococcal Conjugate Vaccine (PCV) Pneumococcal conjugate vaccine comprises of sugars (polysaccharides) from the capsule of the bacterium Streptococcus pneumoniae that are conjoined to a carrier protein. The vaccine shields children under two years of age from pneumonia. It guards against acute forms of pneumococcal disease such as pneumonia, bacteremia, and meningitis. It will not shield against these conditions if they are brought about by agents other than pneumococcal serotypes or by pneumococcus not present in the vaccine. In Kenya, pneumonia is the second leading cause of death among children aged under five years and claims the lives of around 16% of the under five years' children every year, Ikua, (2021). Beginning 2001 – 2003, pneumonia incidence among under five years' old children peaked at 698 per 100,000 person-years and PCV vaccine was employed to arrest the situation.

Pneumococcal Conjugate Vaccine 10-valent (PCV10) This is a pneumococcal conjugate vaccine containing 10 serotypes. PCV10 is available in two presentations: single dose vial (liquid), and two dose preservative free (liquid). Compared to other infectious diseases,

pneumonia is the leading cause of child mortality. It annually claims the lives of over 800,000 children under five years of age, about 2,200 children every day, Kasundriya, (2020). PCV10 vaccine has shown effectiveness in the reduction of the incidence of serious pneumococcal disease among under-five children in Kenya. However, there is limited evidence of the effectiveness of PVC10 vaccine interventions.

Time series sequence of data plots that have been observed at equal intervals

Interrupted Time Series Analysis method of statistical analysis involving tracking a long-term period before and after a point of intervention to assess the intervention's effects.

Modelling the process of analyzing a set of data statistically.

ARIMA model combination of an Autoregressive (AR) and Moving Average (MA) models and differencing (integration) part.

Differencing process of finding the difference between two adjacent values in observations, i.e. $Y'_t = Y_t - Y_{t-1}$. It's employed to make time series become stationary.

Forecasting process of predicting future observations by considering past and present observations. It's the estimating of the future values by using the past and present observations in a given time series.

ABSTRACT

The study on PCV10 vaccination in Kilifi County is highly relevant for understanding and addressing the burden of pneumonia among children under five. By evaluating vaccine uptake, effectiveness, and challenges, the study provides critical evidence on the role of PCV10 in reducing pneumococcal disease and associated mortality. These findings are essential for informing policy decisions at both county and national levels, particularly in optimizing immunization strategies, resource allocation, and community outreach. The main aim of the study was to develop an ITS model for assessing influence of the PCV10 vaccination intervention, test the developed ITS model viability in relation to correlation structure and use the model in predicting future trend of PCV10 vaccination. The study utilized one time prior to intervention and one period following intervention, segmented regression to account for a separate line segment that is drawn to fit into each period of the independent variable, which is divided into intervals. The variables used in the study were; time before PCV10 vaccination intervention, the PCV10 vaccine and time after PCV10 vaccination intervention. The study population comprised of admissions of children aged between two months and five years admitted to Kilifi County Hospital from January 2007 to December 2020. The study findings indicated a downward trajectory as regards the number of pneumonia cases reported. Further, segmented regression results showed that the intercept ($\beta 0$) = 823.16, coefficient estimate of time ($\beta 1$) = -2.72, coefficient estimate of PCV10 intervention ($\beta 2$) = 59.63 and the coefficient estimate of the time after PCV10 intervention ($\beta 3$) = -6.03. In addition, the results exhibited that in the period after the intervention, the number of pneumonia cases had an average value of approximately 422.02. The drop in the number of pneumonia cases observed in the PCV10 intervention period is therefore statistically significant. The study concludes that the developed model is effective in assessing influence of the PCV10 vaccination intervention and able to predict future trend of pneumonia infections in Kilifi County. The study findings are instrumental towards the development of strategies and policies aimed at improving longevity and overall health among Kilifi County residents. The model will guide towards effective allocation of preventive healthcare resources to alleviate pneumonia transmission in Kilifi County.