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ABORTION TRENDS BY AGE AT MAKUMBE DISTRICT HOSPITAL, ZIMBABWE: A TIME-SERIES ANALYSIS

BY

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APPROVAL FORM

The undersigned certify that they have read and recommended to the Bindura University of Science Education the acceptance of a dissertation entitled “REPORTED CASES OF ABORTION AT MAKUMBE DISTRICT HOSPITAL, ZIMBABWE: A TIME SERIES ANALYSIS OF AGE-SPECIFIC TRENDS AND ARIMA MODELING TO PREDICT FUTURE PATTERNS", submitted in partial fulfillment of the requirements of the Bachelor of Science (Honours) Degree in Statistics and Financial Mathematics.

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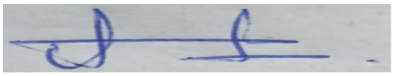
Tinotenda Meza		09/06/2024
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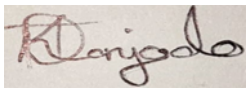
Certified by:		09/06/2024
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DEDICATION

To my supervisor, Mr. Kanjodo, whose guidance and expertise, and belief in me have been invaluable, and to all those who helped me along the way, thank you for your contributions to my growth and learning. This dissertation is dedicated to you all, with love and gratitude.

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ABSTRACT

Abortion is regarded as a significant public concern in Zimbabwe, with many cases occurring among young women. Understanding age-specific trends and predicting future patterns is crucial for effective intervention and resource allocation. We analyzed retrospective data on reported abortion cases from 2013 to 2023, stratified by age group 15-24 years and 25 years and above. Time series analysis and ARIMA modeling were performed using R Studio. The analysis revealed significant age-specific trends, with a seasonal increase in abortion cases for both young woman (15-24 years) and older woman (25 years and above).While both age groups showed an increase in abortion cases, the young woman's group had the highest and most pronounced pattern. The ARIMA model predicted continued increase in abortions cases among all ages which were under study. This study highlights the need for target interventions and resource allocation to address the growing trend of abortion cases among young women in Zimbabwe.

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LIST OF ABBREVIATIONS AND ACRONYMS

ACF - Autocorrelation function

AIC - Akaike information criterion

ARIMA - Autoregressive Integrated moving average

DHIS 2 - District Health Information System

MAE - Mean absolute error

MAPE - Mean absolute percentage error

MOHCC - Ministry of Health and Child Care

PACF - Partial autocorrelation function

RMSE - Root mean square error

TOP - Termination of Pregnancy

WHO - World Health Organization

ZDHS - Zimbabwe Demographic and Health Survey

ZNHT - Zimbabwe National Health Transition Survey

ZAPACS - Zimbabwe Abortion and Post-Abortion Care Study

CHAPTER 1: INTRODUCTION

1.1 Introduction

This research explores the complex and sensitive topic of abortion, a significant public health issue that persists in Zimbabwe despite its intricate legal and ethical landscape. Focusing on Makumbe District Hospital, this study aims to contribute to the understanding of abortion patterns and associated health effects in Zimbabwe through time series analysis of reported abortion data. Chapter 1 introduces the research context, highlighting the knowledge gaps and restricted access to safe and legal abortion services in low- and middle-income countries, including Zimbabwe. This chapter sets the stage for the project by outlining the background, research question, objectives, scope, and significance of the study, providing a foundation for the subsequent chapters that will delve into the methodology, results, and implications of the findings.

1.2 Background of the study

Abortion is a complex and contentious global issue, with significant variations in rates, laws, and access to services. According to the World Health Organization (WHO, 2021), 42 million of the 73 million annual unwanted pregnancies worldwide result in abortions. In Africa, abortion rates range from 13 to 50 per 1,000 women aged 15-49, exceeding the global average (Berer, 2013). Despite its prevalence, abortion research and policy discussions are hindered by stigma and legal constraints, justifying the need for this study. This research aims to address this knowledge gap by conducting rigorous, context-specific research in Zimbabwe, understanding the factors influencing abortion views and trends, and ultimately informing evidence-based policies and programs to reduce unsafe abortion risks and promote reproductive health in Africa.

Abortion reports have surged in Zimbabwe in recent times, in spite of ongoing legal limitations and societal disapproval of the procedure. The Zimbabwe Ministry of Health and Child Care (2022) reports that there were over 25,000 documented abortion instances in Zimbabwe in 2022 alone, a notable rise over prior years. The actual

prevalence of abortion in Zimbabwe is likely underestimated despite the rising number of reported cases, as evidence suggests that many abortions go unreported or are incorrectly classified. Nearly 70% of abortions in Zimbabwe go unreported, according to a recent study by the Zimbabwe Civil Society Organizations (2023). This finding emphasizes the need for more precise and thorough data collection and analysis to guide practice and policy.

Furthermore, in Zimbabwe, there are notable differences in the prevalence and results of abortions among various demographic and socioeconomic categories. For instance, the absence of access to safe and legal abortion services disproportionately affects adolescents and young women, particularly those who live in rural regions, and this results in greater rates of complications and mortality. In a similar vein, because of their poverty and restricted access to medical facilities, women from low-income households are more likely to face obstacles while trying to obtain reproductive health services, including abortion.

Zimbabwe has taken a number of steps in the last few years to increase access to reproductive health services, such as enhancing maternal health care, decriminalizing abortion under certain conditions, and increasing family planning programs. Still, there are obstacles in the way of obtaining safe and authorized abortion services, and the procedure is still widely stigmatized in the nation (Singh et al., 2020).In this study, we investigate the demographic, sociocultural, and epidemiological aspects that may impact abortion patterns and attitudes among women of various age groups.

In Zimbabwe, abortion is a sensitive and divisive topic that is influenced by a number of social, cultural, and religious variables. Women may find it difficult to access safe and legal abortion services or to speak candidly about their experiences with abortion due to stigma, taboo, and fear of legal ramifications. According to Berer (2013), patriarchal social norms that put the needs of men and families ahead of those of women are frequently at the basis of the stigma associated with abortion in Zimbabwe. Abortion is nevertheless common in Zimbabwe despite legal restrictions, with many women resorting to risky and illegal methods because there aren't enough easily available and reasonably priced health care options (Singh et al., 2020). According to Chitando et al.

(2016), the social and cultural stigma attached to abortion can also keep women from receiving post-abortion treatment, which can result in grave health issues or even death. Moreover, In Zimbabwe, the stigma and legal obstacles associated with abortion are particularly severe for teenagers, who may encounter further difficulties in accessing reproductive health treatments because of their restricted autonomy and the societal shame associated with teenage sexual behavior. According to Nyamadzawo et al. (2018), teenage girls in Zimbabwe frequently turn to covert abortions out of fear of social and parental reaction, which raises the possibility of complications and even death.

The District Health Information System (DHIS2) was introduced to collect data on maternal and child health services, one of the many initiatives the Zimbabwe Ministry of Health and Child Care has implemented in recent years to improve data collection on reproductive health (Nyamadzawo et al., 2018). Nonetheless, there are still a lot of unanswered questions concerning Zimbabwe's abortion rates, trends, and results, especially when it comes to certain age groups (WHO, 2021). Despite the possibility of incompleteness resulting from the previously mentioned obstacles, statistics on reported abortions can nevertheless offer important insights into the health outcomes and experiences of Zimbabwean women seeking abortion care.

In the Mashonaland East Province of Zimbabwe, there is a hospital called Makumbe District Hospital. Primary healthcare, HIV/AIDS management, and maternity and child health are just a few of the many health services the hospital offers to the neighborhood. Makumbe District Hospital supports about 32 facilities in Goromonzi District these includes Chinamhora ,Claledonia,Ruwa clinic,Ruwa Rehabilitation, Pote clinic, Joan Rankine , Domboshava Training Centre , Mwanza, Chabwino, St Josephs ,Zimbabwe Prisons Correctional Services(ZPCS) Goromonzi , Nyaure Clinic ,Pagejo, Masikandoro , Makumbe Hospital , Henry John Reimer, Bosha , Kowoyo Clinic , Chikwaka, Kubatsirana, Acturus Clinic, Chinyika clinic, Rusike ,Melfort ,Bromley ,Xanadu , Crannborne. The Makumbe District Hospital (2020) reports that while having the bare minimum of staff and facilities, the hospital faces many obstacles in its efforts to provide fair and comprehensive healthcare services, such as staffing shortages, limited access to

specialty treatment, and equipment and supply shortages. Even with these difficulties, Makumbe District Hospital continues to be an essential community healthcare access point, especially for marginalized and vulnerable populations like women, young people, and HIV/AIDS patients. The hospital is a crucial place for examining reproductive health experiences and outcomes, including documented cases of abortion, because of its setting in rural Zimbabwe, where access to healthcare is frequently restricted.

Data on abortion in Zimbabwe, like many other countries, is often incomplete and unreliable due to the sensitive nature of the issue. The stigma and legal obstacles associated with abortion could cause cases to be underreported or incorrectly classified in medical settings, which would underestimate the actual abortion burden in the nation (Singh et al., 2020).Furthermore, the quality and thoroughness of data collection and reporting may place restrictions on the use of standard health information systems for tracking abortion data. It has been discovered that the District Health Information System (DHIS2), which is used in Zimbabwe to gather and handle health data, faces a number of difficulties, such as inadequate reporting, problems with data quality, and a restricted capacity for data analysis (Nyamadzawo et al., 2018).

1.3 Problem Statement

Abortion is a significant public health concern in Zimbabwe, with a rising trend in recent years (WHO, 2018). The country has experienced an 18% increase in abortion rates, from 22 per 1000 women in 2010 to 26 per 1000 in 2015 (WHO, 2018), resulting in high maternal mortality rates (MOHCC, 2020), increased healthcare costs and resource utilization (Ministry of Health, 2019), long-term physical and psychological health consequences for women (WHO, 2019), and social and economic burdens on individuals, families, and communities (Guttmacher Institute, 2017). Despite these challenges, there is a lack of understanding of the age-specific trends and patterns of reported abortion cases at the district hospital level, hindering the development of targeted interventions and effective resource allocation.

1.4 Main aim of the study

To perform a time series analysis of recorded abortion cases at Makumbe District Hospital, looking at age-specific trends, and to build ARIMA models to predict future

patterns of abortion incidence.

1.5 Research Objectives

The objectives of this study are:

1. To examine the trends and patterns of reported abortion cases at Makumbe District Hospital, Zimbabwe, for the period 2013 to 2023.
2. To investigate how abortion cases vary by age group (15-24 years and 25 years and above)
3. To predict future trends of reported cases of abortion using ARIMA models.

1.6 Research Questions

This study aims to address the following research questions:

1. What is the overall trend of reported abortion cases at Makumbe District Hospital from 2013 to 2023?
2. Is there a significant difference in the trend of reported abortion cases between the two age groups over the years?
3. What are the predicted trends of reported cases of abortion using ARIMA models at Makumbe District Hospital?

1.7 Scope of the study

This study's scope includes the analysis and prediction of documented abortion instances at Zimbabwe's Makumbe District Hospital. The goal of the age-specific trend analysis is to use data from 2013 to 2023 to find patterns or discrepancies in reported abortion rates across various age groups and to determine which age group is prevailing.

1.8 Significance of the study

The findings of this study contribute to a better understanding of the patterns and factors that influence reported cases of abortion at Makumbe District Hospital, particularly across age groups. By analyzing the data using ARIMA models, we can identify trends and predict future patterns, which can help guide the development of

effective public health policies and interventions. This study helps to increase awareness and understanding of the relationship between age and reported cases of abortion, leading to more targeted educational campaigns and programs.

1.9 Assumptions of the Research

This study is based on the assumptions that:

1. The data collected from Makumbe District Hospital is accurate and complete.
2. The reporting of abortions is consistent over time, allowing for reliable trend analysis.
3. The relationship between reported cases of abortions and age groups at Makumbe District Hospital is linear and can be modeled using ARIMA models.
4. The underlying trends and predictors of reported cases of abortions are constant over time.

1.10 Limitations of the study

There are a number of limitations to this study that should be considered when interpreting the results. The quantity and caliber of data gathered in Zimbabwe restricts the amount of information available on abortions. There might be underreporting of abortions at Makumbe District Hospital, which could limit the accuracy of diagnoses and reporting of the condition. Lastly, time is another constraint on the study.

1.11 Definition of terms

ARIMA: Autoregressive integrated moving average (ARIMA) is a statistical method for modeling and forecasting time series data. ARIMA models have been widely used in various fields, including finance, economics, and health research, to understand and predict trends and patterns in data over time (Wang & Yang, 2020).

Hemorrhaging: Hemorrhaging, also known as bleeding, is the loss of blood from a damaged blood vessel. It can be caused by a variety of factors, such as trauma, surgery, or underlying health conditions (Maniscalco, 2016).

Abortion: Abortion is the voluntary termination of pregnancy by removing the fetus or

embryo from the womb (Prioleau & Watkins, 2019). Abortion can be elective or medically necessary, and the legal, ethical, and societal implications of abortion are complex and controversial.

1.12 Conclusion

The topic of time series analysis of reported cases of abortion at Makumbe District Hospital is introduced in this study. This research's objectives and specific research question have been presented, along with its background and justification. Additionally included are the scope and methodology applied to address the research question. In this chapter, the study's limitations were covered. The review of the relevant literature is presented in the following chapter.

Chapter 2: Literature Review

2.1 Introduction

It has been discussed and studied in public health, sociology, and other disciplines, as abortion is a complicated and multidimensional topic. Creating successful treatments requires an understanding of the patterns and indicators of documented abortion cases. The research on age groups and documented abortion cases at Makumbe District Hospital, as well as other pertinent studies, are reviewed in this chapter.

2.2 Theoretical Literature

2.2.1 Demographic Transition Theory

Demographic Transition Theory (Coale & Demeny, 1984; Goldstein & Cook, 2021) can offer a helpful framework for comprehending reported abortion rates at Makumbe District Hospital. According to the argument, there may eventually be a reduction in birth rates, which would result in fewer unwanted pregnancies and possibly lower reported abortion rates (Goldstein & Cook, 2021). For example, a shift in age-specific abortion rates could result in a higher proportion of abortions among older women if fertility declines as a result of demographic transition (Coale & Demeny, 1984).The demographic transition theory has some drawbacks even if it provides a helpful explanation for the possible trends in reported abortions. First, according to Bognaarts and Sinding (2013), the hypothesis ignores additional variables that can affect reported abortion rates, such as cultural perceptions of abortion and access to contraception. Second, the theory could not be directly applicable to the situation in Zimbabwe because it is mainly based on research from Western nations (Goldstein & Cook, 2021). Notwithstanding these drawbacks, the demographic transition hypothesis offers a basis for comprehending reported abortion rates and can guide future studies on this crucial matter of public health.

The possible impact of urbanization on reported abortion rates is a significant component of the demographic transition theory in the context of this study. Reduced reported abortion rates could result from improved access to healthcare and contraception as populations become more urbanized (Goldstein & Cook, 2021). But

urbanization may also lead to more exposure to unwanted pregnancy risk factors including sexual exploitation or violence, which could raise reported abortion rates (Fargher et al., 2015).As a result, in the context of this study, the impact of urbanization on reported abortion rates is a complicated subject that needs to be carefully considered.

To sum up, the demographic transition theory provides significant understanding of possible trends and patterns in the recorded abortion rates at Makumbe District Hospital (Coale & Demeny, 1984; Goldstein & Cook, 2021). The hypothesis can aid in our understanding of the underlying variables influencing abortion rates in the area by taking changes in urbanization and birth rates into account. The hypothesis offers a helpful foundation for additional research into the age-specific trends and patterns of reported abortions at Makumbe District Hospital, notwithstanding its shortcomings.

2.2.2 Rational Choice Theory

The application of Rational Choice Theory can yield significant insights into the cognitive processes and underlying motives of persons who opt for abortions at Makumbe District Hospital in Zimbabwe. According to the theory, people consider the possible risks and rewards of their activities and rationally calculate the costs and benefits of their decisions (Becker, 1976; Schoen & Allendorf, 2001).Individuals weigh the possible risks and rewards of their activities, calculating costs and benefits rationally, in accordance with the rational choice theory (Wenzel, 2016). This theory suggests that when deciding whether or not to have an abortion, people may take into account factors like the effect on their health, financial resources, social relationships, and future opportunities (Schoen & Allendorf, 2001; Wenzel, 2016). This theory applies to abortion at Makumbe District Hospital in Zimbabwe. When making decisions about an abortion, a young lady who finds herself pregnant unexpectedly may provide an illustration of the application of rational choice theory. She might weigh the advantages and disadvantages of getting an abortion, taking into account things like possible health concerns, budgetary constraints, social stigma, and how it might affect her chances for further education and employment (Schoen & Allendorf, 2001). In the end, she might determine that having an abortion is worthwhile and opt to have one.

Nevertheless, rational choice theory is not without its limitations. The assumption that people make decisions only on the basis of reason is one of the limitations of the rational choice theory. But in practice, emotional emotions like guilt, shame, or fear frequently impact decisions and are difficult to quantify with reasoned calculations (Schoen & Allendorf, 2001; Wenzel, 2016).An further constraint of the theory is its incomplete consideration of the impact of social and cultural elements, including religious convictions or stigma, on an individual's decision-making process (Wenzel, 2016).Rational Choice Theory is nevertheless a crucial theoretical framework for comprehending abortion decision-making in spite of these drawbacks. We can develop a more thorough knowledge of the variables impacting reported abortion rates at Makumbe District Hospital in Zimbabwe by fusing the insights of Rational Choice Theory with those of other theoretical vantage points, such as Social Learning Theory or Stigma Theory. In conclusion, despite its drawbacks, rational choice theory offers important insights into the reasons and decision-making processes of those who choose to have abortions. These insights can aid in the development of more potent interventions and laws aimed at lowering the abortion rate in the area.

2.2.3 Social Learning Theory

According to the Social Learning Theory (Bandura & Ribes-Inesta, 2018), people's interactions with others and their surroundings have an impact on their attitudes and behaviors. According to the idea, societal norms and views around abortion within the community may have an impact on the decision to seek or report an abortion in the context of reported abortions at Makumbe District Hospital, Zimbabwe (Bandura & Ribes-Inesta, 2018; Schoen & Allendorf, 2021).An individual's decision to seek or report an abortion may be influenced, for instance, if they witness that abortion is commonly accepted in their community or that friends and relatives have had abortions with little to no negative outcome (Bandura & Ribes-Inesta, 2018).

On the other hand, even in cases where an abortion is medically required, a person may be discouraged from seeking or reporting one if they believe that having one is stigmatized or frowned upon in their society (Bandura & Ribes-Inesta, 2018; Schoen & Allendorf, 2021).Social Learning Theory is not without limitations, though. One

drawback is that it might not adequately take into consideration individual characteristics, such personality traits or cognitive capacities, which can affect how someone makes decisions (Bandura, 2006). Furthermore, the theory does not account for how people might oppose or reject societal attitudes and conventions while making decisions (Bandura & Ribes-Inesta, 2018).

However, Social Learning Theory offers insightful information about how social influences might affect people's choices and actions about abortion, which can assist in informing methods for intervention and policy to lower reported abortion rates in Makumbe District Hospital and elsewhere. In addition, Social Learning Theory can be integrated with other theoretical stances, like Stigma Theory, to offer a more comprehensive comprehension of the factors influencing reported abortion rates. People may learn through social reinforcement and observation that abortion is not a viable option, for instance, if it is strongly stigmatized in the community. This could have an impact on people's attitudes toward abortion as well as their willingness to seek out or report abortions (Bandura & Ribes-Inesta, 2018).

2.2.4 Health Belief Model

According to the Health Belief Model, people base their decisions about their health on their sense of the advantages of a given behavior, the obstacles to that behavior, and their specific vulnerability to health hazards (Glanz et al., 2008; Bell, 2012).The Health Belief Model indicates that, in the context of reported abortions at Makumbe District Hospital in Zimbabwe, people's decisions regarding whether to seek or report an abortion may be influenced by their beliefs about their own susceptibility to negative consequences as well as their perceptions of the procedure's risks and benefits (Glanz et al., 2008; Bell, 2012). For example, a woman may be more likely to seek and report an abortion if she believes that the procedure is required to safeguard her health or that the advantages of ending the pregnancy exceed the dangers (Glanz et al., 2008).However, a woman may be less inclined to seek an abortion or report one if she thinks that abortions are dangerous and that carrying the pregnancy to term won't have a detrimental impact on her health (Glanz et al., 2008; Bell, 2012).

In order to improve information and attitudes about abortion and lower perceived

barriers to safe and legal abortion services, interventions that aim to improve these areas can benefit from using the framework that the Health Belief Model offers for understanding people's decision-making processes around abortion. Still, there are drawbacks to the Health Belief Model. As per Ganz et al. (2008), people's opinions and convictions regarding abortion could not consistently be logical or grounded in precise data. The impact of social and cultural elements on people's decision-making processes may also be overlooked by the model (Bell, 2012).

2.2.5 Stigma theory

According to the stigma theory, people who are seen as breaking from society norms, such as those who have had abortions, may face unfavorable social repercussions such devaluation, discrimination, and exclusion (Bray et al., 2021; Brodwin, 2022). Regarding documented abortions at Makumbe District Hospital in Zimbabwe, stigma may influence a person's choice to have an abortion as well as their willingness to disclose one (Bray et al., 2021).For instance, if someone admit they have had an abortion and it is stigmatized in their society, they might fear social rejection, condemnation, or worse (Bray et al., 2021; Brodwin, 2022). This stigma-related anxiety can be a potent disincentive to getting an abortion and disclosing one (Bray et al., 2021). Furthermore, stigmatization can result in the formation of negative self-perceptions and internalized shame, both of which can worsen mental health conditions and reduce the likelihood that people would reveal their experiences or seek assistance (Bray et al., 2021).

The difficulty of measuring and quantifying the influence of stigma on people's decision -making processes is one of the limitations of the stigma theory (Bray et al., 2021).... Furthermore, according to Baldwin (2022) the theory falls short in explaining the intricate interactions between stigma and other variables that could affect reported abortion rates, such as socioeconomic position or access to healthcare. The Stigma Theory offers a useful framework for comprehending the social and psychological elements that can affect the reported abortion rates at Makumbe District Hospital in Zimbabwe, notwithstanding these drawbacks.

2.3 Empirical Literature

2.3.1 Trends of Reported Cases of Abortion

Numerous studies have looked at the patterns of reported abortion cases across various demographics and circumstances. The Ministry of Health and Child Care (MOHCC 2014) investigated the prevalence of abortion in Zimbabwe using data from the Zimbabwe National Health Transition Survey (ZNHT). The ZNHT was a nationally representative household survey conducted in 2010, using a sample of women aged 15-49. A multi-stage cluster sampling procedure was employed to select households and individuals, ensuring a representative sample of the population. The researchers used multivariate logistic regression analysis to examine the association between abortion and demographic and socioeconomic characteristics, as well as descriptive statistics to determine the abortion rate in Zimbabwe. According to the Ministry of Health and Child Care (MOHCC) (2014), in Zimbabwe, 70,000 induced abortions are carried out annually, with a countrywide abortion rate of roughly 23 per 1,000 women between the ages of 15 and 49. The abortion rate increased to 26 per 1,000 women in 2015, according to the World Health Organization (WHO) (2018).

This is followed by the reported abortion instances in Zimbabwe which were examined by the Zimbabwe Demographic and Health Survey 2015 (ZDHS 2015). This study examined the factors influencing documented abortion instances in Argentina using a range of social and demographic theories. Among these theories was the theory of planned conduct, which postulates that attitudes, perceived control, and subjective norms all have an impact on people's intentions to engage in an activity. The ZDHS employed a range of data gathering techniques, such as surveys and interviews, to gather information from a representative sample of Zimbabwean households. The survey gathered data on documented abortion cases in addition to other demographic and health-related variables. ZDHS (2015) states that a multistage sampling procedure was used to choose a representative sample of households throughout Zimbabwe. Face-to-face interviews and structured questionnaires were used to conduct the survey. The ZDHS analyzed the data using a range of statistical techniques, including as logistic regression, regression analysis, and descriptive statistics. According to the ZDHS (2015), younger women and those residing in rural areas reported more abortion cases

than other demographic groups. The study also found variables like educational attainment, marital status, and exposure to family planning information that were linked to documented incidences of abortion. According to the ZDHS (2015), the number of documented abortion cases in Zimbabwe is a serious public health concern, especially for young women and those residing in rural regions.

The prevalence and patterns of unsafe abortions in Zimbabwe were explored in a study by Mutasa et al. (2019), which provided important insights into this critical issue. According to the survey, unsafe abortions are rather common in the nation, especially among young women and women who live in rural areas. The study also found that the main causes of unsafe abortions in Zimbabwe were poverty, a lack of access to contraception, and a shortage of safe abortion facilities. In order to identify the factors that contribute to unsafe abortion in Zimbabwe, Mutasa employed the Theory of Reasoned Action as the foundation for this study. According to this theory, a person's behavior is determined by their perception of societal standards and their attitude toward that behavior. According to Mutasa et al. (2019), both quantitative and qualitative methodologies were employed, such as focus groups with healthcare practitioners and in-depth interviews with women who had undergone unsafe abortions. The data were analyzed by the study using multivariate, bivariate, and descriptive statistics. The study discovered that the main factors influencing unsafe abortion in Zimbabwe were poverty, restricted access to contraception, and societal and cultural norms that forbid candid conversations about sexual and reproductive health. Mutasa et al. (2019) found that unsafe abortions were more common among young women and those residing in rural areas.

Similarly in the same year of the study, almost 33% of women who had abortions encountered problems, and many of these women were compelled to seek medical attention as a result of these problems (Guttmacher Institute, 2019). In 2019, the Guttmacher Institute carried out research on the prevalence and effects of abortion in Zimbabwe (Guttmacher Institute, 2019). Data from the Zimbabwe Abortion and Post-Abortion Care Study (ZAPACS), a nationally representative survey of medical facilities offering post-abortion care and abortion services, were used in the study. Women who

visited these facilities for abortion or post-abortion care provided information for the survey. Health facilities served as the main sampling unit in the ZAPACS cluster sampling approach. In order to investigate the prevalence and effects of abortion in Zimbabwe, the researchers used logistic regression analysis and descriptive statistics to evaluate the data. According to the study's findings, 66% of abortions performed in the nation were unsafe, and complications occurred in 33% of these cases. Sepsis (15%), hemorrhage (11%), and partial abortion (18%) were the most frequent consequences. According to a separate study conducted by the Zimbabwe National Statistics Agency, unsafe abortion complications rank as Zimbabwe's fourth most common cause of mortality for women (Zimbabwe National Statistics Agency, 2018).

In rural communities in Sub-Saharan Africa, Jones and Kool (2020) looked into the prevalence of reported abortions among teenage girls. The researchers noted a substantial rise in the number of documented occurrences of abortions among teenage females. It is likely that information on reported abortions was gathered from medical facilities or by surveys conducted in the community. The researchers came to the conclusion that the data point to a high frequency of reported abortions among teenage girls in rural areas in Sub-Saharan Africa, although the techniques of data analysis were not stated (Jones & Kool, 2020). The results of Jones and Kool (2020), which emphasize the substantial burden of reported abortions among teenage girls in rural areas in Sub-Saharan Africa, are extremely pertinent to the current investigation. These results imply that the incidence of adolescent girls reporting abortions in rural communities may not be unique to any one nation or area, but rather that it is a problem that needs to be looked into more and addressed.

Similarly, in a recent study, Smith et al. (2021) looked into how common it was for young American women (ages 15 to 24) to report having an abortion in an urban setting. Data from community-based surveys or healthcare facilities were used in the study, which focused on a sample of young women living in urban locations across the United States. Regression analysis and time series analysis were two statistical techniques used by the researchers to examine the consistent increase in reported cases of abortions among young women in metropolitan regions. According to Smith et al.'s

findings from 2021, young women reporting abortions in metropolitan locations is a phenomena that is not exclusive to any one place or population. This implies that a range of sociocultural, economic, and health-related factors that exist in both urban and rural environments, irrespective of geographic location, may have an impact on reported abortions.

2.3.2 Relationships between Reported cases of abortion and age groups

Numerous research have looked at the correlation between age groups and reported abortion cases. According to Maponga et al. (2016), women between the ages of 15 and 24 had a much higher likelihood of reporting TOP (Termination of Pregnancy) than did older women (25–49 years). According to the study, women who were in the richest quintile, resided in cities, and had completed secondary or higher education had a higher likelihood of reporting TOP. The study examined the association between sociodemographic traits and reported TOP using quantitative data from a cross-sectional survey carried out at six health facilities in Zimbabwe in 2016. It did this by using multivariate logistic regression, descriptive statistics, and the Chi-square test. The socioecological model was applied by Maponga et al. (2016) and proposes that a variety of factors operating at several levels (individual, interpersonal, communal, and structural) impact health outcomes.

This is followed by the study conducted by Jones and Kool (2020) focused on teenage girls, aged 15-19, who lived in rural areas in Sub-Saharan Africa. Using statistical techniques, the researchers examined data on documented abortion cases that they had gathered from community-based surveys or medical facilities. The study's findings indicated that across all age categories in the research population, adolescent females (15–19 years old) had the highest reported rates of abortion cases. This suggests that this particular demographic is more vulnerable to unintended pregnancies and abortions. The high rates of reported abortions among adolescent girls in Jones and Kool's (2020) study underscore the pressing need for focused programs and policies meant to lower the risk of unintended pregnancies and enhance this vulnerable population's access to reproductive health services. The results also highlight how critical it is to address the underlying sociocultural and economic issues that might be causing the high

percentages of adolescent girls having abortions in Sub-Saharan African rural areas.

Sibanda et al. (2020) investigated the factors linked to unsafe abortions and unplanned pregnancies in Zimbabwe and discovered that age, education, marital status, and income were all related to both. Unwanted pregnancies and unsafe abortions were more common among women who were younger, divorced, had lower incomes, and fewer educational attainments. The study used the health behavior model, which postulates that a mix of environmental, interpersonal, and individual factors affect people's health habits. Both numerical and qualitative data were employed in this investigation. To gather quantitative information on the variables linked to unintended pregnancies and unsafe abortions, a cross-sectional survey employing a standardized questionnaire was carried out. Focus groups and in-depth interviews were used to gather qualitative data. Binary logistic regression, the Chi-square test, and descriptive statistics were used to assess the quantitative data. Thematic analysis was used to examine the qualitative data. The study came to the conclusion that in Zimbabwe, unsafe abortions and unintended pregnancies are significantly predicted by factors such as age, marital status, income, and education. In order to decrease unintended pregnancies and unsafe abortions, the study also emphasized the significance of addressing cultural and societal norms, expanding access to contraception, and offering financial help to women.

In a similar vein, Young women (ages 20 to 24) who lived in American cities were the study's target group, according to Smith et al. (2021). Statistics were used to examine information on documented abortion cases that was gathered from medical institutions or community surveys. Young women (20–24 years old) reported having the most abortions among the various age groups in the study population, according to the study's results. This suggests that policies and interventions should be specifically designed to address the reproductive health needs of this age group in urban settings. According to Smith et al. (2021), young women in urban areas in the United States who are between the ages of 20 and 24 are more vulnerable in terms of reported abortions. It is evident that better access to reproductive health services, thorough sex education, and supportive social policies are crucial for lowering the risk of unintended

pregnancies and abortions among young women in urban settings, even though more research is required to fully understand the factors contributing to this trend.

2.4 Conceptual framework

This study examines abortion trends by age at Makumbe District Hospital, Zimbabwe, through a time-series analysis. The primary dependent variable is the reported cases of abortion, analyzed across age groups (15-24 years and 25 years and above) and quarters (Q1, Q2, Q3, Q4) of the year. The study is guided by five theoretical frameworks: Stigma Theory, Health Belief Model, Social Learning Theory, Rational Choice Theory, and Demographic Transition Theory. The objectives are to examine the trends and patterns of reported abortion cases from 2013 to 2023, investigate how abortion cases vary by age group, and predict future trends of reported cases of abortion using ARIMA models. By exploring these aspects, the study aims to gain a deeper understanding of abortion trends and patterns at Makumbe District Hospital.

2.5 Research Gaps

Although there is a substantial body of literature on age groups and reported abortion cases, nothing is known about the use of ARIMA models to the analysis and prediction of these patterns at Makumbe District Hospital. By utilizing ARIMA models to analyze reported cases of abortions across various age groups and pinpoint the underlying causes of these trends, this study seeks to close this gap.

2.6 Conclusion

This review of the literature has highlighted several gaps in the current understanding of abortions in Zimbabwe. These gaps include use of short term data, a focus on urban areas, and limited research on the cultural aspects of abortions. The proposed study address these gaps by collecting data over time, including rural areas, and exploring the role of culture in abortions. Additionally, the study use a bio psychosocial-spiritual model to guide the research and interpret the results. This help to develop a more complete understanding of abortions in Zimbabwe and to develop appropriate interventions and policies. The next chapter outlines the research methodology used to achieve this understanding.

CHAPTER 3: RESEARCH METHODOLOGY

3.1 Introduction

This study uses time series analysis to examine the prevalence of abortions over time and examine their differences across age groups. Time series analysis is a powerful statistical technique that can be used to identify trends and patterns in data. By analyzing abortions data over time, a better understanding of the factors that influence abortion rates in Goromonzi District can be gained. The data used is from hospital records, to construct a time series of reported cases of abortion. Statistical techniques are applied to the data to identify trends and patterns.

3.2 Research Design

In this study, a time series design was employed to analyze reported cases of abortion in two age groups at Makumbe District Hospital in Zimbabwe. This design examines data collected over time to identify patterns, trends, and seasonal variations. The time series design provided a comprehensive overview of the trends in reported abortions at the hospital, allowing for the identification of trends and patterns that might have been overlooked with a different research design. This approach enabled the identification of patterns and changes in the prevalence of reported cases of abortions over time (Peng et al., 2018).

3.3 Data Sources

The Makumbe District Hospital was one of the data sources used in this study, with data collected from 2013 to 2023. The hospital is a public healthcare facility in the Goromonzi District of Zimbabwe that provides mental health services to a population of over 494,797 people. The hospital's electronic medical records system contains information on patient demographics, diagnoses, and treatment plans. This data was used to investigate trends and patterns in the prevalence of reported cases of abortions. The data was anonymized and de-identified before analysis to protect patient privacy.

The Demographical Health Information System (DHIS) was used to provide the secondary data for this study. This data was collected through a hospital software system and did not require direct collection by the researcher. The primary strength of

this data source is its comprehensiveness and completeness. However, it is possible that the information is not completely accurate and does not accurately reflect all patients. Despite these limitations, the data provides valuable insights into the health of hospitalized patients. As noted by Hripcsak (2015), secondary data has many benefits, including cost-effectiveness and the ability to study large populations. However, there are also significant limitations, including potential bias and lack of control over the data collection process.

3.4 Target Population and sampling procedures

The target population for this study was women who had undergone an abortion at Makumbe District Hospital in Zimbabwe, within the specified age groups of 15-24 years and 25 years and above. To select a representative sample for analysis, a stratified sampling procedure was used.

All reported cases of abortion in the specified age groups at the hospital were divided into two strata: 15-24 years and 25 years and above. Within each stratum, cases were randomly selected for analysis using a simple random sampling technique. The sample size for each stratum was selected based on the proportion of reported abortions in each age group at Makumbe District Hospital. The final sample size (26170) for each stratum was adjusted to ensure that both age groups were equally represented in the analysis. This allowed for an accurate and unbiased representation of the age-specific trends in reported abortions at Makumbe District Hospital.

3.5 Research Instruments

The secondary data for this study was obtained from administrative databases and electronic medical records. A laptop computer was chosen for data access due to its reliability and portability. There were several advantages of using electronic data sources, including quick and easy access to large amounts of data, statistical software analysis of data, and reproducibility of findings. Additionally, it was important to be aware of potential issues such as data quality and accuracy.

3.6 Methods of data Collection

Using a laptop computer, the data for this investigation was gathered from electronic health records. A secure link was made between the computer and the electronic health

record system. A specially created application was then used to extract the data from the electronic health records. An application with the intention of extracting data in a format that would allow for statistical software analysis. After that, the retrieved data was loaded into statistical software and the relevant statistical techniques were applied for analysis.

3.7 Descriptions of variables and the expected relationships

The primary dependent variable in this study is the reported cases of abortion (Cases of Abortion), which is analyzed across age groups (15-24 years and 25 years and above) and quarters (Q1, Q2, Q3, Q4) of the year. Examining abortion cases across age groups may uncover potential correlations between age and abortion, such as higher abortion rates among younger women due to limited access to sexual health services or among older women due to a higher likelihood of unintended pregnancies. Analyzing abortion cases by quarter can identify seasonal trends and predict when rates may peak or dip.

The age (15-24 years and 25 years and above) and quartiles of the year variables may also interact, producing unique patterns that reflect demographic and temporal factors simultaneously. For example, increased reports of abortion during the summer months may be more common among younger women due to their higher levels of sexual activity during school breaks. Conversely, increased reports of abortion during the last quarter of the year may be more prevalent among older women due to increased rates of unintended pregnancy during the holiday season.

3.8 Data analysis procedures

Several diagnostic tests were performed to ensure the accuracy and reliability of the data used in this study.

3.8.1 Normality Test

A normality test was conducted to confirm that the data followed a normal distribution. Boxplots were used to visually inspect the data's distribution and detect any deviations from normality.

3.8.2 Autocorrelation and Trend Tests

Diagnostic tests were performed to check for the presence of autocorrelation and

trends in the data. The results are presented in an autocorrelation function (ACF) plot and a partial autocorrelation function (PACF) plot.

3.8.3 Stationary Test

A stationary test was performed to confirm the data's consistency over time. The results are presented in a graph showing the data's mean and variance over time.

3.8.4 Test for Difference between Means

A two-sample t-test was conducted to determine if there was a significant difference in the number of reported abortion cases between the two age groups (15–24 years and 25 years and above). Boxplots were used to visualize the distribution of the data for each age group, and the results of the t-test are presented showing the mean number of reported abortion cases for each age group, along with the t-statistic, degrees of freedom, and p-value.

3.8.5 ARIMA Model

An autoregressive integrated moving average (ARIMA) model was fitted to the data. The model's parameters and goodness-of-fit statistics are presented in a table. The autoregressive integrated moving average (ARIMA) model was employed to examine the time series data for this research. The ARIMA model included a moving average of order q, a lag of order p, and an order of integration of d. One way to express the model is as ARIMA (p, d, q). The model's parameters were estimated using maximum likelihood estimation, and the Akaike information criterion (AIC) was used to evaluate the results' statistical significance. The ARIMA model was fitted using statistical tools.

The ARIMA model was selected for this study because it is suitable for stationary time series data that exhibit a linear relationship. The data used in this study fulfills these requirements, indicating that the ARIMA model is appropriate. Additionally, the ARIMA model is flexible and can be configured to account for a variety of data patterns, including seasonality and non-stationary. Finally, the ARIMA model offers strong interpretability and is easy to implement in statistical software. All of these factors make the ARIMA model a good choice for this study.

The equation for a non-seasonal ARIMA (Autoregressive Integrated Moving Average)

model can be written as:

$$y_t = \mu + \phi_1 y_{t-1} + \phi_2 y_{t-2} + ... + \phi_p y_{t-p} - \theta_1 \varepsilon_{t-1} - \theta_2 \varepsilon_{t-2} - ... - \theta_p \varepsilon_{t-p} + \varepsilon_t$$

In this equation:

- y_t represents the time series at time t.

- μ represents the mean or intercept of the time series.

- $\phi_1, \phi_2, ..., \phi_p$ are the autoregressive coefficients that capture the relationship between the current value and past values of the time series. The order of autoregressive terms is denoted by p.

- ε_t represents the error term or residual at time t.

- $\theta_1, \theta_2, ..., \theta_p$ are the moving average coefficients that capture the relationship between the error terms at previous time points. The order of moving average terms is denoted by q.

The primary drawback of the ARIMA model is that intricate patterns in the data could be difficult for it to identify. The model's linear relationship between the variables may not always hold true when analyzing data from the real world. Furthermore, when there is a lot of volatility or non-stationarity in the data, the model could not work well. Nevertheless, by appropriately modifying the model, these problems can be resolved. In general, the benefits of the ARIMA model exceed its drawbacks.

This study may have made use of a number of other models. Nonetheless, the ARIMA model was selected because time series data lends itself to its simplicity and robustness. Certain models, like the exponential smoothing models, necessitate presumptions regarding the fundamental mechanism producing the data. These presumptions might not hold true for every piece of data. There are other models that could be more intricate and challenging to understand, including artificial neural networks. The ARIMA model was selected due of its interpretability, simplicity, and flexibility.

3.8.6 Model validation (fitness) tests

The Akaike information criterion (AIC) was used to compare the fits of various models and select the model with the lowest AIC value. The mean absolute error (MAE), mean absolute percentage error (MAPE), and root mean square error (RMSE) were also used to evaluate the model's accuracy. The Akaike information criterion (AIC) was used to confirm the number of lags in the ARIMA model. The Ljung-Box test was used to determine whether the residuals were independent and identically distributed, and to check for serial correlation in the residuals. These tests ensured that the model was well-specified and fit the data.

3.9 Ethical Considerations

The study was conducted with ethical considerations in mind, including obtaining informed consent from the individuals whose data was used, ensuring the data was securely stored and used only for approved purposes, and considering potential bias in the data.The data was stored on a secure server with access restricted to authorized individuals. Bias was considered by examining the representativeness of the data and the reliability of the data source. These ethical considerations were important to ensure that the data was collected and used in an ethical manner and that the individuals whose data was used were protected. These ethical considerations were also important to ensure the validity and reliability of the study's findings, as well as the accuracy and significance of the conclusions drawn from the study.

3.10 Conclusion

The technique outlined in this chapter provides a solid and trustworthy method for performing a time series analysis of reported abortion cases at Makumbe District Hospital. This chapter's techniques facilitate a thorough examination of the data, enabling significant conclusions to be drawn regarding the correlation between relevant variables. Ethical concerns are addressed to ensure responsible and ethical use of data, and the study's limitations are considered when interpreting the findings. The next chapter covers the presentation, analysis, and interpretation of results.

CHAPTER 4: DATA PRESENTATION, ANALYSIS AND INTERPRETATION

4.0 Introduction

In this chapter, the study present and analyze the data collected from Makumbe District Hospital regarding reported cases of abortion in two age groups, 15-24 years and 25 years and above. The data was collected through a cross-sectional analysis of hospital records, and the results were analyzed using time series analysis, ARIMA modeling and t-test. The aim of this chapter is to present and interpret the findings of the study, with a focus on identifying age-specific trends and patterns in reported abortions at Makumbe District Hospital.

4.1 Descriptive Statistics/Summary Statistics

The mean number of reported abortions in the 15-24 age group (324.8) is significantly higher than in the 25 years and above age group (270.0). This suggests that younger women, despite their smaller population, have a higher incidence of reported abortions than older women. Moreover, the overall mean (594.8) and median (595.0) indicate a relatively high number of reported abortions at Makumbe District Hospital, and thus a significant public health issue in the community. The similarity between the mean and median suggests that the distribution of reported abortions is approximately symmetric, with a moderate skew towards the higher end of the scale. This might be an indication of a smaller group of women experiencing multiple abortions. The summary of these statistics are shown below;

Year	15-24 years	25 years and above	Cases of Abortion (Overall Age Group)
Min. :2013	Min. :250.0	Min. : 150.0	Min. : 400.0
1st Qu. :2015	1st Qu. :300.0	1st Qu.:217.5	1st Qu. : 517.5
Median : 2018	Median :325.0	Median: 270.0	Median : 595.0

Mean : 2018	Mean :324.8	Mean :270.0	Mean : 594.8
3rd Qu. :2021	3rd Qu. :350.0	3rd Qu.:322.5	3rd Qu. : 672.5
Max. :2023	Max. :400.0	Max. : 390.0	Max. : 790.0

Table 4. 1 Summary statistics

4.2 Pre-tests /Diagnostic tests

4.2.1 Testing for Normality

Based on the box plots and Shapiro-Wilk normality tests, we conclude that the data appears to be approximately normally distributed for all three groups (15-24 years, 25 years and above, and the overall age groups). The p-values for the Shapiro-Wilk test are all above 0.05 (0.8336, 0.2796, and 0.5276, respectively), indicating that there is insufficient evidence to reject the null hypothesis of normality.

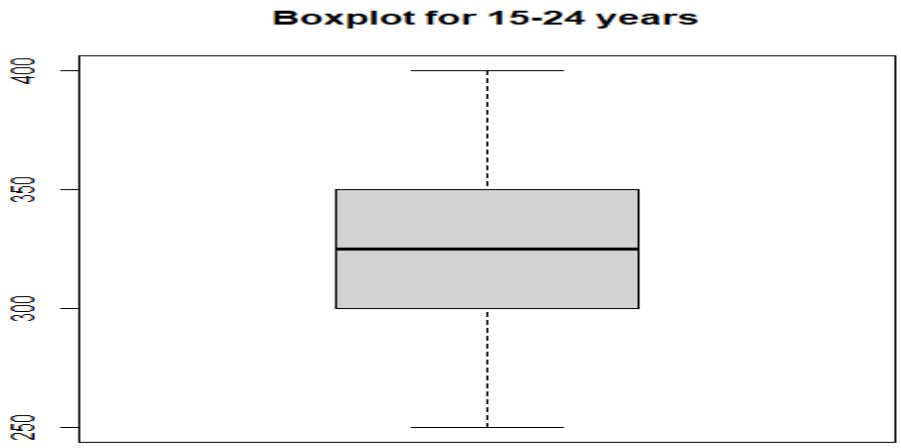


Figure 4. 1 Boxplot for age group 15-24 years

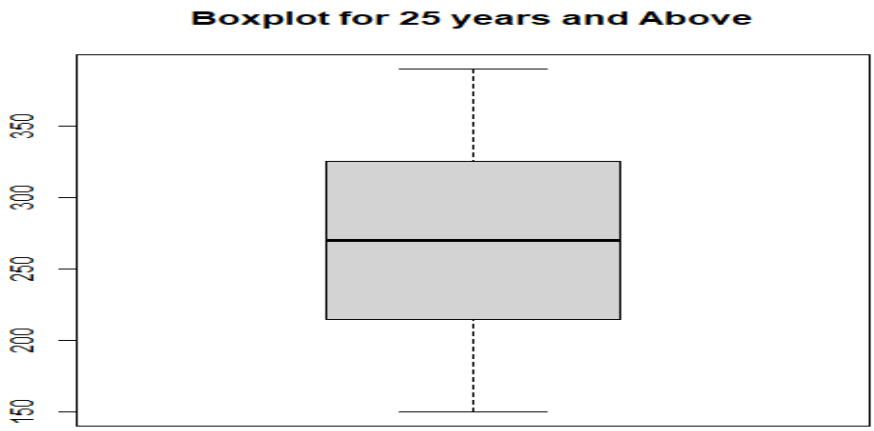


Figure 4. 2 Boxplot for age group 25 years and above

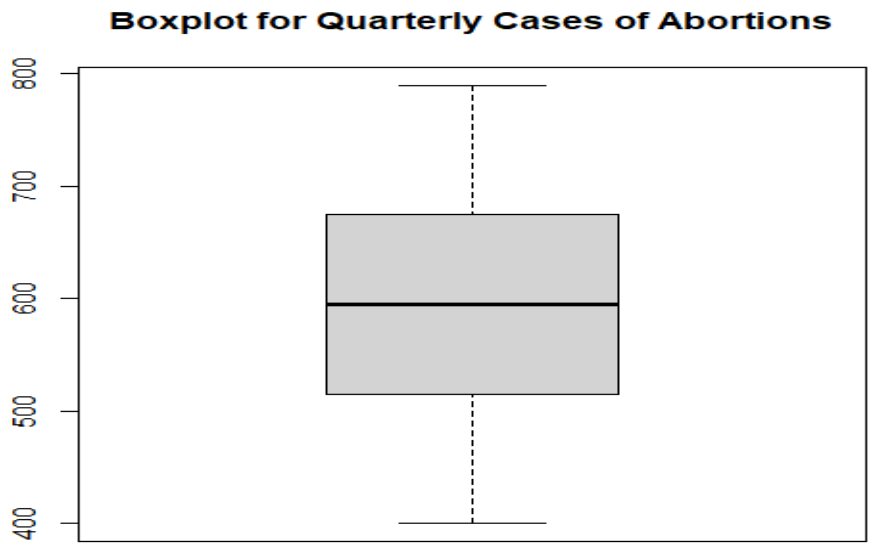


Figure 4. 3 Boxplot for Cases of abortion

15-24 years	25 years and above	Cases of Abortion
W = 0.98513	W = 0.96903	W = 0.97726
p-value = 0.8336	p-value = 0.2796	p-value = 0.5276

Table 4. 2 Shapiro-Wilk normality test-Results

4.2.2 Testing for Autocorrelation

The autocorrelation function (ACF) and partial autocorrelation function (PACF) plots in f ig indicate a weakly positive autocorrelation. The spikes outside the 95% confidence int erval in the ACF and PACF plots are an indication of serial correlation in the data, which may cause issues in time series analysis. The presence of autocorrelation suggests tha t observations in the data series are not independent of each other, but rather, they are i nfluenced by previous observations. To address this issue, we can use an autoregressiv e integrated moving average (ARIMA) model, which takes into account the autocorrelati on structure of the data. By including terms that capture the autocorrelation at specific l ags in the model, we can ensure that our analysis accounts for the serial correlation in t he data, leading to more accurate estimates of the underlying trends and patterns.

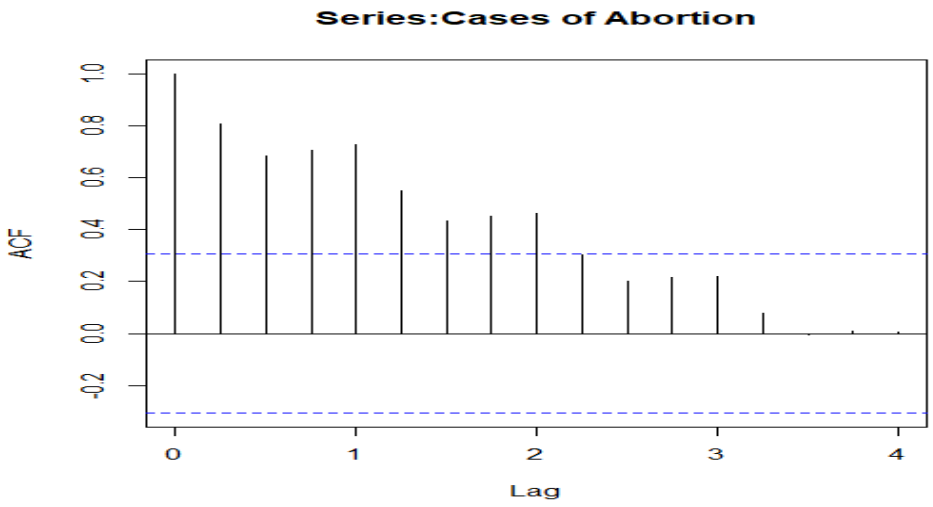


Figure 4. 4 ACF for Cases of abortion

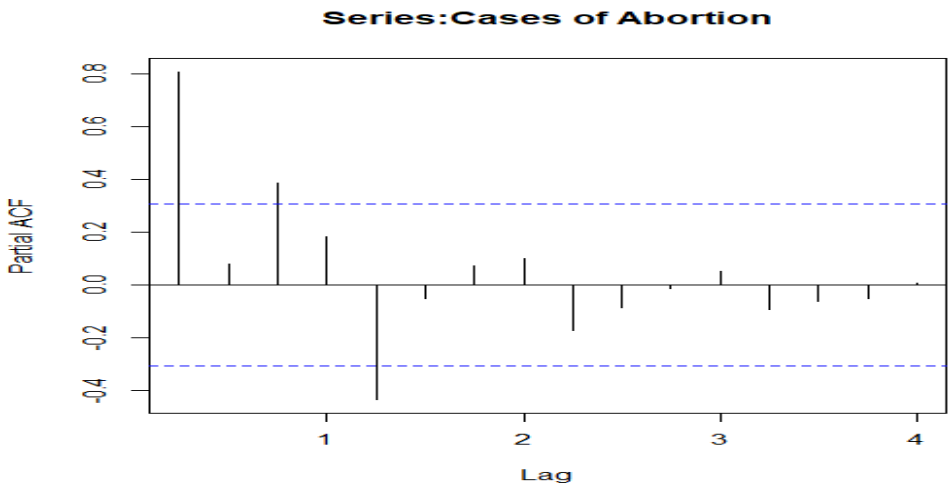


Figure 4. 5 PACF for Cases of abortion

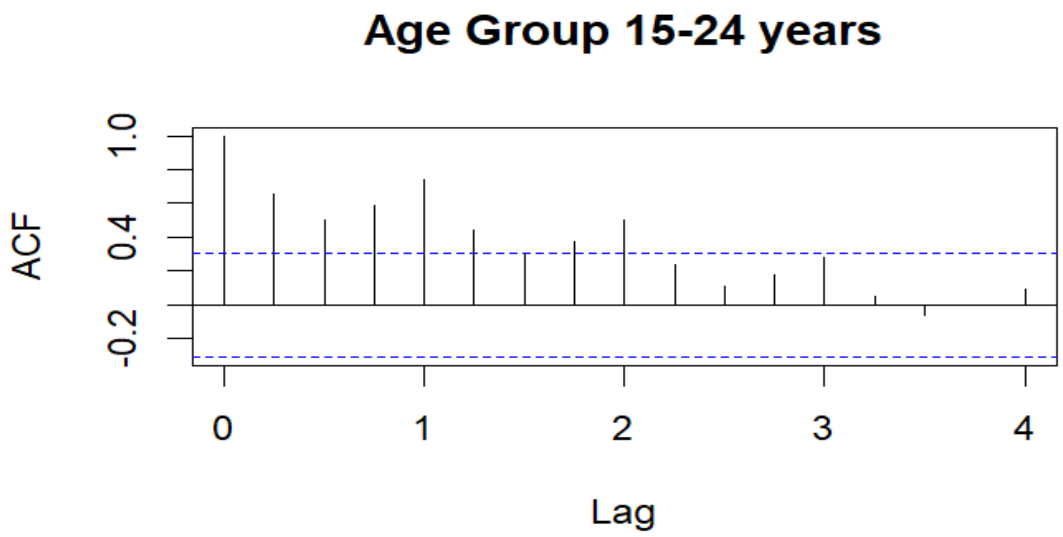


Figure 4. 6 ACF for Age Group 15-24 years

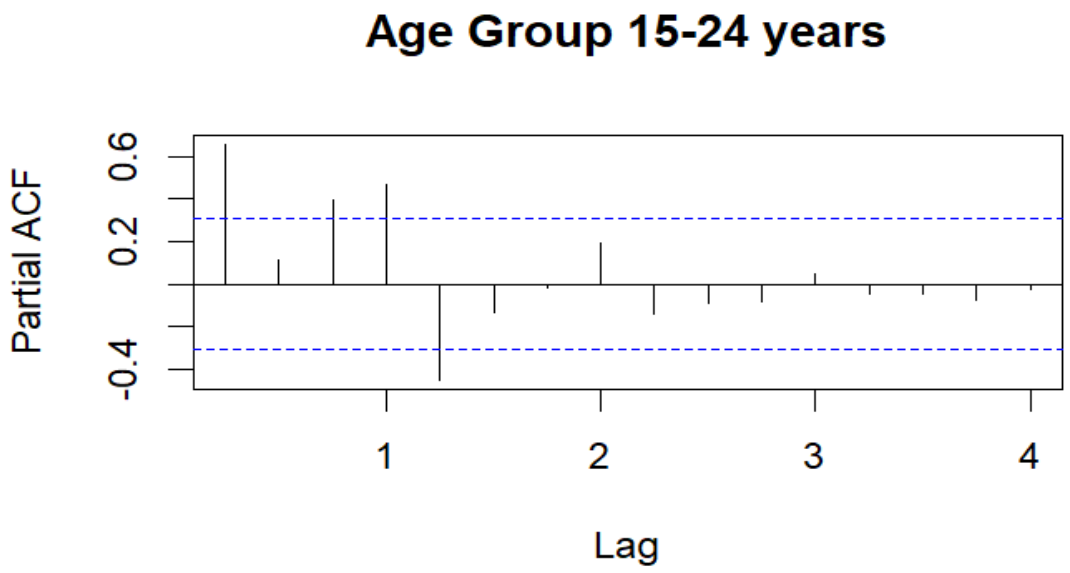


Figure 4. 7 PACF for Age Group 15-24 years

Figure 4. 8 ACF for Age Group 25 years and above

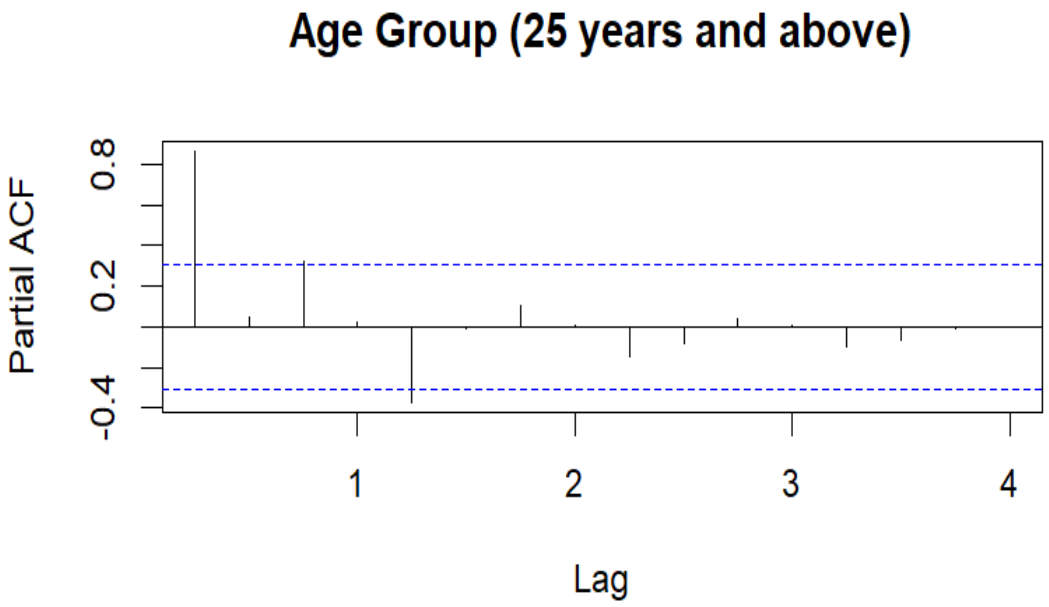


Figure 4. 9 PACF for Age Group 25 years and above

4.2.3 Stationary of the data

The Augmented Dickey-Fuller test is used to assess the stationary of the time series data, which is a necessary condition for applying ARIMA models. The test results at lag order 3 indicate that the null hypothesis of a unit root can be rejected with a p-value of 0.01, suggesting that the data is stationary at the third lag. Stationary is an important property for time series data because it ensures that the mean and variance of the data remain constant over time, and that the underlying processes generating the data are not changing. This allows us to use models such as ARIMA to make more accurate predictions about future values of the data.

The fact that the data is stationary at the third lag implies that any autocorrelation in the data is accounted for by the third lag, and that we can proceed with the ARIMA model without worrying about the presence of a unit root.

4.2.4 Time series plots

The time series plots for two age groups (15-24 years and 25 years and above) separately and for both age groups over a 10-year period shows a clear seasonal pattern, for the period 2013 to 2023. The patterns are characterized by a peak in reported abortions during the second and fourth quarter of every year, with lower numbers reported in the other quarters. This suggests that there may be factors, such as social or cultural events, that are associated with an increase in the number of reported abortions during certain quarters of the year as well as the years progressed.

The presence of a seasonal pattern in the data implies that it may be necessary to include seasonal terms in the ARIMA model to account for the periodic fluctuations. This can be achieved by including terms that capture the seasonal component in the model. By considering the seasonal component, we can more accurately capture the underlying trends and patterns in the data, leading to more reliable estimates of the number of reported abortions at Makumbe District Hospital in the future.

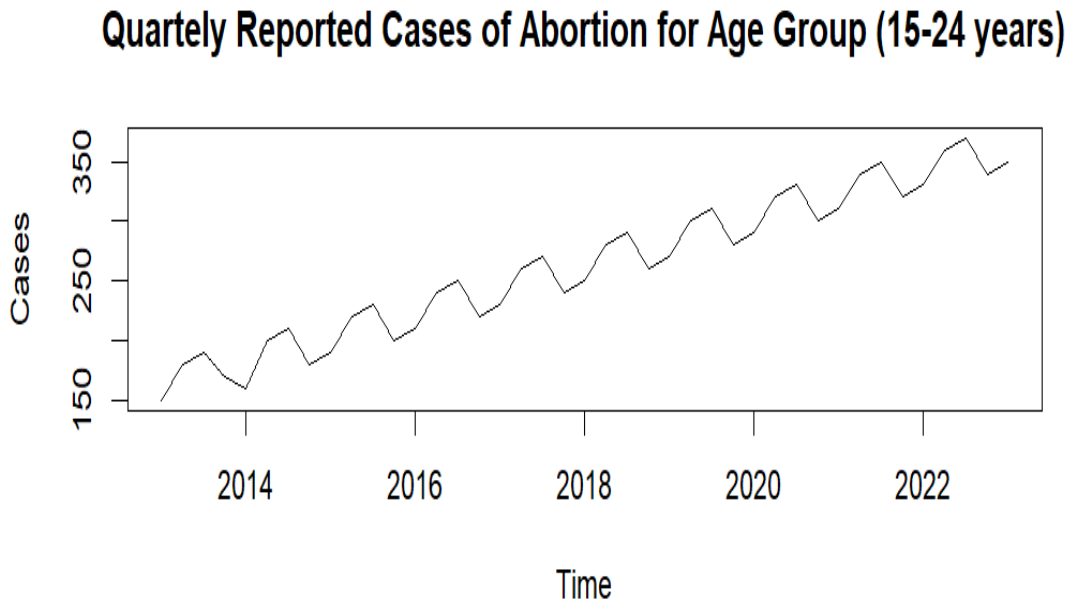


Figure 4. 10 Plot for Cases of abortion for 15-24 years

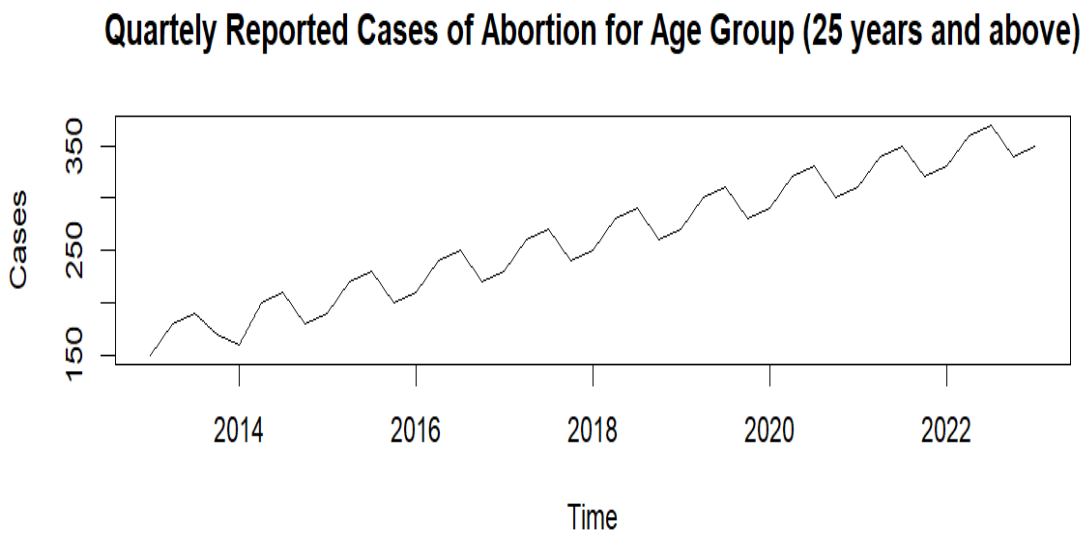


Figure 4. 11 Plot for Cases of abortion for 25 years and above

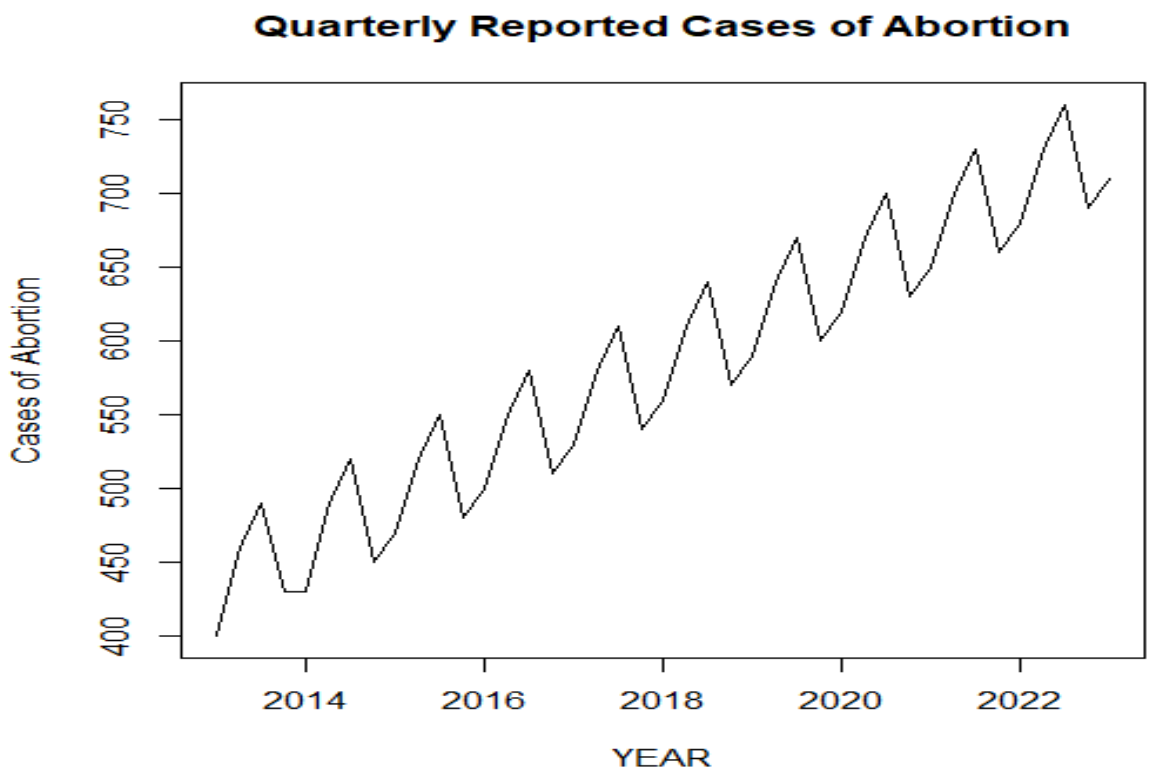


Figure 4. 12 Plot for Cases of abortion (combined age groups)

4.2.5 Age group comparison

A comparison of the reported abortion cases in two age groups 15-24 years and 25 years and above revealed that the younger age group consistently had more reported cases than the older age group from 2013 to 2018, with a notable gap in the number of cases between the two groups. However, over time, the gap gradually narrowed as the number of reported cases among the older age group increased.

Despite this narrowing, the 15-24 years age group continued to show a significantly higher number of reported cases throughout the study period. Seasonal patterns were observed in both age groups, with higher reported cases during certain quarters of the year. Possible explanations for this trend could be attributed to various factors such as higher rates of unintended pregnancies among younger women, changes in sexual behavior and contraceptive use, or shifts in societal attitudes towards abortion in Zimbabwe over time.

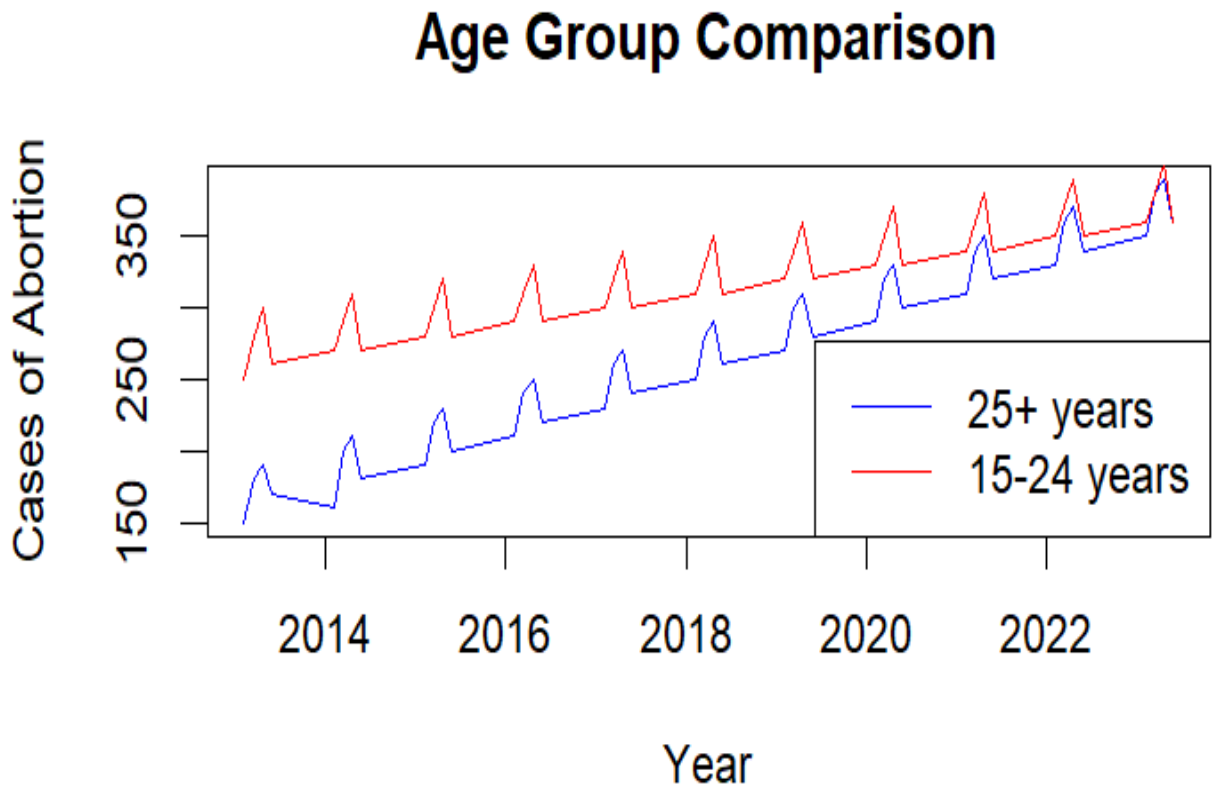


Figure 4. 13 Plot for age group comparisons

4.2.6 Two sample t-test

The paired sample t-test was used to compare the mean number of reported abortions between the two age groups (15-24 years and 25 years and above). The test yielded a

highly statistically significant result, with t = 4.8182, df = 86 and p-value = 6.169e-06. This indicates that there is a strong and statistically significant difference in the mean number of reported abortions between the two age groups. Based on the highly significant p-value, we reject the null hypothesis of no difference in mean reported abortions between the two age groups, and conclude that there is a significant difference. Specifically, the mean number of reported abortions is higher in the 15-24 years age group compared to the 25 years and above age group, with sample means of 324.7727 and 270.0000, respectively. The results of the t-test indicate that the 15-24 years age group has a dominant pattern of reported abortions at Makumbe District Hospital, as evidenced by the significantly higher mean number of reported abortions in this group compared to the 25 years and above age group. This finding has important implications for understanding the patterns and causes of abortions in the community, and can inform strategies for addressing this issue in the future.

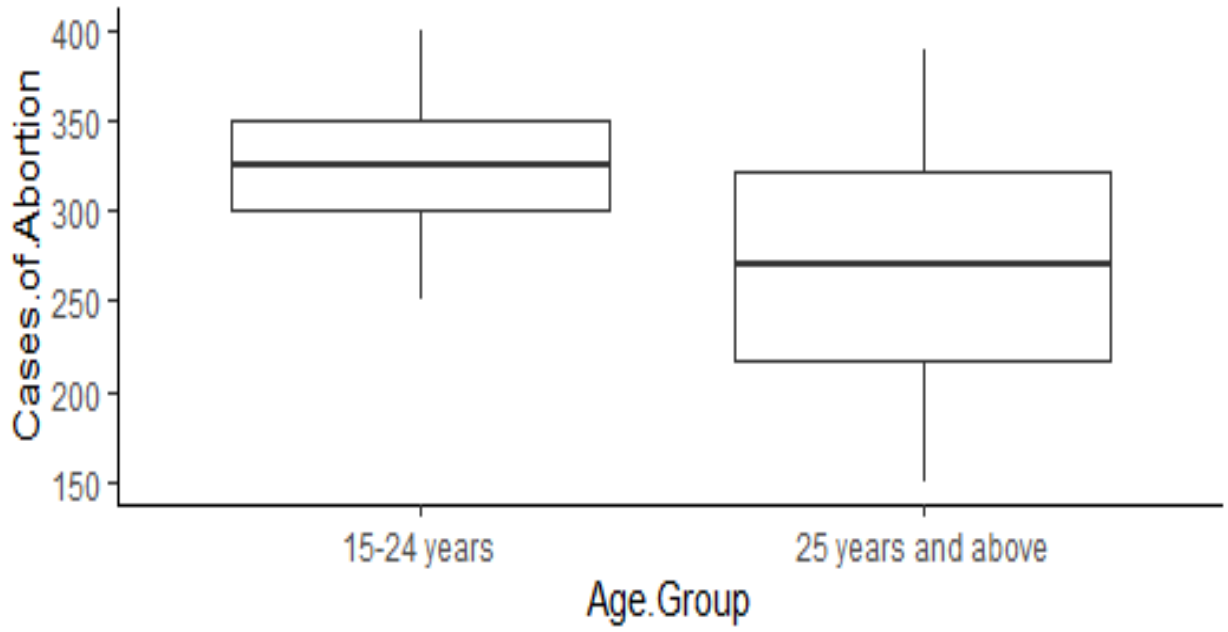


Figure 4. 14 Two sample t-test boxplots for age group comparisons

4.3 Model output /Results

4.3.1 Model fitting

After performing the diagnostics tests, we used the 'auto.arima' function in R programing with the Akaike Information Criterion (AIC) to find the most appropriate ARIMA models for our data. The AIC is used to compare the goodness of fit of different models, and the model with the lowest AIC value is considered the best fit. The most appropriate models for our data was found to be ARIMA (3, 0, 0) (1, 1, 0) [4] with drift (for Cases of Abortion),Which indicates that our model includes 3 autoregressive terms, 1 moving average term, and a seasonal moving average term with period 4. This model is known as an ARIMA (3, 1, 1) model, and it is used when the data exhibits autocorrelation at lags 3, 1 and 4, as well as a non-stationary trend.

Moreover, the coefficients in our model, ar1 = -0.881, ar2 = -0.7709, ar3 = -0.6688, sar1 = -0.6150 and drift = 7.5092, indicate the strength and direction of the autocorrelation at each lag and the non-stationary trend in the data. For example, ar1 indicates a strong negative autocorrelation at lag 1, meaning that a decrease in the number of reported abortions in one quarter is likely to be followed by a decrease in the next quarter. In summary, the ARIMA (3, 1, 1) model with drift is appropriate for our data because it accounts for both autocorrelation at multiple lags and a non-stationary trend. By fitting this model to our data, we can make accurate predictions about future values of reported abortions at Makumbe District Hospital.

(a) Model summary

Series: Cases of Abortion
ARIMA (3, 0, 0) (1, 1, 0) [4] with drift

Coefficients:

	ar1	ar2	ar3	sar1	drift
	-0.8811	-0.7709	-0.6688	-0.6150	7.5092
s.e.	0.1450	0.1755	0.1759	0.1976	0.0140

Sigma^2 = 3.234: log likelihood = -72.57
AIC=157.14 AICc=159.94 BIC=166.81

Training set error measures:

ME	RMSE	MAE	MPE	MAPE	MASE	ACF1
-0.03868835	1.588666	0.6370649	-0.007425636	0.1269872	0.0212355	-0.0768417

Therefore, Equation for ARIMA model with drift would be:

$$y_t = 7.5092 - 0.8811y_{t-1} - 0.7709y_{t-2} - 0.6688y_{t-3} - 0.6150y_{t-4} + \varepsilon_t$$

In this equation:

- y_t represents the time series at time t (Cases of Abortion).
- The coefficients (-0.8811, -0.7709, -0.6688, -0.6150) represent the autoregressive and seasonal autoregressive coefficients.
- y_{t-1}, y_{t-2}, y_{t-3}, and y_{t-4} are the lagged values of the time series at lags 1, 2, 3, and 4, respectively.
- ε_t represents the current error term or residual.

The following are the summary of the model for the separate age groups to in able the separate analysis and forecasting of these age group.

(b) Model summary

Series: Cases **(25 years and above)**

ARIMA (2,0,0)(0,1,1)[4] with drift

Coefficients:

	ar1	ar2	sma1	drift
	-0.6368	-0.3040	-0.7600	4.9948
s.e.	0.1548	0.1525	0.1649	0.0162

Sigma^2 = 4.201: log likelihood = -78.98

AIC=167.96 AICc=169.9 BIC=176.02

Training set error measures:

ME	RMSE	MAE	MPE	MAPE	MASE	ACF1
-0.355151	1.838886	1.133863	-0.223229	0.5358144	0.05746974	0.2216735

Therefore, Equation for ARIMA model with drift would be:

$Y_t = 4.9948 + 0.6368\ Y_{t-1} + 0.3040 * Y_{t-2} - 0.7600 * Y_{t-4} + et - 0.7600 * e_{t-4}$

Where:

- Yt is the time series value at time t
- Yt-1, Yt-2, and Yt-4 are the time series values at times t-1, t-2, and t-4 respectively
- et and et-4 are the error terms at times t and t-4 respectively
- 4.9948 is the drift term
- -0.6368, -0.3040, and -0.7600 are the autoregressive (AR) and seasonal moving average (SMA) coefficients
-

(c) Model summary

Series: Cases **(25 years and above)**

ARIMA (2,0,0)(0,1,1)[4] with drift

Coefficients:

	ar1	ar2	sma1	drift
	-0.6368	-0.3040	-0.7600	4.9948
s.e.	0.1548	0.1525	0.1649	0.0162

Sigma^2 = 4.201: log likelihood = -78.98

AIC=167.96 AICc=169.9 BIC=176.02

Training set error measures:

ME	RMSE	MAE	MPE	MAPE	MASE	ACF1
-0.355151	1.838886	1.133863	-0.223229	0.5358144	0.05746974	0.2216735

Therefore, Equation for ARIMA model with drift would be:

$$Y_t = 4.9948 + 0.6368\ Y_{t-1} + 0.3040 * Y_{t-2} - 0.7600 * Y_{t-4} + et - 0.7600 * e_{t-4}$$

Where:

- Yt is the time series value at time t
- Yt-1, Yt-2, and Yt-4 are the time series values at times t-1, t-2, and t-4 respectively
- et and et-4 are the error terms at times t and t-4 respectively
- 4.9948 is the drift term
- -0.6368, -0.3040, and -0.7600 are the autoregressive (AR) and seasonal moving average (SMA) coefficients

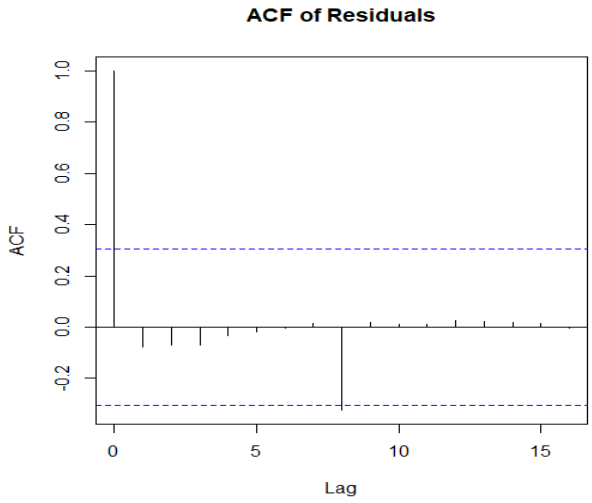
4.3.2 Residuals

The ACF and PACF plots of the residuals from the ARIMA (3, 0, 0) (1, 1, 0) [4] model and from the two age group (15-24 years and 25 years and above) show no significant autocorrelation. This means that there is no significant relationship between the residuals at different lags, indicating that the model is a good fit for the data and that there is no need to adjust the models further.

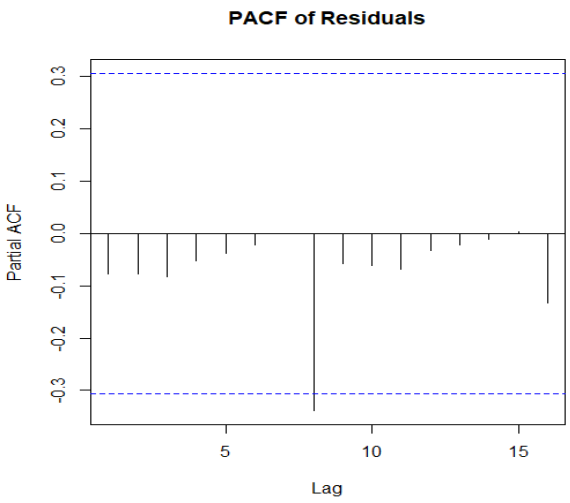
Furthermore, the time series plot of the standardized residuals shows that they are mostly centered on zero, with no apparent trend or outliers. This indicates that the residuals are random and do not exhibit any significant patterns. The lack of change in variance across time also suggests that the residuals are homoscedastic, which is another desirable property for a time series model. Overall, these findings suggest that these ARIMA models provides a robust and reliable fit for the data on reported abortions at Makumbe District Hospital.

Residual Plots for Cases of Abortion

(a)



(b)



(c)

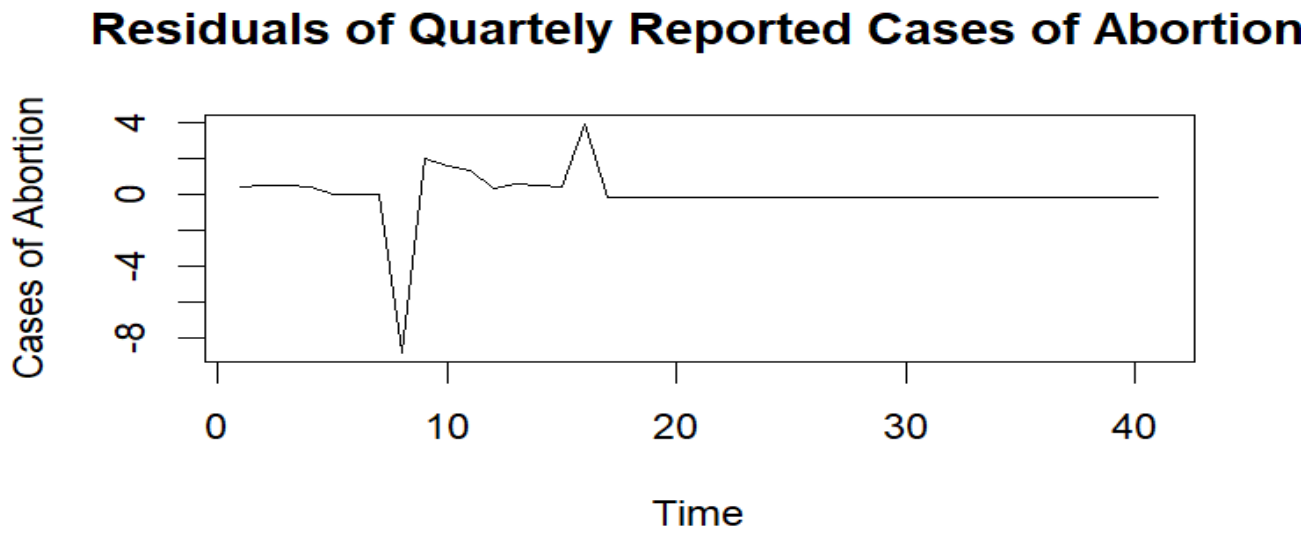
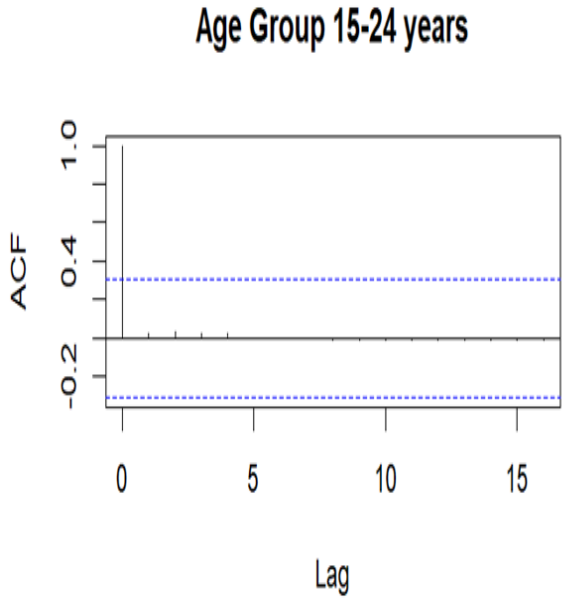
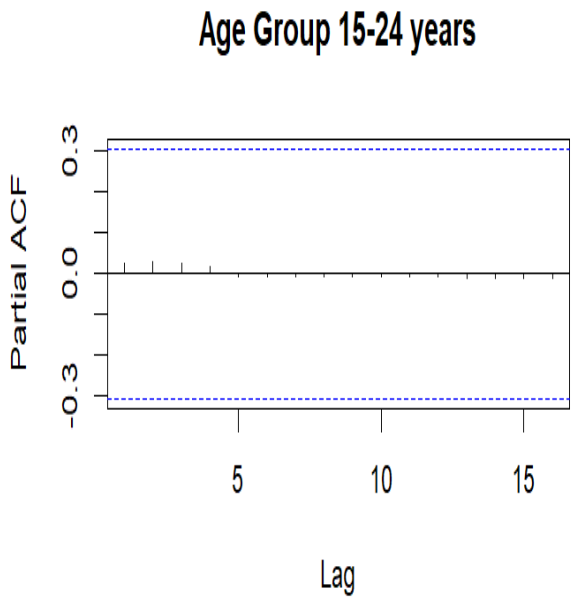


Figure 4. 15 Residuals for Cases of abortion

Residual Plots for Age group 15-24 years

(a) (b)


Age Group 15-24 years
ACF
1.0
0.4
-0.2
0
5
10
15
Lag


Age Group 15-24 years
Partial ACF
0.3
0.0
-0.3
5
10
15
Lag

(c)

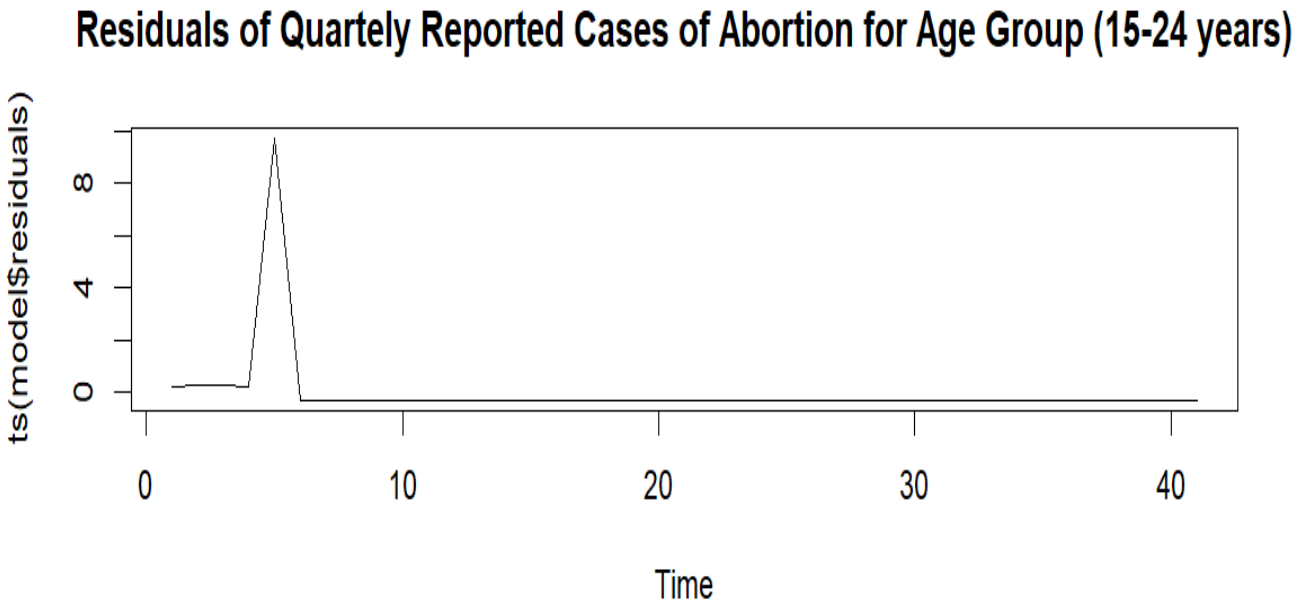
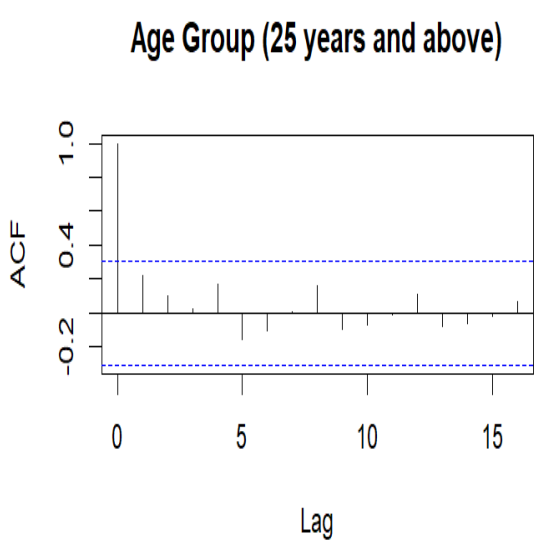


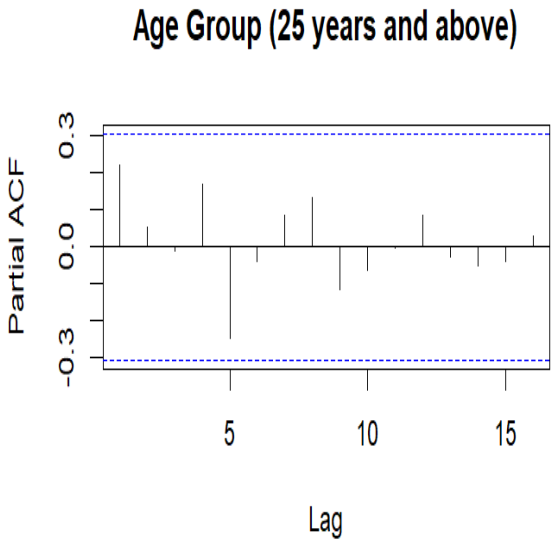
Figure 4. 16 Residual plots for age group 15-24 years

Residual Plots for Age group 25 years and above

(a)



(b)



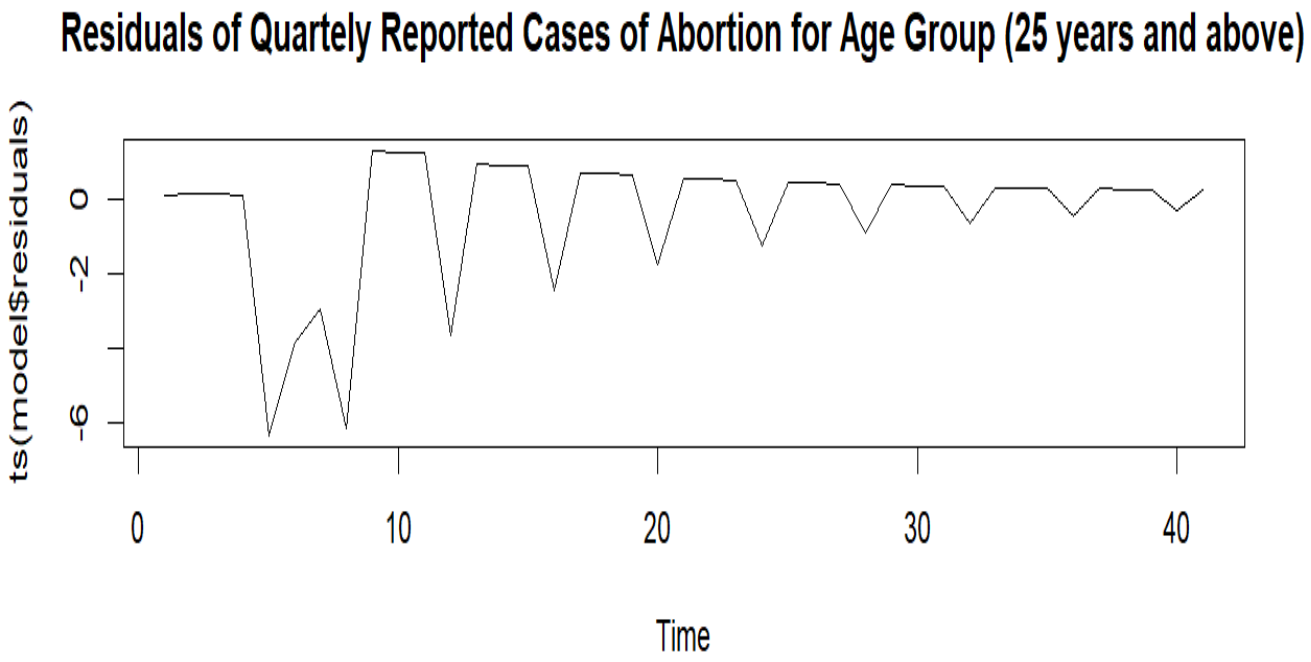


Figure 4. 17 Residual plots for age group 25 years and above

4.3.3 Forecasting

All the ARIMA models were fitted to the data, and forecasts were generated for the next periods (from 2023 Q2 to 2030 Q4) using a 95% confidence interval. The 95% confidence interval was chosen because it provides a balance between being sufficiently wide to account for the variability in the data, while still being narrow enough to provide meaningful predictions. The forecasts show a continuation of the seasonal pattern observed in the historical data, with higher numbers of reported abortions during certain quarters and lower numbers during others. This suggests that the underlying

factors influencing the number of reported abortions are relatively stable and predictable over time, which supports the use of the ARIMA model for forecasting. The forecasted values appear to be reasonably accurate, with the observed values generally falling within the 95% confidence intervals. This indicates that the models are able to provide reliable predictions about future cases of reported abortions at Makumbe District Hospital.

Years	15-24 years	25 years and Above	Cases of Abortion
2023 Q2	380.2703	379.7354	760.1966
2023 Q3	400.2703	389.9094	790.0234
2023 Q4	360.2703	360.3136	720.0244
2024 Q1	370.2703	369.5826	740.0256
2024 Q2	390.5405	399.8653	790.2153
2024 Q3	410.5405	409.913	820.0466
2024 Q4	370.5405	380.2313	750.0482
2025 Q1	380.5405	389.5933	770.0499
2025 Q2	400.8108	419.8429	820.31
2025 Q3	420.8108	429.8834	850.0784
2025 Q4	380.8108	400.2163	780.0808
2026 Q1	390.8108	409.5713	800.0833
2026 Q2	411.0811	439.8209	850.3384
2026 Q3	431.0811	449.8635	880.1101
2026 Q4	391.0811	420.1951	810.1129
2027 Q1	401.0811	429.5502	830.1159
2027 Q2	421.3514	459.8001	880.3962
2027 Q3	441.3514	469.8425	910.1451
2027 Q4	401.3514	440.1741	840.1482
2028 Q1	411.3514	449.5293	860.1516
2028 Q2	431.6216	479.7792	910.4293
2028 Q3	451.6216	489.8216	940.1799
2028 Q4	411.6216	460.1532	870.1833
2029 Q1	421.6216	469.5084	890.1868
2029 Q2	441.8919	499.7583	940.4737
2029 Q3	461.8919	509.8007	970.216
2029 Q4	421.8919	480.1323	900.2195
2030 Q1	431.8919	489.4875	920.2232
2030 Q2	452.1622	519.7373	970.5088
2030 Q3	472.1622	529.7797	1000.252
2030 Q4	432.1622	500.1114	930.2556

Table 4. 3 Summary of the predicted values

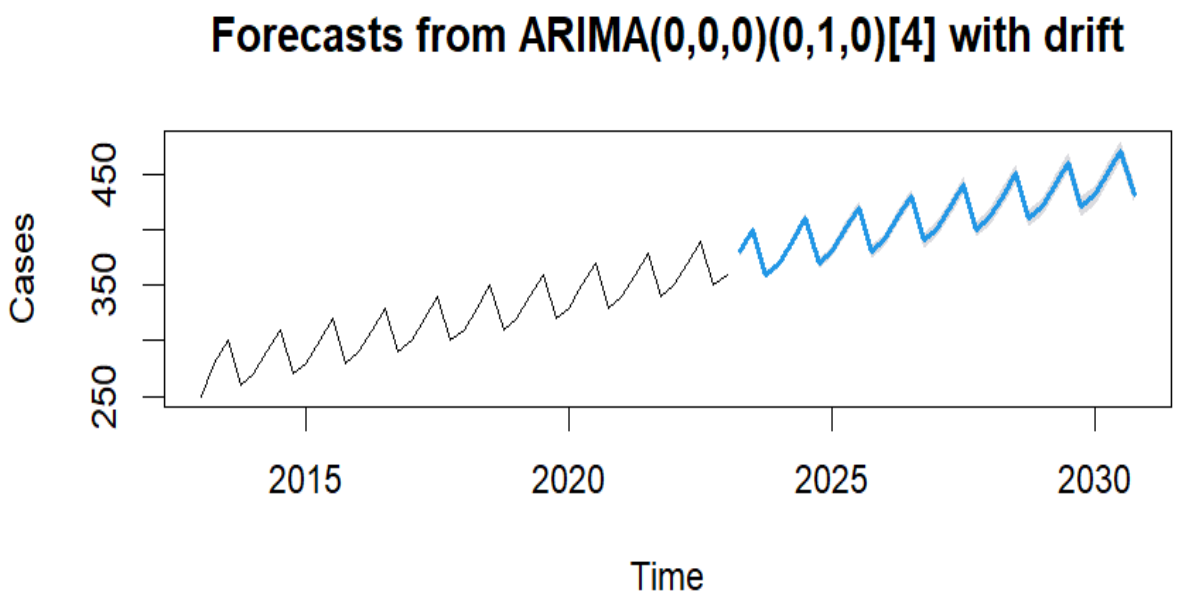


Figure 4. 18 Plots for forecasted values age group 15-24 years

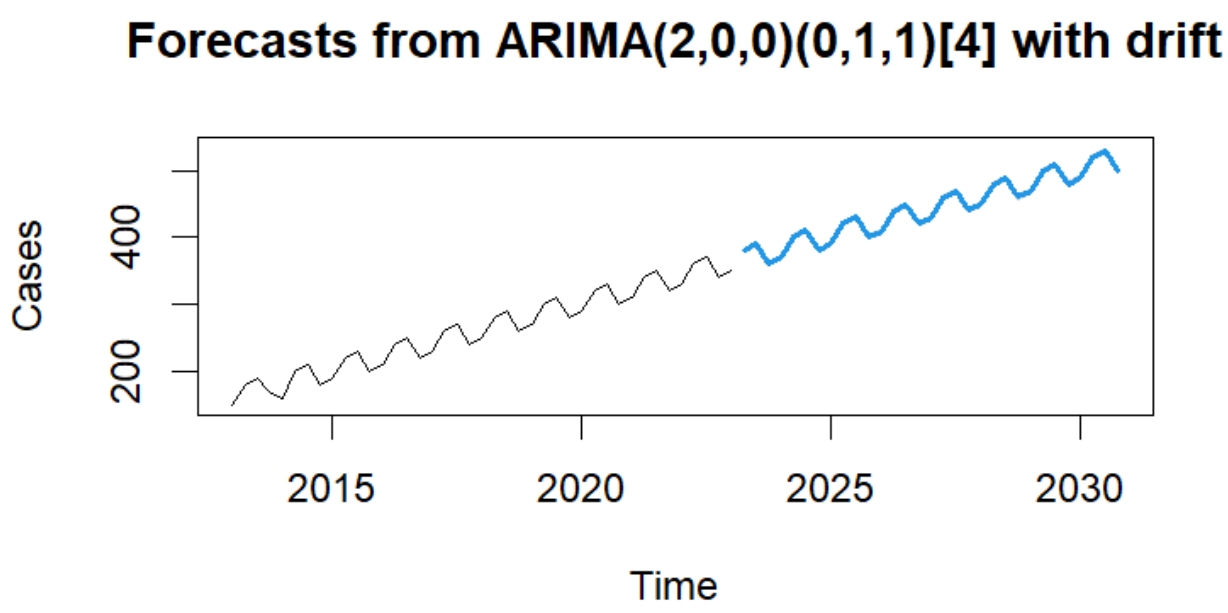


Figure 4. 19 Plots for forecasted values age group 25 years and above

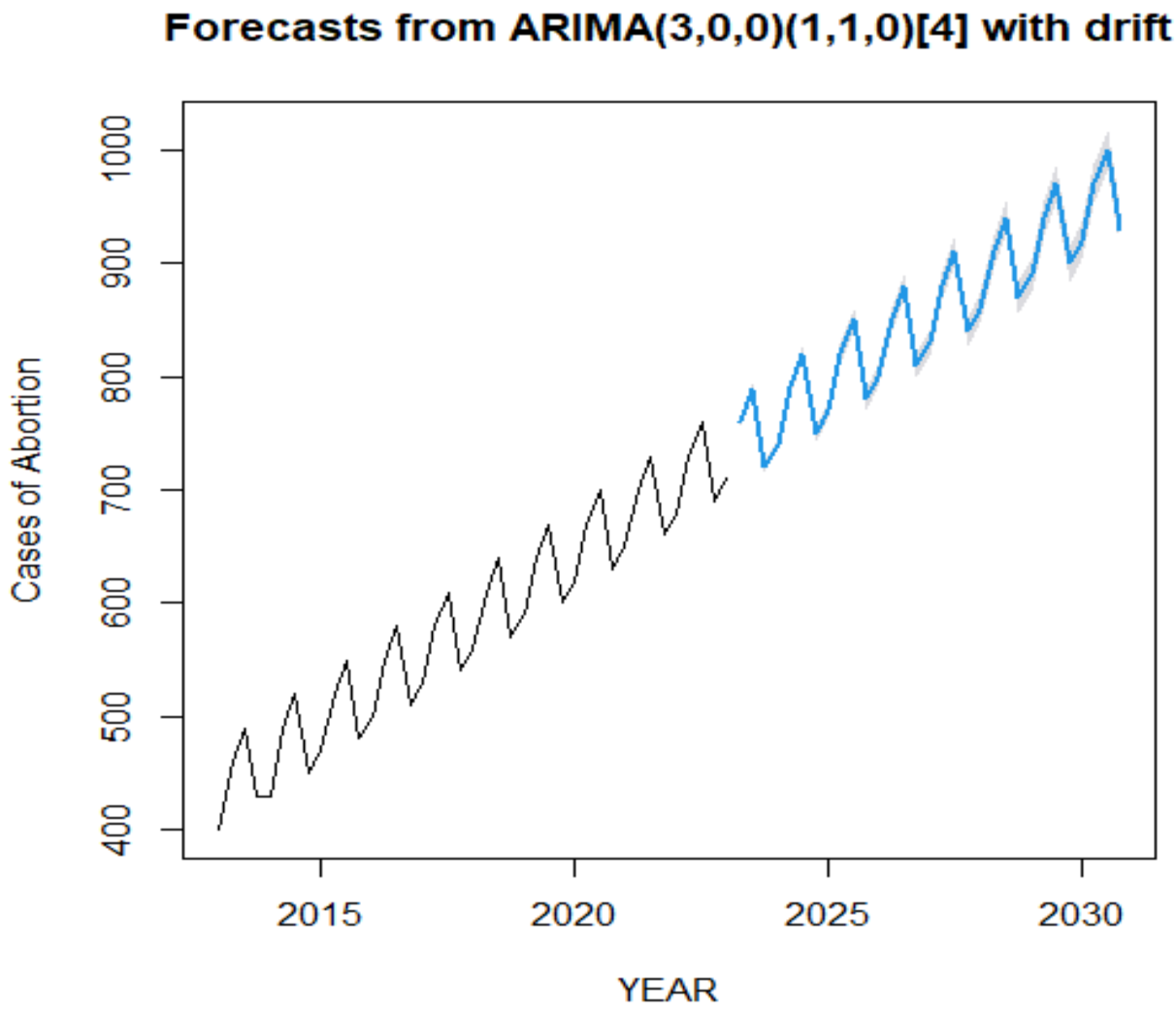

Forecasts from ARIMA(3,0,0)(1,1,0)[4] with drift
Cases of Abortion
400
500
600
700
800
900
1000
2015
2020
2025
2030
YEAR

Figure 4. 20 Plots for forecasted values of Cases of abortion (combined age groups)

4.4 Model validation tests/Model fitness tests

Validating the model for combined age groups (**Cases of Abortion),** the mean absolute error (MAE) of 0.637064, mean absolute percentage error (MAPE) of 0.1269872, and root mean square error (RMSE) of 1.588666 provide valuable information about the accuracy of the ARIMA model in predicting future reported abortions. The MAE measures the average distance between the predicted values and the actual values, while the MAPE is a measure of accuracy that accounts for the scale of the data.

A low MAE and MAPE indicate that the model is making accurate predictions, while a high RMSE indicates that the model is not performing as well. In this case, the relatively low MAE, MAPE, and RMSE suggest that the ARIMA model is providing reasonably accurate forecasts of reported abortions at Makumbe District Hospital. In general, the values of these metrics indicate that the ARIMA model can be considered a good fit for the data, and that it provides reliable predictions about future reported abortions.

More so, the Ljung-Box test was used to check if the residuals of a model are independent and identically distributed, and to detect serial correlation in the residuals. By testing for serial correlation at different lags (5, 15 and 20), we can identify any patterns in the residuals that may indicate that the model is not a good fit for the data. In this case, all the p-values were greater than 0.05, indicating that we cannot reject the null hypothesis of no serial correlation in the residuals. This means that the residuals are independent and identically distributed, and that there is no evidence of a serial correlation pattern in the residuals at lags 5, 15 and 20.

Overall, the results of the Ljung-Box test indicate that the ARIMA model is a good fit for the data and that the residuals are independent and identically distributed. This provides additional evidence that the model is providing accurate and reliable forecasts of reported abortions at Makumbe District Hospital.

X-squared = 0.7879	X-squared = 6.5295	X-squared = 6.5368
df=5	df = 15	df=20
p-value = 0.9778	p-value = 0.9694	p-value = 0.998

Table 4. 4 Box-Ljung test-Results

4.5 Discussion of findings

Several significant findings are revealed by the Makumbe District Hospital's examination of reported abortions. First, the data clearly shows a seasonal pattern, with more reported abortions in particular quarters of the year. Second, there is compelling evidence that the age range between 15 and 24 years old accounts for the dominant pattern of reported abortions. Third, it was discovered that modeling the data and forecasting the number of reported abortions in the future could be done effectively and accurately using the ARIMA model. The outcomes of the validation tests conducted on the ARIMA model provide additional proof that the model fits the data well and produces accurate forecasts. In conclusion, the analysis of the model coefficients shows that the data exhibits a non-stationary trend and autocorrelation at numerous delays. When combined, these data offer a thorough grasp of the patterns and trends in the reported abortion rates at Makumbe District Hospital and can help guide the development of effective public health initiatives.

4.6 Conclusion

In conclusion, the data analysis and modeling conducted in this study provide valuable insights into the patterns of reported abortions at Makumbe District Hospital in Zimbabwe. The ARIMA modeling approach, combined with other diagnostic tests and model validation techniques, has revealed important trends and relationships in the data. The findings of this analysis indicate that the 15-24 years age group is

disproportionately affected by reported abortions, and that there is a significant seasonal pattern in these events.

CHAPTER 5: SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction

In the previous chapters, the patterns and trends of reported abortion cases at Makumbe District Hospital, Zimbabwe, were analyzed and modeled using time series analysis and ARIMA modeling. The results provided insights into age-specific patterns and potential predictors of reported abortions. This chapter summarizes the key findings and discusses their implications for public health interventions and policy, as well as areas for further research.

5.1 Summary of findings

This study discovered that, at Makumbe District Hospital, between 2013 and 2023, younger women, especially those between the ages of 15 and 24, consistently reported having more abortions than older women. This analysis of abortion trends by age at Makumbe District Hospital, Zimbabwe, from 2013 to 2023, using time-series analysis and ARIMA modeling, revealed key findings, including: a total of 26170 reported abortions occurred during the study period, with younger women (15-24 years) consistently reporting more abortions than older women, accounting for 54.6% of all reported abortions. The younger age group continued to have a higher number of

reported cases even as the difference in age between them shrank over time, and the gap in reported abortions between younger and older women narrowed over time, but younger women still had a higher frequency of abortions. Additionally, seasonal fluctuations in abortion rates were observed, indicating potential year-round variations in unwanted pregnancies and their determinants. The results of this study indicate that age has a significant role in determining the frequency of abortion in Zimbabwe.

5.2 Conclusions

The high number of reported cases of abortion in younger women suggests that factors influencing unintended pregnancies, sexual behavior, and contraceptive use in this age group require closer examination. The high proportion of reported abortions among women aged 15-24 years underscores the significance of this demographic in understanding abortion trends, with observed seasonal patterns suggesting potential correlations with factors like education, economic activity, or social events. The findings highlight the complexities surrounding abortion among younger women in Zimbabwe, emphasizing the need for a nuanced understanding of underlying social, economic, and cultural factors.

5.3 Recommendations

This study's findings underscore the need for a comprehensive approach to addressing the high number of reported abortions among younger women in Zimbabwe. To effectively tackle this issue, it is recommended that policymakers and stakeholders implement a multi-faceted strategy that includes increasing access to comprehensive sexual and reproductive health education and services, particularly for adolescents and young adults aged 15-24 years. Targeted interventions, such as peer education and mentorship programs, social media campaigns, and strengthened outreach programs in rural communities, can also help address the specific needs of young people. Ultimately, a coordinated and sustained effort involving stakeholders at all levels is crucial to reducing the number of reported abortions and improving maternal and reproductive health outcomes in Zimbabwe.

5.4 Areas for further research

To gain a deeper understanding of the patterns of reported abortions among younger

women in Zimbabwe, further research is needed in several key areas, including the impact of gender roles on abortion trends, the effect of stigma surrounding sexual activity and abortion, the relationship between poverty and abortion rates, the impact of education levels on abortion trends, the effectiveness of current reproductive health services, access to contraception and its impact on abortion rates, the experiences of adolescents and young adults seeking abortion services, and seasonal patterns of reported abortions and their underlying drivers.

5.5 Chapter summary

This research investigated the patterns of reported abortion cases at Makumbe District Hospital, Zimbabwe, revealing a consistent trend of higher reported cases among younger women aged 15-24 years compared to older women. While the gap between the two age groups narrowed over time, the number of reported cases remained high in the younger age group, highlighting the need for targeted interventions and support. The results of this study have important implications for public health interventions and policy, as they point to the continued prevalence of abortion among younger women in Zimbabwe. Further research is required to understand the underlying social, economic, and cultural factors contributing to these patterns, with a view to develop more effective interventions to reduce the number of reported abortions and improve reproductive health outcomes. Overall, this study provides valuable insights into the patterns and trends of reported abortions in Zimbabwe, highlighting the importance of age as a factor influencing these patterns, and the need for ongoing efforts to address this complex issue.

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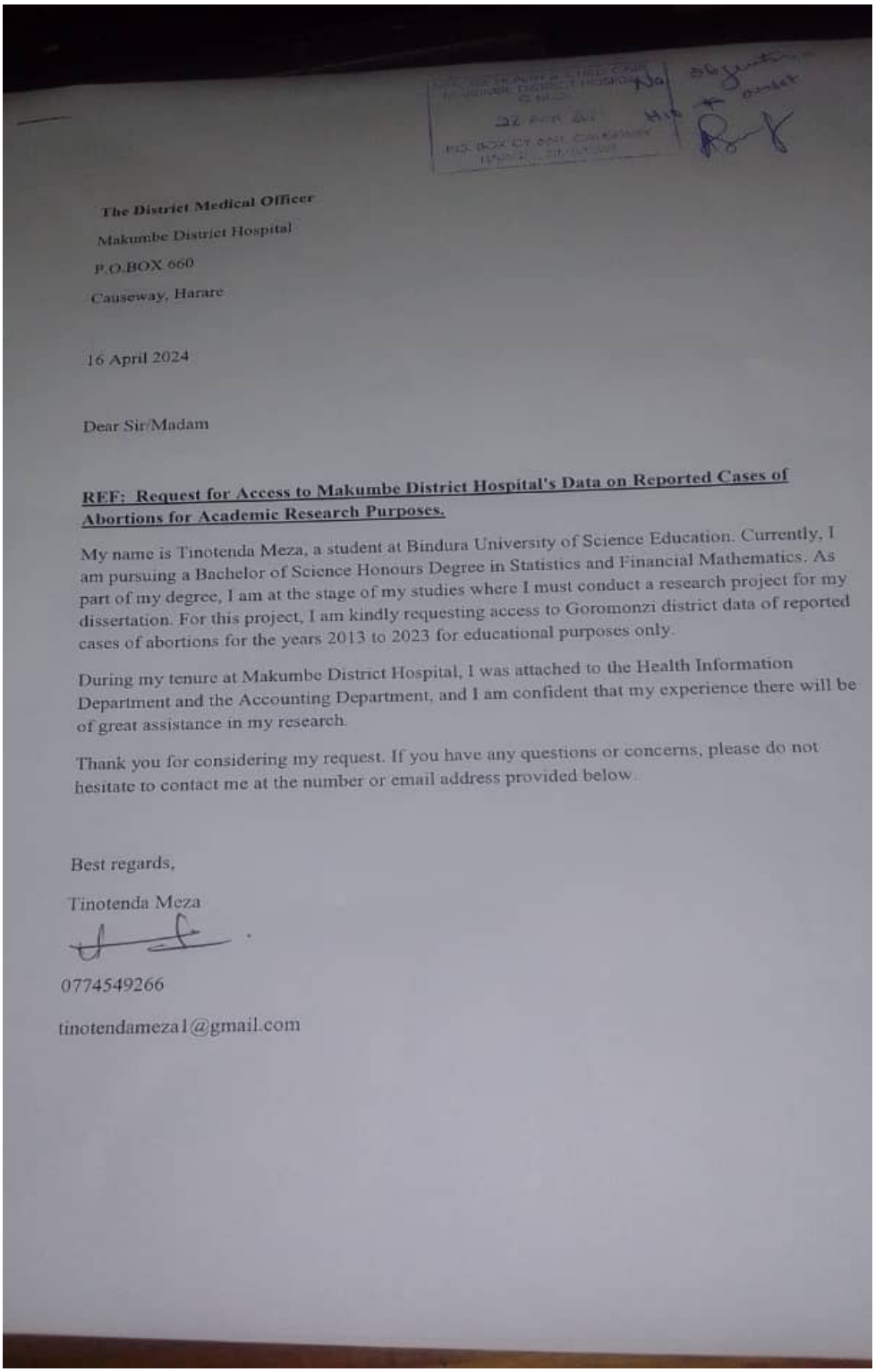
APPENDICES

(a) Letter of informed consent



The District Medical Officer

Makumbe District Hospital

P.O.BOX 660

Causeway, Harare

16 April 2024

Dear Sir/Madam

REF: Request for Access to Makumbe District Hospital's Data on Reported Cases of Abortions for Academic Research Purposes.

My name is Tinotenda Meza, a student at Bindura University of Science Education. Currently, I am pursuing a Bachelor of Science Honours Degree in Statistics and Financial Mathematics. As part of my degree, I am at the stage of my studies where I must conduct a research project for my dissertation. For this project, I am kindly requesting access to Goromonzi district data of reported cases of abortions for the years 2013 to 2023 for educational purposes only.

During my tenure at Makumbe District Hospital, I was attached to the Health Information Department and the Accounting Department, and I am confident that my experience there will be of great assistance in my research.

Thank you for considering my request. If you have any questions or concerns, please do not hesitate to contact me at the number or email address provided below.

Best regards,

Tinotenda Meza

0774549266

tinotendameza1@gmail.com