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REPORTED CASES OF ABORTION AT MAKUMBE DISTRICT HOSPITAL, ZIMBABWE: A TIME SERIES ANALYSIS OF AGE-SPECIFIC TRENDS AND ARIMA MODELING TO PREDICT FUTURE PATTERNS.

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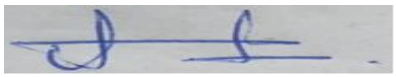
Tinotenda Meza		09/06/2024
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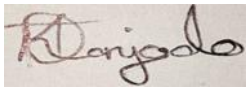
Certified by:		09/06/2024
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Dedication

To my supervisor, Mr. Kanjodo, whose guidance and expertise, and belief in me have been invaluable, and to all those who have been inspired 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.

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. The ARIMA model provides a valuable to for predicting future patterns and informing public health policy.

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List of Abbreviations

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

1.1 Introduction

Abortion remains a serious public health issue that needs more research despite its complex legal and ethical issues. The prevalence of abortion and the associated health effects are still mostly unknown, despite the fact that access to safe and legal abortion services is still restricted in many low- and middle-income nations, including Zimbabwe. This chapter looks at reported abortion patterns at Makumbe District Hospital using time series analysis in an effort to add to the body of knowledge.

1.2 Background of the study

Abortion is a complex and contentious issue worldwide, with considerable variation in rates, laws, and access to services across countries and regions. The World Health Organization (WHO, 2021) estimates that 42 million of the 73 million unwanted pregnancies that occur annually in the world result in abortions. Estimates of abortion rates in Africa range from 13 to 50 per 1,000 women aged 15 to 49, which is higher than the global norm (Berer, 2013). Research and policy conversations on abortion are frequently impeded by stigma and legal constraints, even though abortion is highly prevalent in the African region. This emphasizes how important it is to do thorough and well-designed research in order to comprehend the variables affecting abortion views and trends in various settings.

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. We do this by looking at recorded cases of abortions at Zimbabwe's Makumbe District Hospital. This study intends to advance knowledge of abortion trends and attitudes in Zimbabwe by analyzing reported cases of abortions at Makumbe District Hospital. It also intends to provide guidance for future policies and initiatives aimed at reducing unplanned pregnancies and unsafe abortions. This study's conclusions could strengthen the body of knowledge supporting increased access to reproductive health services, fewer unwanted pregnancies, and enhanced health and wellbeing for women in Zimbabwe and elsewhere.

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.

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. By examining reported incidents of abortions among women of various age groups, this study seeks to advance knowledge of abortion stigma and its effects on women's reproductive health and wellbeing in Zimbabwe. In particular, we aim to look into how women seeking abortion care at Makumbe District Hospital experience and fare in relation to the cultural and legal factors around the procedure.

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). This study examined patterns and outcomes among women of various ages using data on documented abortion cases at Makumbe District Hospital. 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. Our goal is to add to the body of knowledge

supporting the enhancement of reproductive health policies and practices in the nation by investigating the patterns and trends in reported abortions at Makumbe District Hospital.

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.

Utilizing data from Makumbe District Hospital offers a rare chance to investigate the variables influencing abortion outcomes and trends in Zimbabwe. We can gain more insight into the needs and experiences of women in the community as well as possibilities to improve reproductive health outcomes and services by looking at reported incidents of abortion among women in various age groups. Furthermore, by examining the documented abortion cases at Makumbe District Hospital, it is possible to get understanding of how local and regional factors affect Zimbabwe's reproductive health. The experiences of women in the Makumbe village may differ from those in more metropolitan or affluent places because it is an underprivileged area with limited access to healthcare. This emphasizes the significance of customizing treatments and policies to match local needs and obstacles. Lastly, the quality of the community's reproductive health services may also be examined thanks to the data utilized from Makumbe District Hospital. In order to promote safer and more favorable health outcomes for women in the Makumbe community and beyond, we can identify areas for improvement in service provision, such as counseling, education, and post-abortion care, by examining the features and outcomes of reported abortions.

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). We stress the significance of exercising caution when interpreting the findings of this study and accept the limitations of the data on reported abortions at Makumbe District Hospital that are currently available. Notwithstanding these drawbacks, our results might offer insightful information about the variables affecting abortion patterns and results in Zimbabwe, emphasizing the need for more thorough and trustworthy data collection and analysis to guide programmatic and policy responses.

Additionally, the scope of our research is limited to documented abortion instances at Makumbe District Hospital, which may not accurately reflect the overall abortion landscape in Zimbabwe. However, by examining abortion patterns and results in this particular context, we can investigate the caliber of healthcare offered in this community and pinpoint local and regional variables that can affect reproductive health and service accessibility in Zimbabwe.

In summary, our research can offer significant insights into the determinants impacting abortion patterns and outcomes in Zimbabwe, even though the data on reported abortions in Makumbe District Hospital may be limited. We may add to a more thorough picture of reproductive health in the nation and guide future research and treatments by acknowledging the limitations of the data and interpreting the results cautiously.

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. This study aims to address this knowledge gap by conducting a time series analysis of reported abortion cases at Makumbe District Hospital.

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

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

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. Using historical data, ARIMA modeling uses time series analysis techniques to forecast future trends and patterns in reported abortion rates. The research intends to advance knowledge of age-specific patterns in abortions reported

1.8 Significance of the study

The findings of this study will 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 will also help 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

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

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.

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.

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).

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).

Notwithstanding these drawbacks, Makumbe District Hospital in Zimbabwe reports abortions, and the Health Belief Model sheds important light on the mental processes underpinning these

reports. Through comprehending people's perspectives on the advantages and hazards of abortion, we can create interventions that bridge information gaps and foster favorable views about safe and authorized abortion practices.

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. For instance, previous studies that investigated the incidence of abortions in Zimbabwe, with different estimates being published over time. 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, according to a 2014 report by the MOHCC. The abortion rate increased to 26 per 1,000 women in 2015, according to a later WHO data from 2018 (WHO, 2018). The MoHCC (2014) investigated the prevalence of abortion in Zimbabwe using data from the Zimbabwe National Health Transition Survey (ZNHT). In 2010, a nationally representative household survey known as the ZNHT was carried out using a sample of women in the 15–49 age range. To choose households and individuals for participation in the survey, a multi-stage cluster sampling procedure was employed, guaranteeing a representative sample of the nation's populace. 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.

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 University of Zimbabwe study "Unsafe Abortion in Zimbabwe" by Mutasa et al. (2019) offered important information about the prevalence and patterns of unsafe abortions in Zimbabwe. 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.

According to a University of Zimbabwe study published in 2018, 33% of all reported abortions were performed on women between the ages of 15 and 24. These women made up the largest percentage of abortion cases. Furthermore, the survey discovered that girls between the ages of 15 and 19 had the highest prevalence of adolescent pregnancies and abortions, making about 23% of all reported abortions. This emphasizes the necessity of focused interventions to address the underlying issues that lead to unwanted pregnancy and abortion among young women in Zimbabwe, such as limited access to reproductive health care and contraception.

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.

2.3.3 Use of Time Series Analysis and ARIMA Models in Public Health Research

A statistical method called time series analysis is used to examine data that has been gathered over an extended period of time. "Autoregressive integrated moving average," or "ARIMA," models are a kind of time series model that can be used to predict trends and spot patterns in data. A wide range of disciplines, including economics, finance, and epidemiology, have made substantial use of ARIMA models.

An increasing number of studies use ARIMA models to analyze data related to public health. For instance, Guo et al. (2021) estimated the number of HIV infection cases that will be reported in a Chinese community using ARIMA models. In a similar vein, Park et al. (2022) forecast the occurrence of influenza in a population of South Koreans using ARIMA models. These studies show how ARIMA models can be used to produce precise forecasts and insights into trends in public health.

It is evident that ARIMA models could be a useful tool for examining patterns and potential determinants of reported abortion cases at Makumbe District Hospital across various age groups.

2.4 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.

2.5 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 will address these gaps by collecting data over time, including rural areas, and exploring the role of culture in abortions. Additionally, the study will use a bio psychosocial-spiritual model to guide the research and interpret the results. This will help to develop a more complete understanding of abortions in Zimbabwe and to develop appropriate interventions and policies.

CHAPTER 3

Research Methodology

3.1 Introduction

This study will use 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, we can gain a better understanding of the factors that influence abortion rates in Goromonzi District. The data used is from hospital records, to construct a time series of reported cases of abortion. We will then use a variety of statistical techniques to analyze the data.

3.2 Research Design

In this study, a cross-sectional research design was used to analyze reported cases of abortion in two age groups, 15-24 years and 25 years and above, at Makumbe District Hospital in Zimbabwe. This design enabled us to collect data simultaneously from both age groups by analyzing the hospital records. This approach provided a comprehensive overview of the trends in reported abortions at the hospital, without the potential biases that may be introduced by interviews and surveys.

However, the use of cross-sectional analysis and time series modeling allowed us to identify trends and patterns in reported abortions at the hospital that might have been overlooked with a different research design. The strength of the cross-sectional design in this study was its ability to capture a snapshot of the abortion trends in both age groups at a specific point in time.

In general, the cross-sectional research design was selected due to its ability to accommodate the shortcomings of other research methods while offering a methodical and thorough way to examine documented cases of abortions at Makumbe District Hospital. In order to lower the frequency of reported abortions in both age categories at the hospital, the analysis that follows will assist in informing policies and measures.

This approach enabled us to identify patterns and changes in the prevalence of reported cases of abortions over time (Peng et al., 2018). In addition, we were able to examine the relationship in abortions between age groups (Cohen, 2018). This enabled us to identify the factors contributing to the prevalence of abortions (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 stated in a 2015 publication in the "International Journal of Medical Informatics" by G. Hripcsak, 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 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. There were ethical implications to consider when accessing electronic data sources, such as the need to ensure that the data was de-identified and that data subjects had provided informed consent. 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 will be analyzed across age groups (15-24 years and 25 years and above) and quarters (Q1, Q2, Q3, Q4) of the year. By examining abortion cases across age groups, we expect to 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. By analyzing abortion cases across the four quarters of the year, we can potentially 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

3.8.1 Diagnostic tests

To ensure the accuracy and reliability of the data used in this study, a number of diagnostic tests were performed. First, a normality test was conducted to confirm the data was normally distributed. Then, a number of diagnostic tests were performed to check for the presence of autocorrelation and the presence of trends. Additionally, a stationary test was performed to confirm the data's consistency over time. Finally, an autoregressive integrated moving average (ARIMA) test was conducted.

Moreover, Using R programming, a t-test was run to see 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). The parametric nature of this test made it suitable for comparing the means of two independent groups, which is why it was selected.

3.8.2 Analytical model

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:

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

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.

3.8.3 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. Informed consent was obtained by providing a detailed explanation of the study's potential risks and benefits. 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

For the purpose of performing a time series analysis for reported cases of abortion at Makumbe District Hospital, the technique outlined in this chapter offers a solid and trustworthy method. This chapter's techniques will enable a thorough examination of the data and the derivation of significant conclusions on the correlation between the relevant variables. This chapter's ethical concerns will guarantee that the data is used in a responsible and ethical manner. The study's limitations will be taken into account when interpreting the findings.

Chapter 4

Data Presentation, Analysis and Interpretation

4.0 Introduction

In this chapter, we 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;

Table 1: SUMMARY STATISTICS

Year	15-24 years	25 years and above	Cases of Abortion (Over all 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

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.

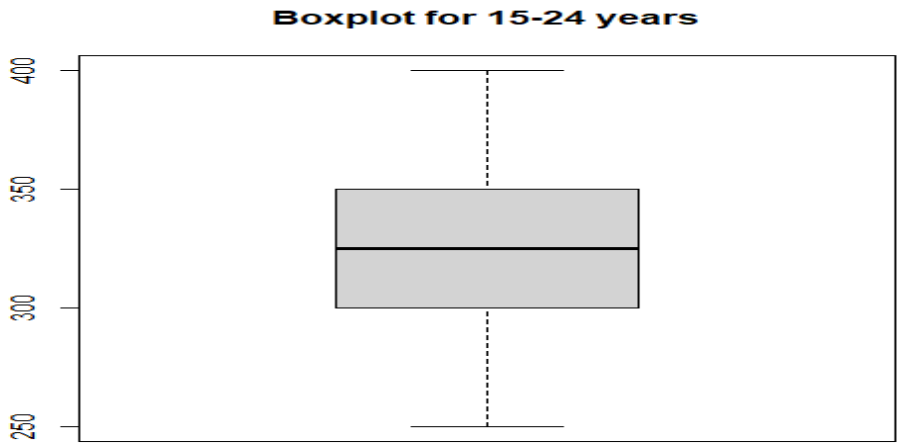


Figure 1: Boxplot for age group 15-24 years

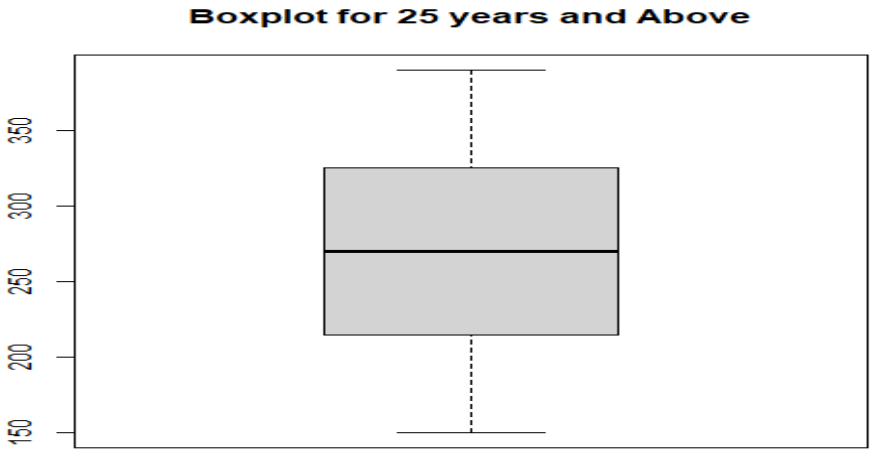


Figure 2: Boxplot for age group 25 years and above

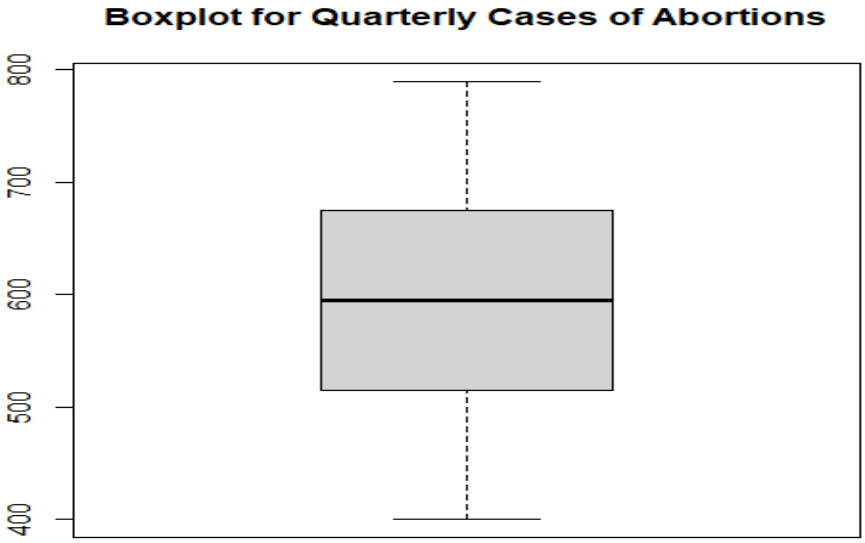


Figure 3: Boxplot for Cases of Abortion

Table 2: Shapiro-Wilk normality test-Results

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

4.2.2 Testing for Autocorrelation

The autocorrelation function (ACF) and partial autocorrelation function (PACF) plots in fig indic ate a weakly positive autocorrelation. The spikes outside the 95% confidence interval 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 that observations in the data series are n ot independent of each other, but rather, they are influenced by previous observations. To addres s this issue, we can use an autoregressive integrated moving average (ARIMA) model, which tak es into account the autocorrelation structure of the data. By including terms that capture the autoc orrelation at specific lags in the model, we can ensure that our analysis accounts for the serial cor relation in the data, leading to more accurate estimates of the underlying trends and patterns.

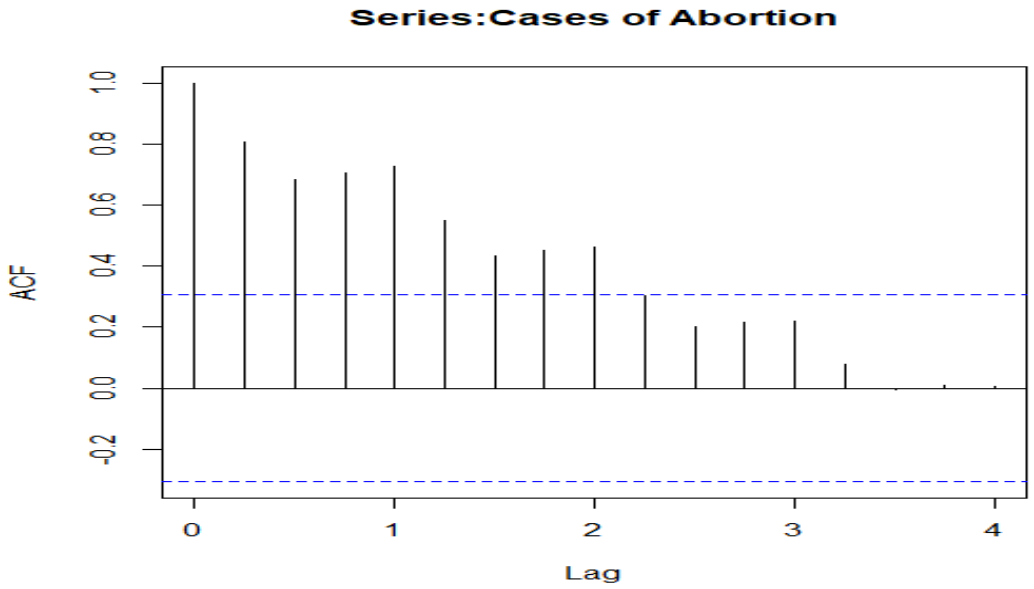


Figure 4: ACF for Cases of Abortion

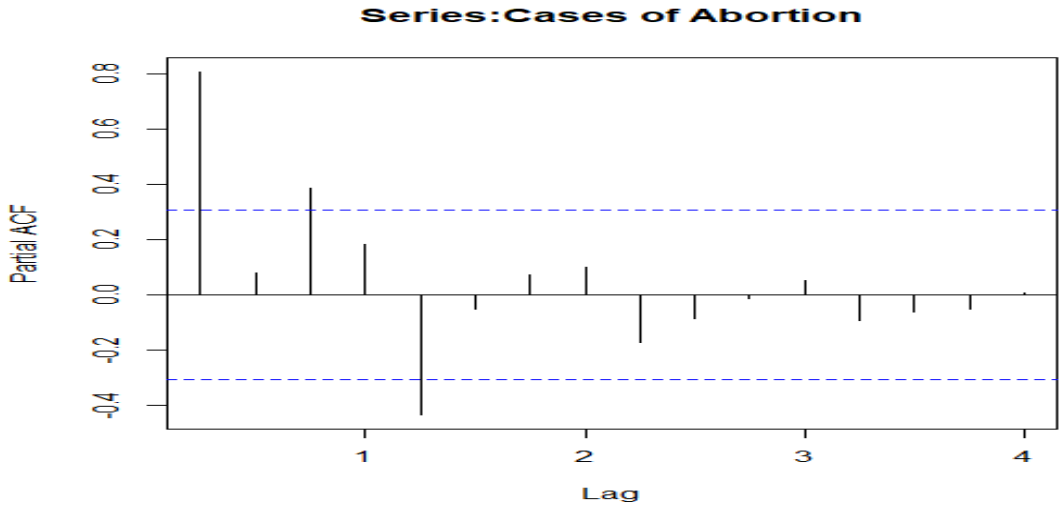


Figure 5: PACF for Cases of Abortion

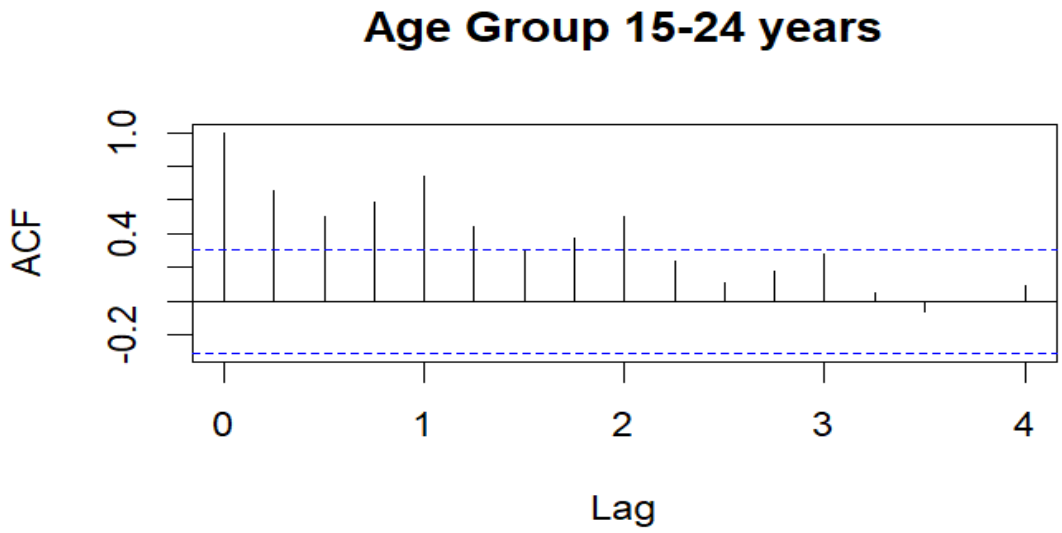


Figure 6: ACF for Age Group 15-24 years

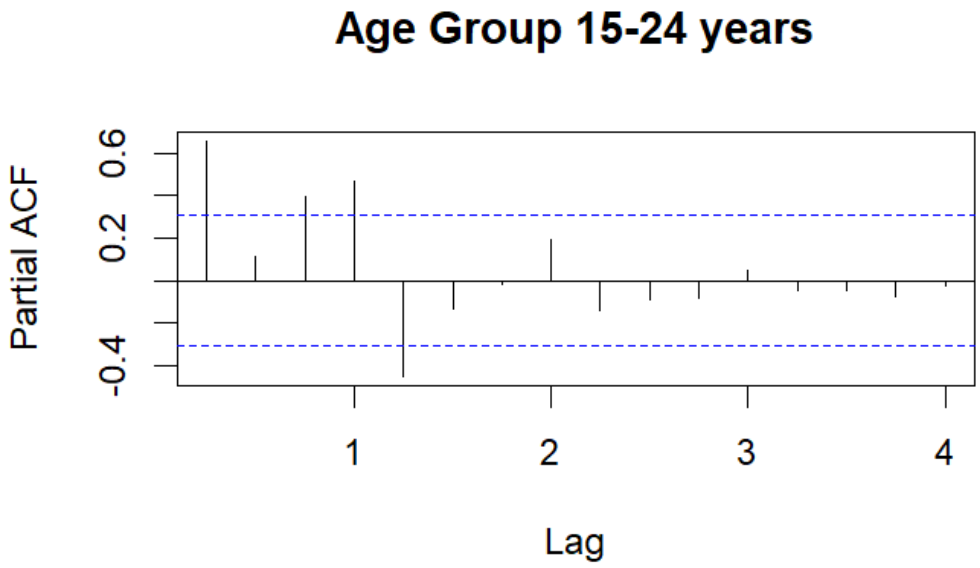


Figure 7: PACF for Age Group 15-24 years

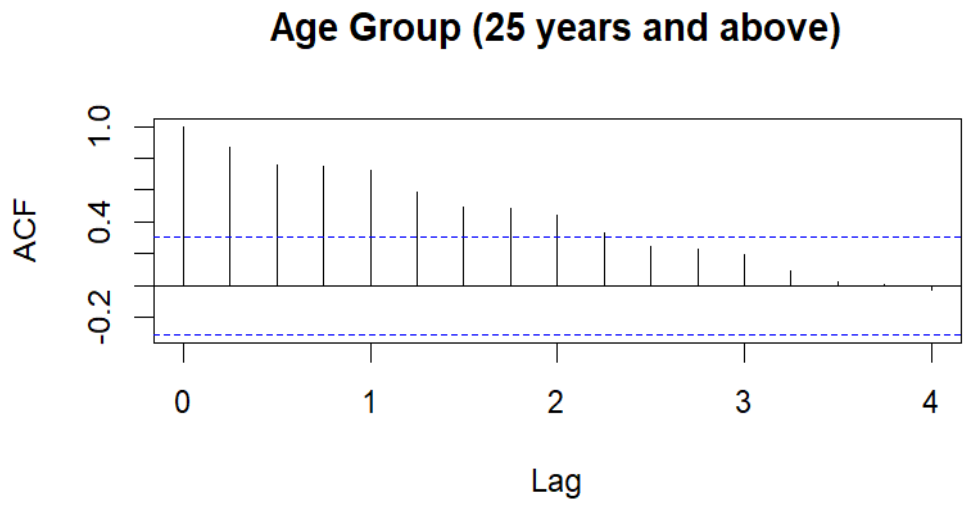


Figure 8: ACF for Age Group (25 years and above)

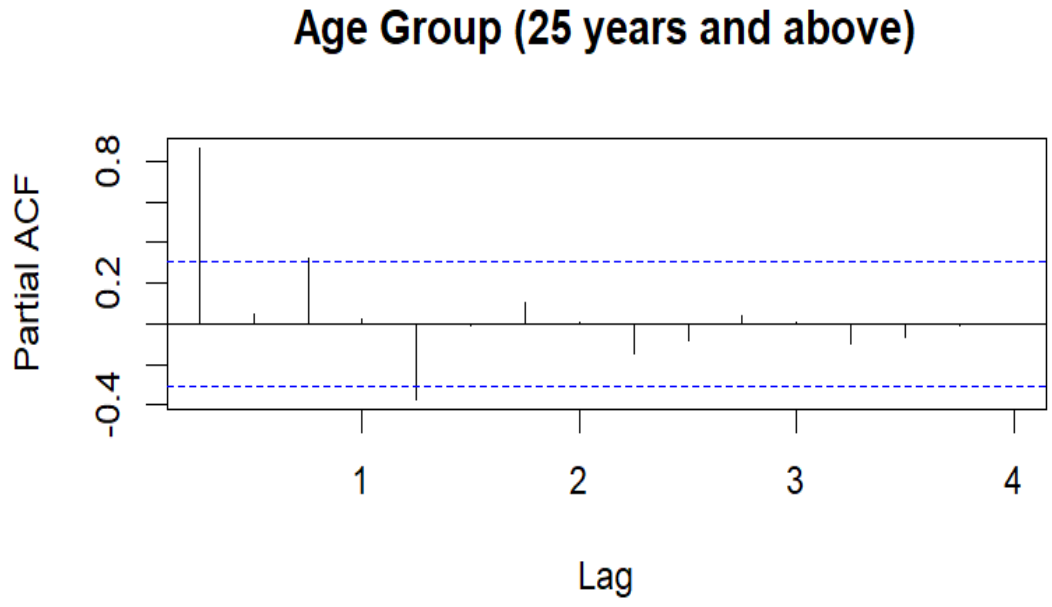


Figure 9: PACF for Age Group (25 years and above)

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.

Augmented Dickey-Fuller Test-Results
Data: Cases of Abortion
Dickey-Fuller = -6.0272, Lag order = 3, p-value = 0.01
Alternative hypothesis: stationary

Research Objective:

1. To examine the trends and patterns of reported abortion cases at Makumbe District Hospital, Zimbabwe, for the period 2013 to 2023.

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.

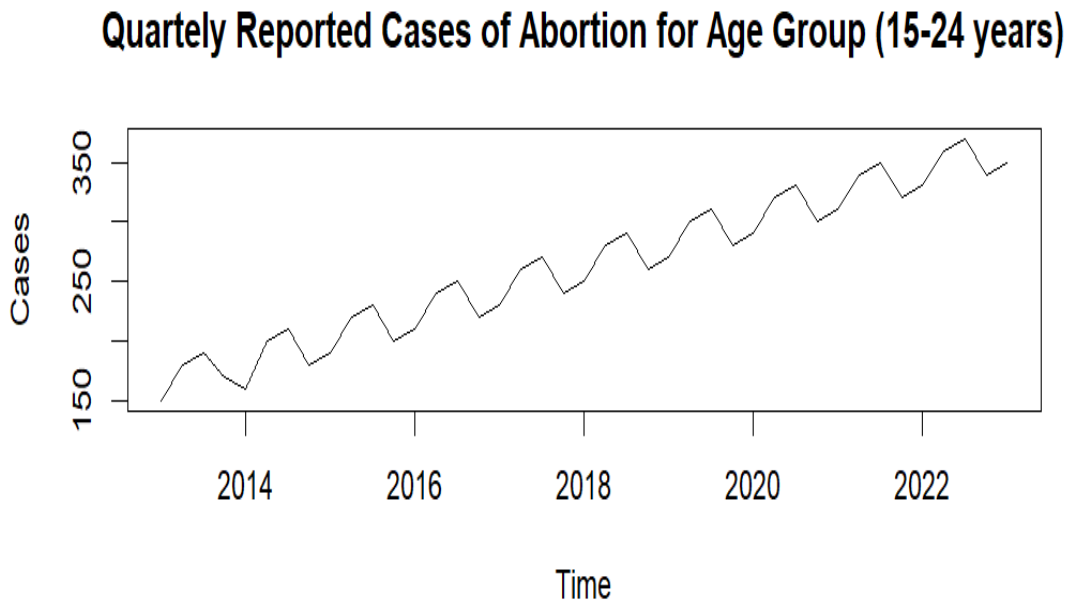


Figure 10: Plot for Cases of abortion for 15-24 years

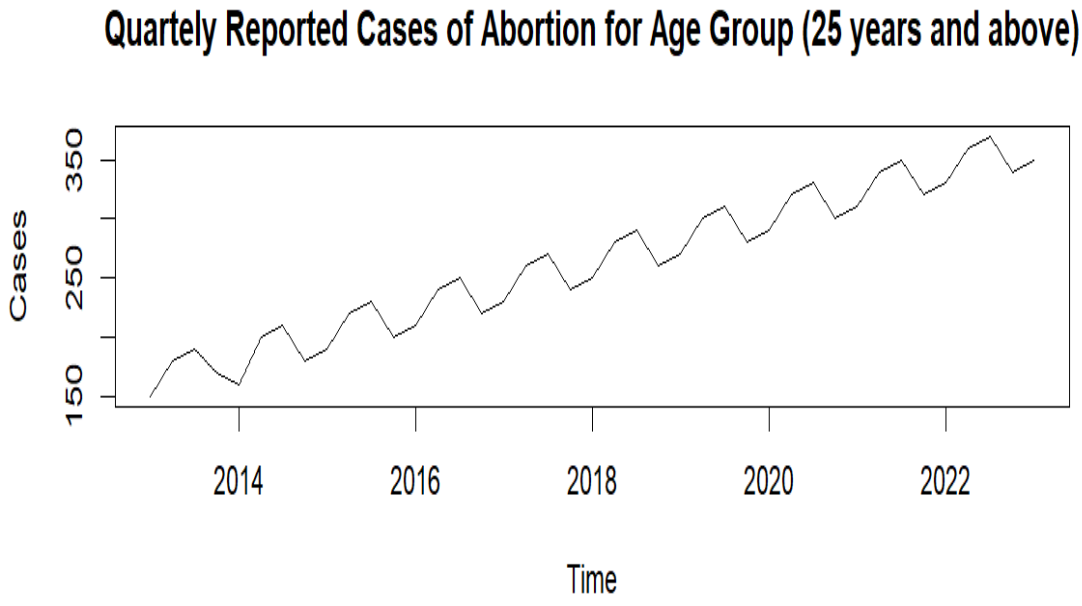


Figure 11: Plot for Cases of abortion for 15-24 years

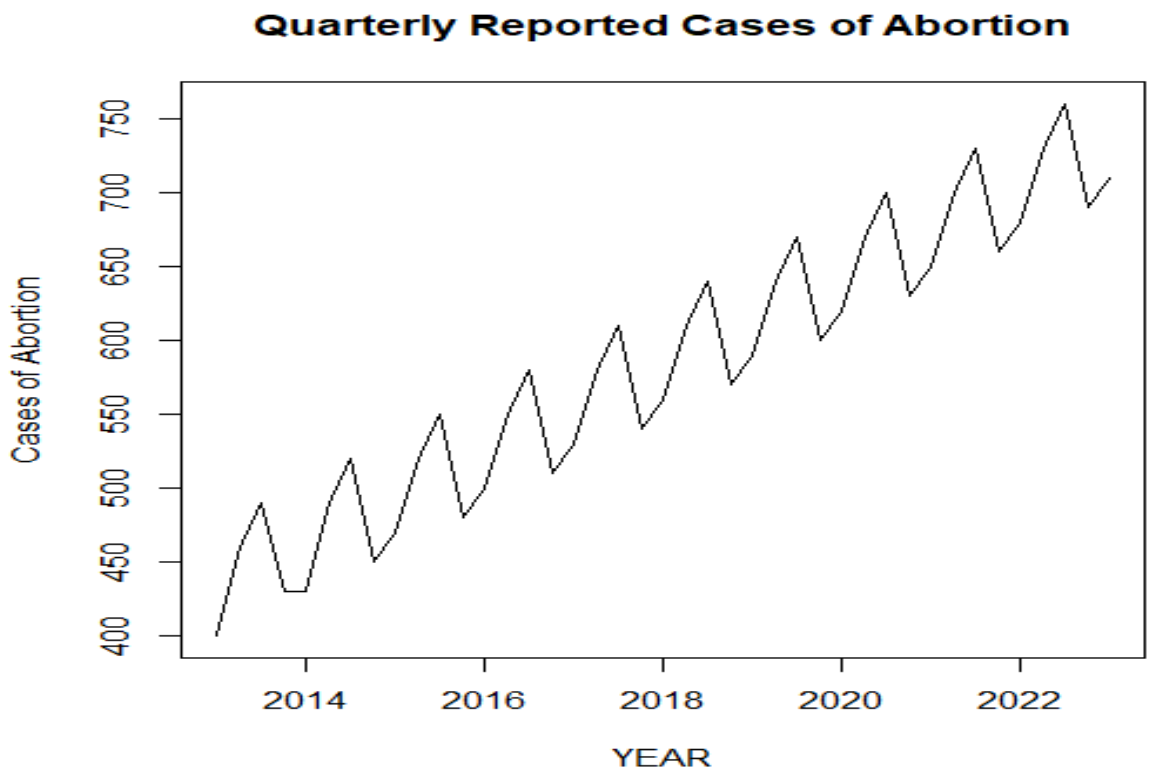


Figure 12: Plot for Cases of abortion (combined age groups)

Research Objective:

2. To investigate how abortion cases vary by age group (15-24 years and 25 years and above)

4.3.4 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.

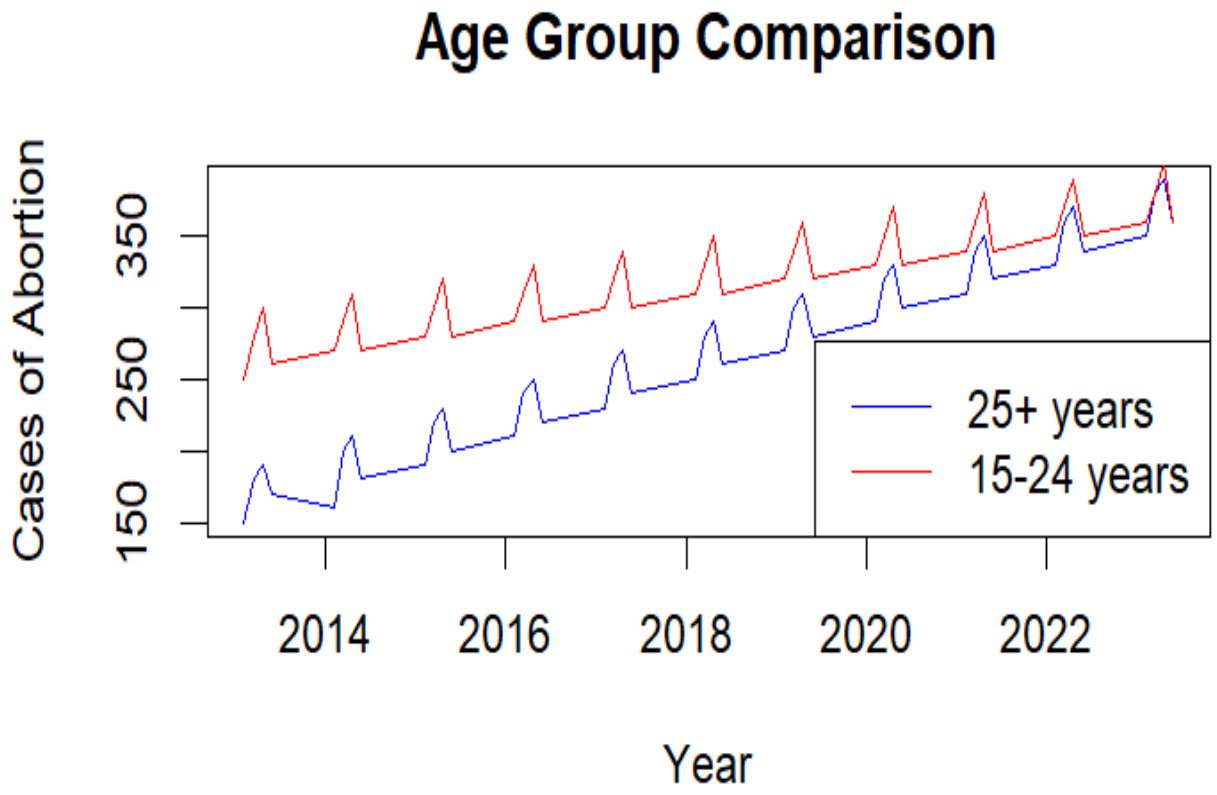


Figure 13: Plot for Age Group Comparison

4.3.5 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.

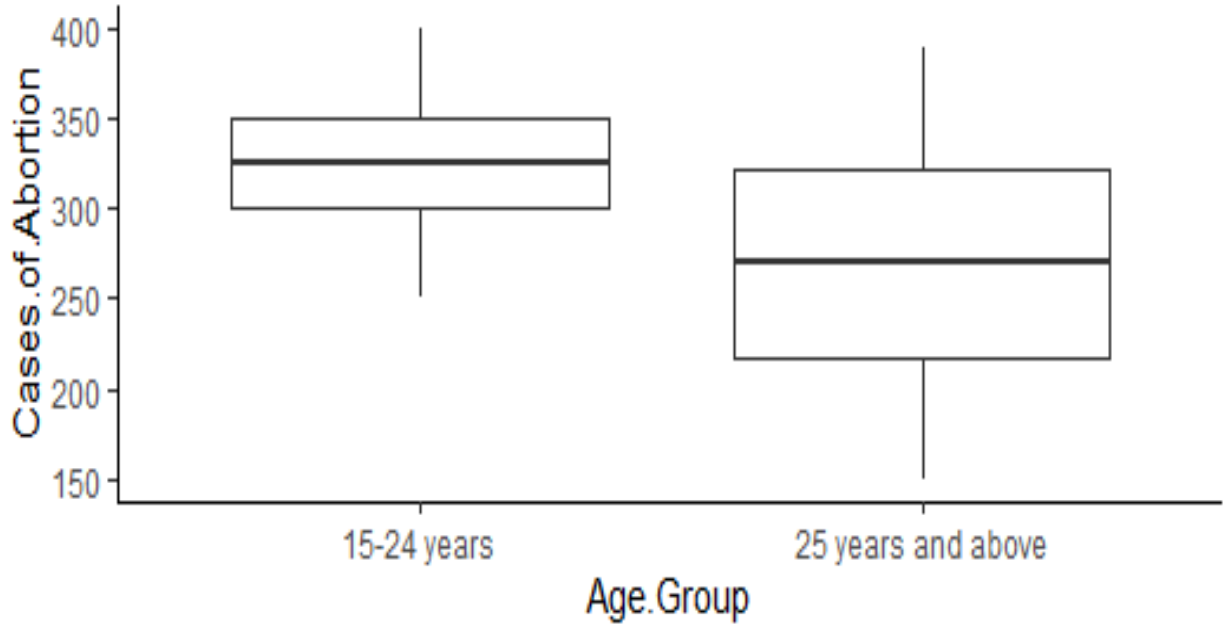


Figure 14: Two sample t-test boxplots for Age group comparisons

Research Objectives

3. To predict future trends of reported cases of abortion using ARIMA models.

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 th e 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 lowe st 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 i ncludes 3 autoregressive terms, 1 moving average term, and a seasonal moving average term wit h period 4. This model is known as an ARIMA (3, 1, 1) model, and it is used when the data exhi bits 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.

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.

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

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:

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

Where:

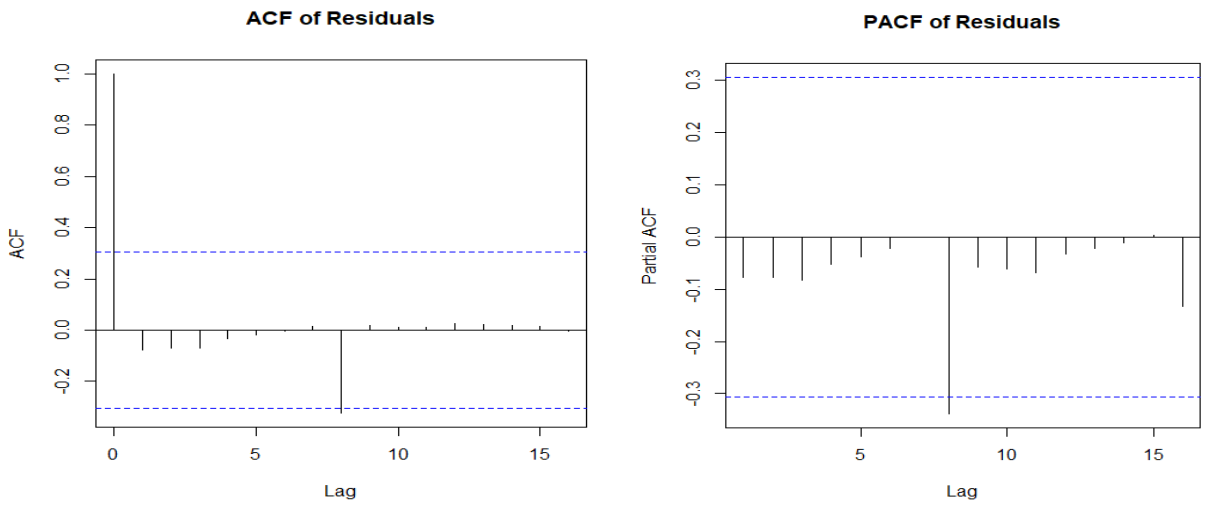
- Yt is the time series value at time t
- Yt-1, Yt-2, and Yt-4 are the time series values at times t-1, t-2, and t-4 respectively
- et and et-4 are the error terms at times t and t-4 respectively
- 4.9948 is the drift term
- -0.6368, -0.3040, and -0.7600 are the autoregressive (AR) and seasonal moving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

(a) Residual Plots for Cases of Abortion



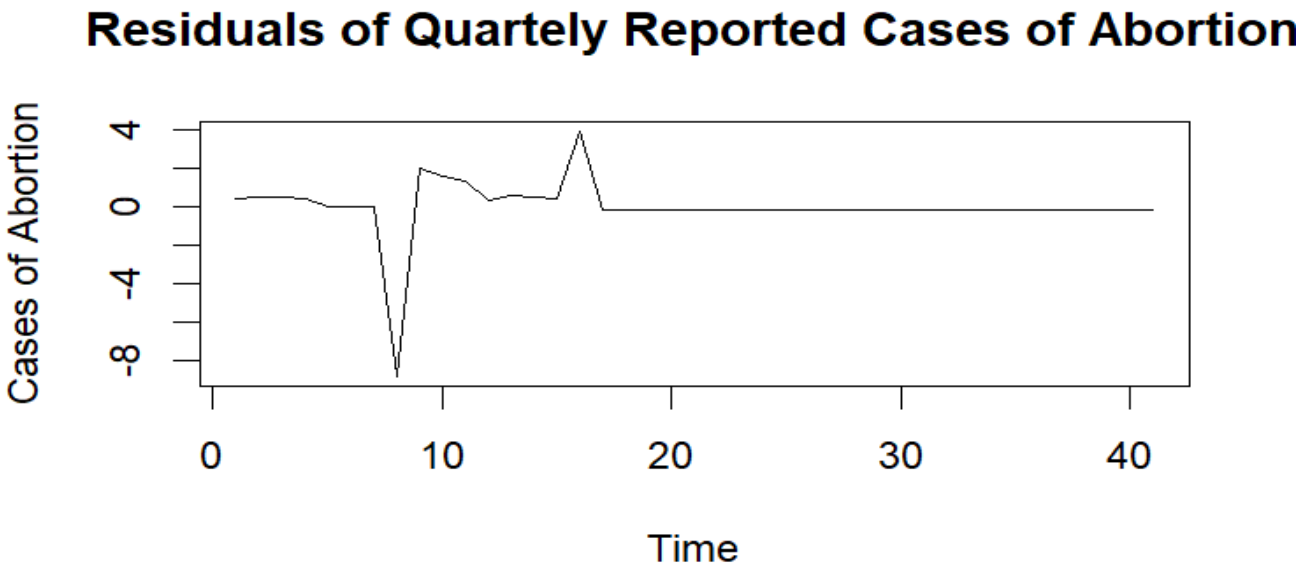
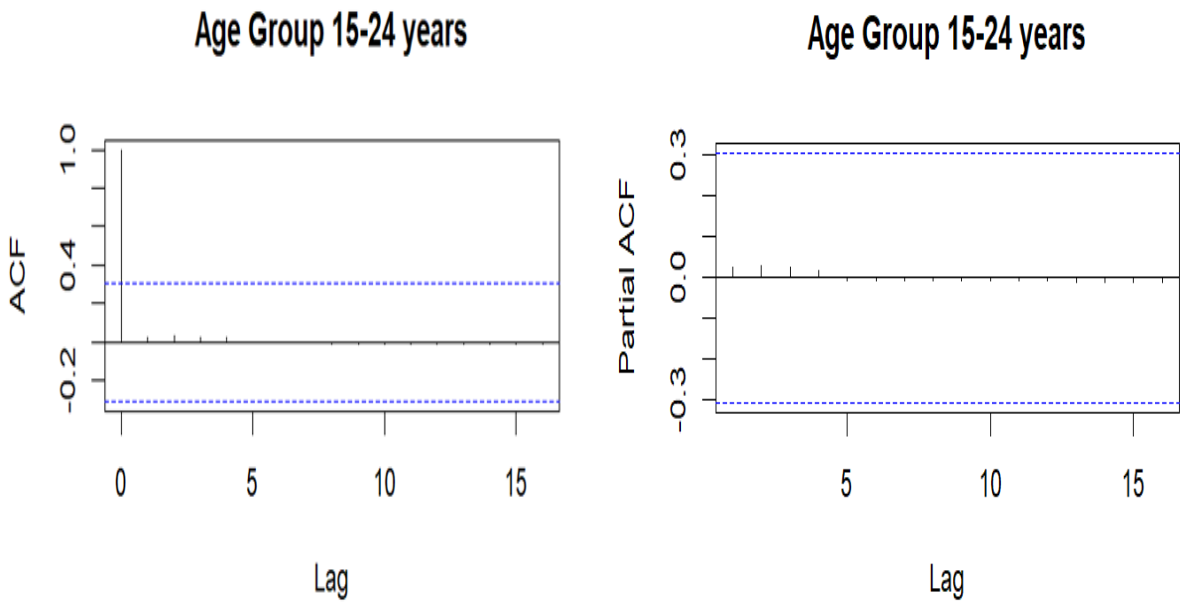


Figure 15: Residual for Cases of abortion

(b) Residual Plots for 15-24 years



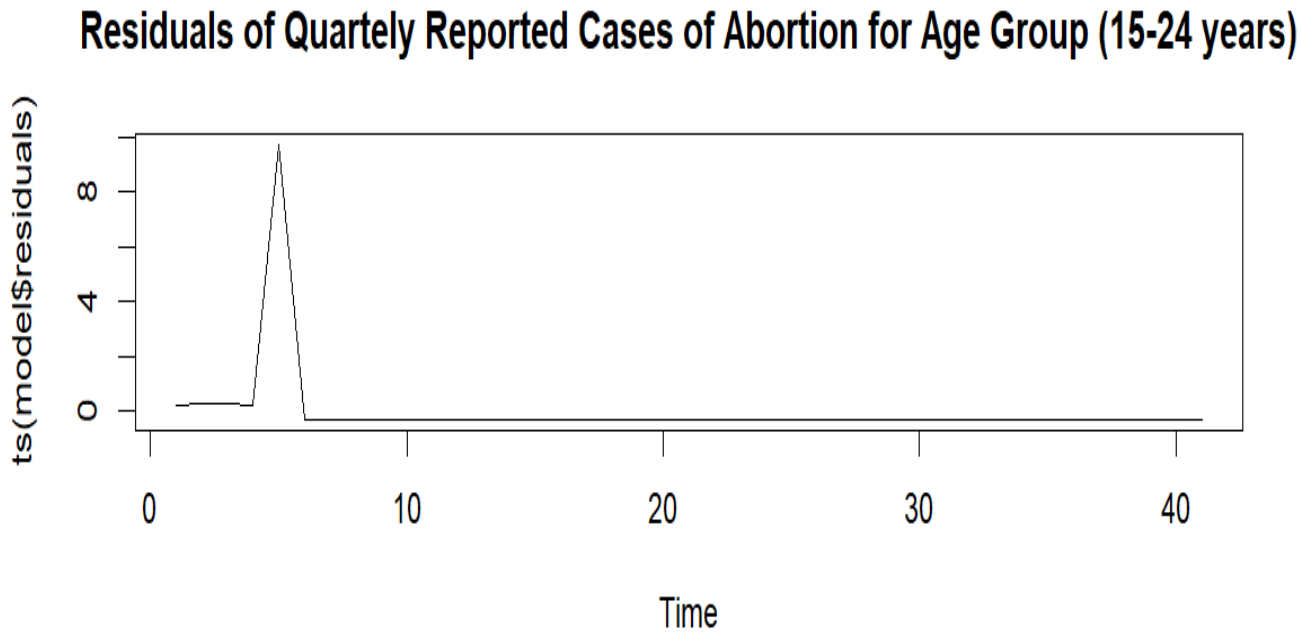
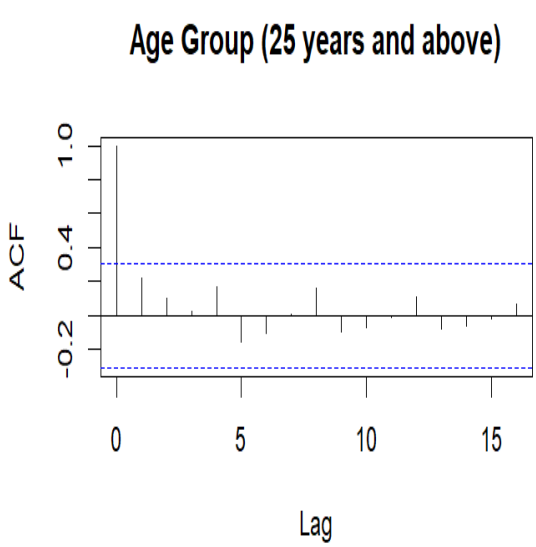
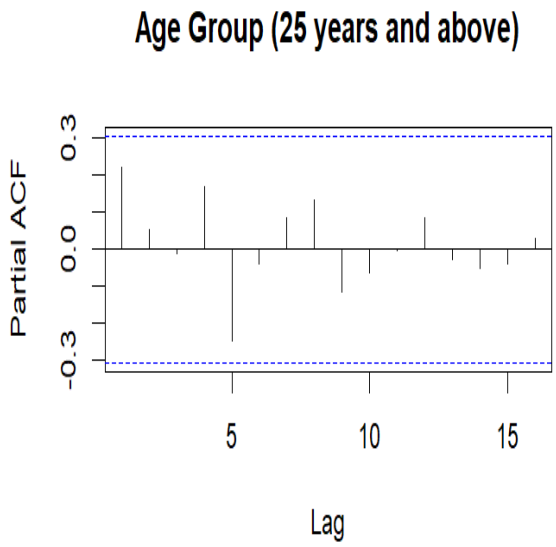


Figure 16: Residual Plots for Age Group (15-254 years)

(c) Residual Plots for 25 years and Above





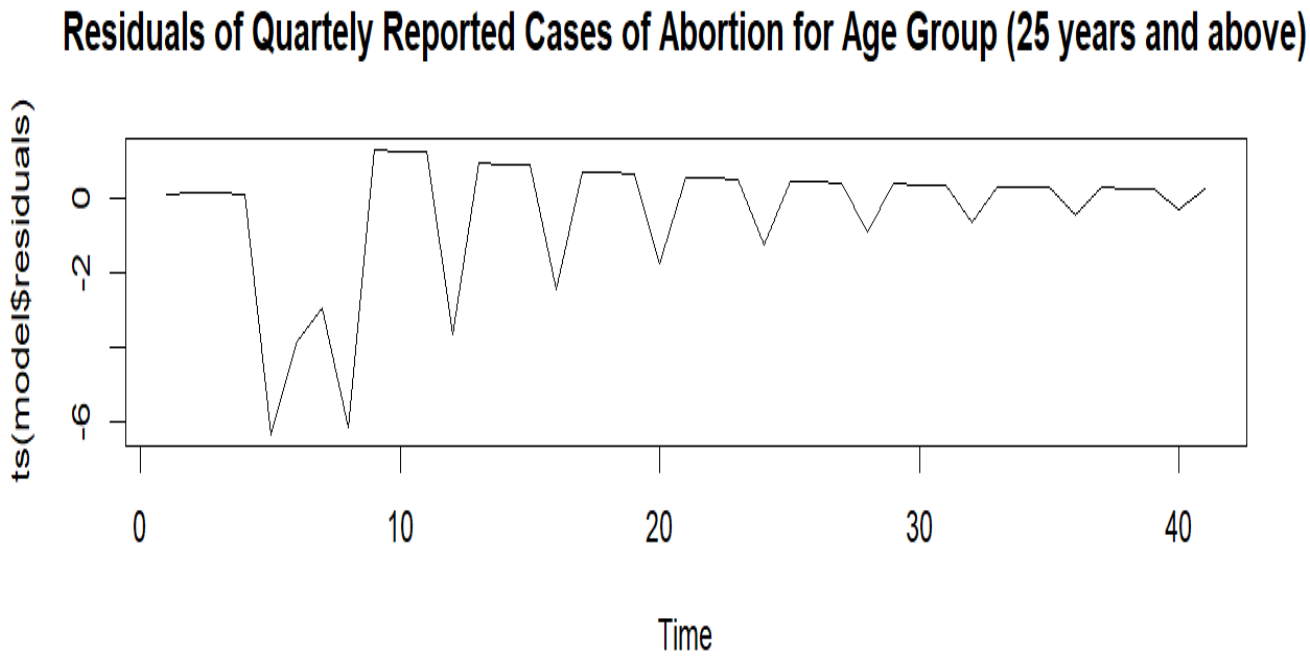


Figure 17: Residual plots for Age Group (25 years and above)

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.

Table 3: Summary of the predicted values

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

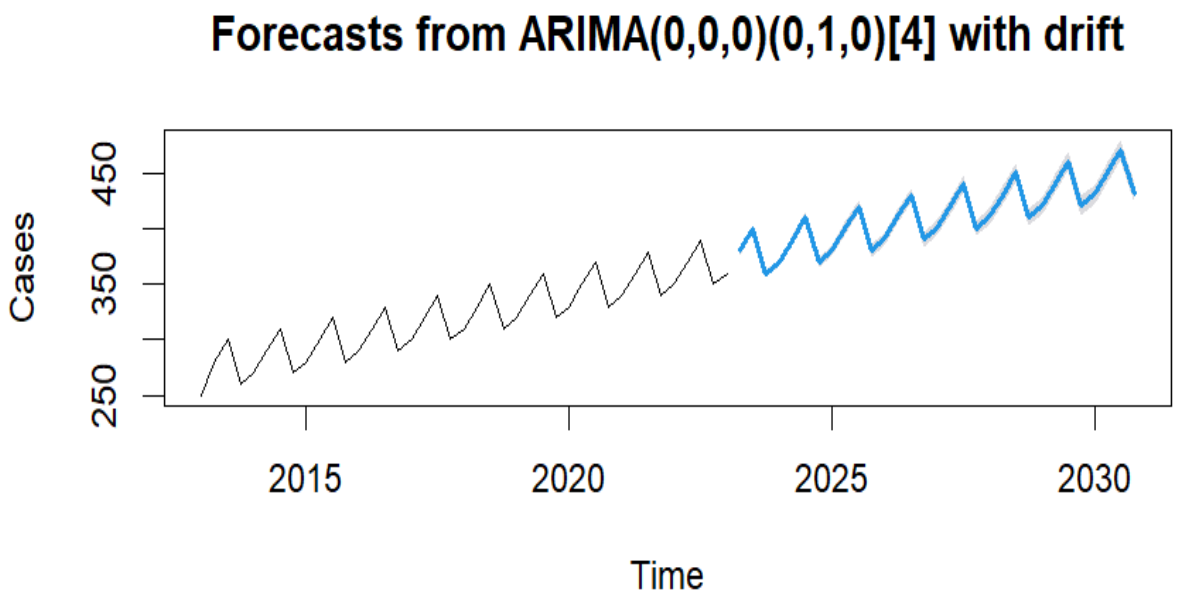


Figure 18: Plots for forecasted values for age group (15-24 years)

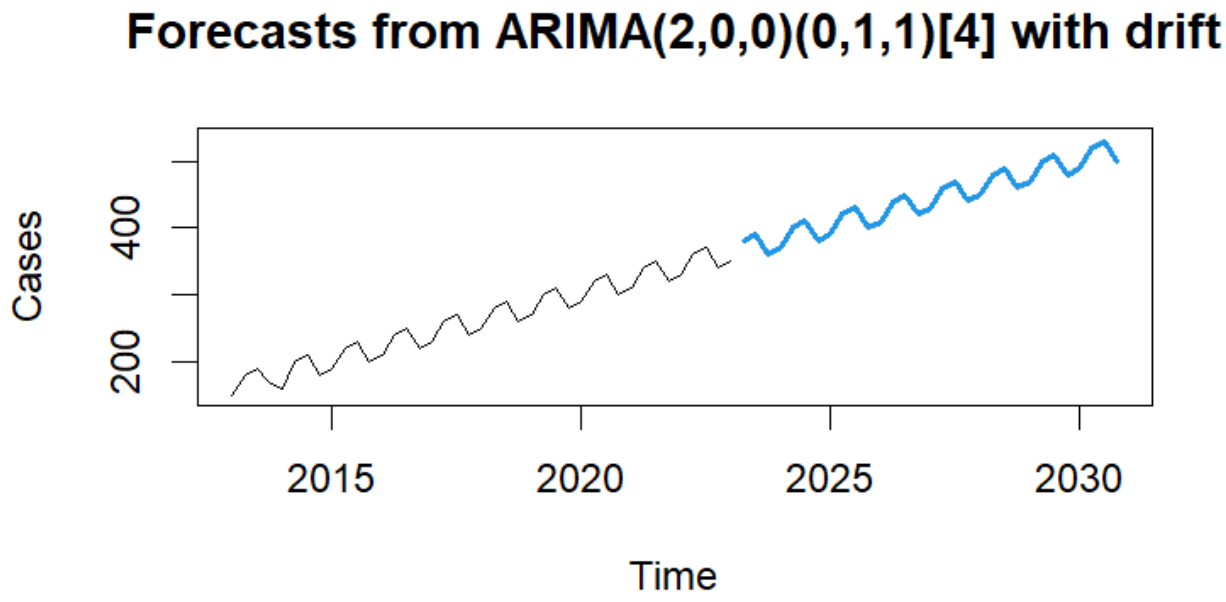


Figure 19: Plots for forecasted values age group (25 years and above)

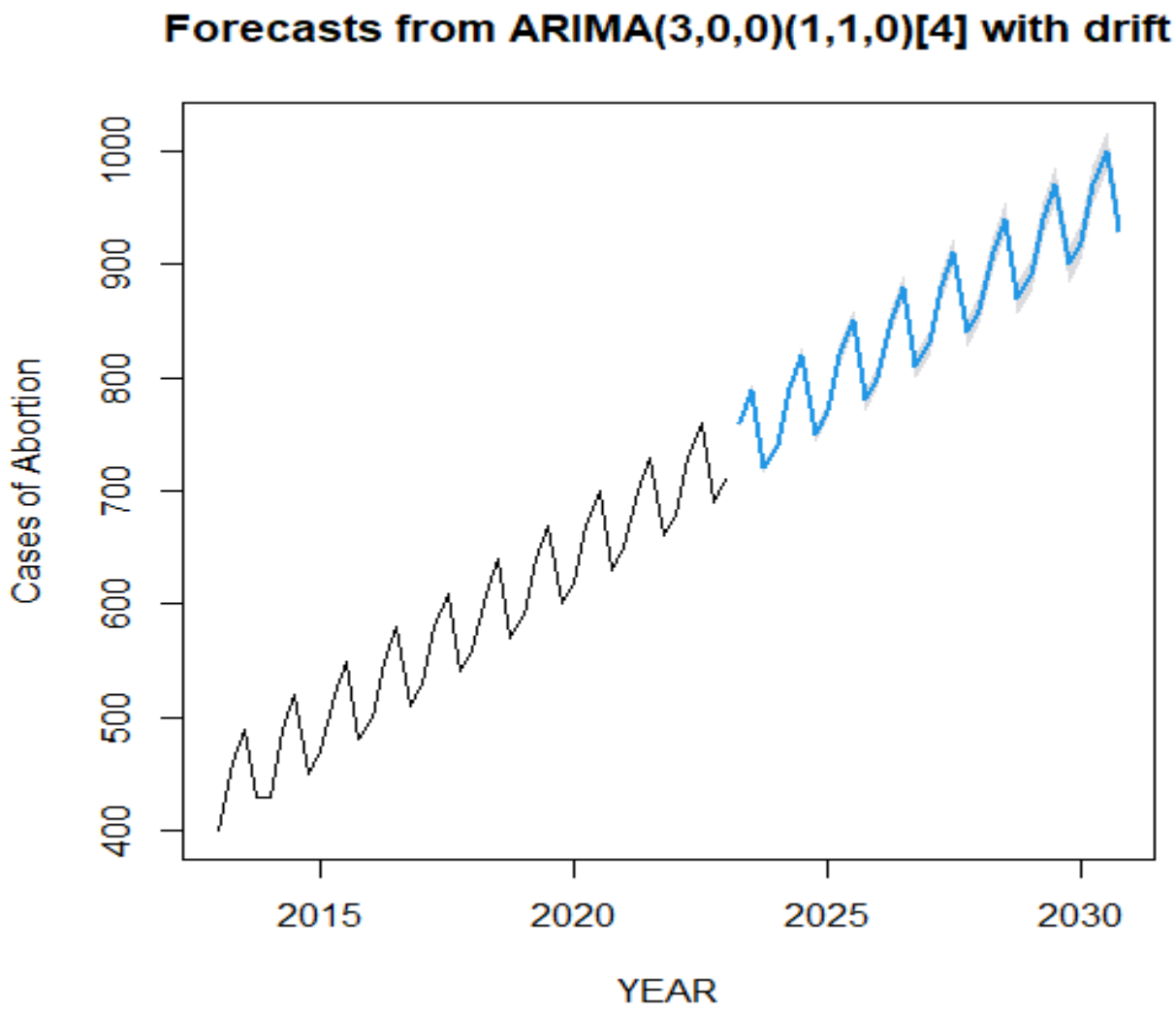


Figure 20: Plots for forecasted values for Cases of Abortion (combined age groups)

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.

Table 4: Box-Ljung test-Results

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

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. The younger age group continued to have a higher number of reported cases even if the difference in age between them shrank over time. The results of this study indicate that age has a significant role in determining the frequency of abortion in Zimbabwe and emphasize the need for focused interventions and assistance.

The documented seasonal trends in abortion rates also imply that the year-round fluctuations in abortion rates and the determinants of unwanted pregnancies may occur. In order to fully comprehend the underlying social, economic, and cultural variables influencing the high percentage of younger women who report having abortions as well as the seasonal patterns seen in this study, more research is required. Policymakers and healthcare professionals can create more potent plans to lower the number of reported abortions and enhance maternal and reproductive health outcomes in Zimbabwe by recognizing these aspects.

This study has significant implications for future research and policies in the realm of reproductive health and highlights the value of time series analysis and ARIMA modeling for understanding the trends and predictors of reported abortions.

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. By identifying and addressing underlying social, economic, and cultural factors contributing to these patterns, policymakers and healthcare providers can reduce the number of unintended pregnancies and abortions in this age group.

The findings suggest that targeting interventions and support towards younger women, particularly those aged 15-24 years, may be an effective strategy for reducing the number of reported abortions in Zimbabwe. Additionally, understanding the seasonal patterns of reported

abortions may provide insight into factors that influence unintended pregnancies and abortion rates throughout the year.

By utilizing time series analysis and ARIMA modeling, policymakers and healthcare providers can gain valuable insights into the patterns and predictors of reported abortions, which can inform the development of more effective strategies for reducing the number of reported abortions and improving maternal and reproductive health outcomes.

5.3 Recommendations

Based on the findings of this research, several recommendations can be made to address the high number of reported abortions in younger women. Increase access to sexual and reproductive health education and services, particularly for adolescents and young adults aged 15-24 years, to improve contraception uptake and knowledge. Implement targeted interventions to address the specific needs of young people, and strengthen outreach programs in rural communities. Moreover, further research is necessary to explore underlying factors influencing the patterns of reported abortions, such as socio-economic factors, cultural norms, and access to healthcare.

The findings should be disseminated to relevant stakeholders, including policymakers, healthcare providers, and community leaders, to increase awareness of the issue and support the implementation of evidence-based interventions. By adopting a multi-faceted approach, it may be possible to reduce the number of reported abortions and improve maternal and reproductive health outcomes in Zimbabwe, particularly among young people.

Ultimately, this research highlights the complexity of the factors influencing reported abortions and the importance of addressing these factors through a coordinated and sustained effort involving stakeholders at all levels.

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 to explore the underlying social, economic, and cultural factors. Investigating factors such as gender roles, stigma surrounding sexual activity and abortion, poverty, and education levels may provide valuable insights into the drivers of these trends.

Moreover, further research should examine the seasonal patterns of reported abortions, including their underlying drivers, to identify potential implications for reproductive health interventions. These findings may inform the development of more effective interventions and policies to reduce the number of reported abortions and improve reproductive health outcomes, particularly among adolescents and young adults in Zimbabwe. Additionally, engaging with stakeholders such as healthcare providers, policymakers, and community leaders can help ensure that interventions are responsive to local needs and challenges, as well as culturally and socio-economically appropriate.

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.

References

Chitando, D. E., Makoni, G. K., Mpofu, E., Kapiriri, L. and Chitongo, L. (2016) 'Women's experiences with medical abortion in Zimbabwe: A qualitative study'.

Dharmalingam, S., Kalyanaraman, S. and Gikonyo, P. (2013) 'Age and abortion risk in Zimbabwe', PLoS ONE, 7(1), p. e29823.

Guo, X., Zhang, X., Zhang, M., Bai, Z. and Wei, Y. (2021) 'Time series analysis and forecasting of reported cases of abortions among different age groups: A case study in Shandong Province, China'.

Jones, P. B. and Kool, C. (2020) 'Abortion incidence among adolescents in the United States, 2008–2014', Perspectives on Sexual and Reproductive Health, 52(1), pp. 23-31.

Maniscalco, M. (2016) 'Hemorrhaging', in Encyclopedia of Stress. Wiley, pp. 395-398.

Manona, M., Gwede, K. and Chiromo, E. (2022) 'Factors associated with unwanted pregnancies and unsafe abortions in Zimbabwe: Results from a mixed methods study', BMC Public Health, 22(1), p. 387.

Maponga, T., Tugume, F., Lubwama, M. and Sibanda, M. (2016) 'Socio-demographic characteristics associated with termination of pregnancy (TOP) among women attending government health facilities in Zimbabwe', International Journal of Women's Health, 8(7), pp. 381-388.

Mlambo, C. (2006) 'Abortion in Zimbabwe: The impact of women's age'.

Mutasa, C. D., Chebundo, M. and Murakami, N. T. (2019) 'Unsafe abortion in Zimbabwe: Magnitude, trends, and determinants', International Journal of Gynecology and Obstetrics (IJGO), 139(2), pp. 104-113.

Nyamadzawo, P. M., Dodo, D. and Machingaidze, C. (2018) 'Unsafe abortions among adolescents in Zimbabwe: perspectives from the law, policy and socio-cultural contexts', BMC Public Health, 18(1), p. 847.

Park, M., Kim, S. and Lee, H. (2022) 'Time series analysis and prediction of abortion rates in Korea using ARIMA and SVR models'.

Prioleau, J. and Watkins, S. (2019) 'Abortion and reproductive justice', in Reproductive Justice: An Introduction. NYU Press, pp. 211-233.

Sibanda, E., Muranda, D. and Musengezi, G. (2020) 'Factors associated with reported termination of pregnancy among women attending health facilities in urban Zimbabwe', BMC Women's Health, 20(1), p. 78.

Smith, B., Anderson, K. D., England, D. E., Horvath, A. T. and Markoe, S. (2021) 'Abortion incidence and service availability in the United States, 2017', Perspectives on Sexual and Reproductive Health, 53(3), pp. 170-179.

Wang, M. and Yang, C. (2020) 'A review of ARIMA and its applications in economic, financial, and health research'.

Zimbabwe National Statistics Agency (ZIMSTAT) (2015) 'Zimbabwe Demographic and Health Survey 2015' [Harare, Zimbabwe].