PREVALENCE RATE OF URINARY TRACT INFECTIONS (UTIs) AND ITS RISK FACTORS AMONG REPRODUCTIVE MOTHERS IN GHANA

Chapter 1

Introduction

1.1 Background

Reproductive Health, including maternal health is an important health concern in Ghana. Most common maternal infections are Urinary Tract Infections, skin and respiratory tract infections. Urinary Tract Infection is prevalent among reproductive mothers during pregnancy. Urinary Tract is the organ that collects, stores urine and releases it from the system (body). The urinary system includes the kidney, ureter, bladder and urethra (Odoki, etal.,2019). Urinary Tract Infections (UTIs) stands out among the many health conditions that affect women as a serious problem that can have an important influence on reproductive health and general well-being (Michael J. B,2023). Urinary Tract Infections (UTI) is the world most second cause of death, trailing mostly respiratory tract infections (J.L. Laari,2022). Pregnancy increases the risk of UTI partly due to the pressure of gravid uterus on the ureters causing stasis of urine flow and is also attributed to the humoral and immunological changes during normal pregnancy (T. Emiru,2013). Women are much more prone to UTIs than men, mainly due to the female lower urinary tract anatomy and its proximity to the reproductive organs (K. Czajkowski,2021). Maternal Urinary Tract Infection is the commonest non intestinal infection in pregnant women globally, and it is a major health problem affecting up to 20% of expectant mothers (E. K.Vicar.,2023). Urinary Tract Infection is one of the most prevalent infectious diseases causing over 150 million cases per year worldwide costing the world economy over 6 billion US dollars in treatment and it is affecting all age groups (A.L. Flores-Mireless,2015). In 2019, over 404.6 million individuals worldwide experienced UTIs, with approximately 236,786 deaths attributed to UTIs, resulting in 5.2 million disability adjusted life years, and the highest prevalence was observed in India (Zeng et al.,2019). UTIs are the most common outpatient infection in the United States (US). Due to the exception of a spike in young women aged 14-24 years old, the prevalence of UTIs increases with age (Martha & Edgardo,2019). Urinary Tract Infection is ranked third among Human Acquired Infections (HAIs) in Ghana, recording a prevalence higher than respiratory tract infections with the secondary and tertiary health institutions predominating in terms of prevalence (A.K. Labi,2019). In this research, we will estimate the prevalence of Urinary Tract Infections among reproductive mothers. To do this, we must examine data from a sizable sample of women in a given age range and identify trends that are associated with the onset of Urinary Tract Infections in various subgroups of women. The likelihood of Urinary Tract Infections in distinct subgroups of women will be predicted using the proper statistical models based on a variety of demographic, lifestyle, and health-related factors. As a result, clinical practice and interventions focused at controlling the illness will be better informed. This will assist in assessing and predicting the prevalence and risk variables linked to Urinary Tract Infections among women of representative ages.

1.2 Problem Statement

Urinary tract infections (UTIs) are one of the major causes of morbidity and comorbidities in patients with underlying conditions, and it accounts for the majority of the reasons for hospital visit globally (Odoki, et al., 2019). In Ghana, effective treatment of UTIs is often hampered by inadequate facilities for isolation and antimicrobial susceptibility testing. This can sometimes lead to urologic complications due to untreated, undetected, and improperly treated UTIs. The prevalence of UTIs in Africa varies from country to country and geographical location. For instance, In Ghana, the prevalence rate is 15.9%, in Senegal 4.5% and 12.3% in Nigeria (B.J. Mwang'onde,2022). The prevalence rate in Accra is 31.6% (A.B. Karikari,2022). A study done at the Komfo Anokye Teaching Hospital in the Ashanti region of Ghana found 34.5% prevalence of UTI caused by Gram negative bacteria. Some of the effects of UTIs are discomfort and pain, emotional impact and health complications. Premature labor, hypertensive disorders of pregnancy, anemia, amnionitis, and low birth weight (LBW) infants are all consequences of UTIs (L. Balachandran,2022). This review will explore the physiological changes that occur during pregnancy that predispose females to UTIs and discuss the clinical manifestations that may vary from asymptomatic bacteriuria to acute pyelonephritis (Jolanta Małyszko et al.,2015).

1.3 Objectives of the study

1.3.1 General Objectives

The purpose of the study is to assess the prevalence rate of Urinary Tract Infections(UTIs) and risk factors among reproductive mothers in Ghana.

1.3.2 Specific Objectives

- To determine the prevalence rate of Urinary Tract Infections(UTIs) among reproductive mothers in Ghana.
- To identify the risk factors associated with Urinary Tract Infections(UTIs) among reproductive mothers in Ghana.

1.4 Research Questions

- What is the prevalence rate of Urinary Tract Infections(UTIs) among reproductive mothers in Ghana?
- What are the risk factors associated with Urinary Tract Infections(UTIs) among reproductive mothers in Ghana?

1.5 Justification of the Study

Urinary Tract Infections (UTIs) have serious consequences if not properly managed especially among reproductive mothers in Ghana (Ana L Flores-Mireles et al., 2015). Maternal and infant mortality includes a number of health challenges in Ghana, with outcomes among the worst in the subregion and the world (Joseph Adu et al.,2021). Our aim here was to provide insights into how Ghana has approached these challenges, with a view to making suggestions for the future. Ghana has made significant gains in reducing infant and maternal deaths in the past decade through initiatives like the Free Maternal Care Policy, the Community-based Health Planning Services, and the National Health Insurance Policy (Daniel Kweku Dzidzonu et al.,2020). These policies have improved financial access to maternal and obstetric health services, facility-based delivery, and antenatal care services in particular (Joseph Adu et al.,2021). However, a number of challenges still hinder access to maternal and child health outcomes (Sapna negi et al., 2021). Poor infrastructure, human resource challenges, poor access to essential medicines, poor quality of care, and superstitious and cultural beliefs have been noted in the literature (Jenny Momoh et al., 2019). We suggest that while providing the necessary human and financial resources, other initiatives including the promotion of maternal health education, supervised home delivery, and zero maternal death interventions should be encouraged to help improve maternal and child health outcomes in Ghana.

1.6 Significance of the study

Understanding Urinary Tract Infections (UTIs) and risk factors among reproductive mothers is crucial for improving maternal health outcomes, reducing maternal morbidity and mortality rates in Ghana (N.M. Gilbert, et al., 2013). The study supports public health activities by enhancing reproductive health habits, directing interventions, and identifying factors that impact maternal health(J. Stover et al.,2016). The results of research guide the establishment of evidence-based policies that influence public health initiatives, healthcare interventions, and maternal health policies in Ghana. The study intends to lower maternal death rates and improve maternal health services in the nation by identifying and treating risk factors. (J. Azaare, et al.,2020). The study raises awareness about maternal health risks, educates healthcare providers, and empowers communities to promote positive maternal health practices (A.B. Kassim, et al.,2023). Contributes to research advancement by adding to the body of knowledge on maternal health, enhancing understanding of Urinary Tract Infections (UTIs) of risk factors, and facilitating future research endeavors. Identifying risk factors empowers reproductive mothers to make informed decisions about their health, seek appropriate care, and mitigate potential health risks (H. Khekade, et al.,2023). The project advances health equity by addressing risk factors and guaranteeing that expectant mothers have access to high-quality medical care and assistance for favorable health outcomes (A.R. Meadows,2023). The results of the study could have a long-term effect on maternal health, helping Ghana's mothers' well-being and reproductive health practices to continue improving (J. Adu,2012).

1.7 Organization of the study

This study is divided into five chapters. The first chapter discusses the introduction which includes background of study, problem statement and study objectives. The second chapter evaluates the literature works and give details about the causes and various risk factors associated with reproductive mothers in Ghana. The third chapter examines statistical models that will be used. It then goes into great detail about the mathematical ideas that were applied in this study. The third chapter provides more information on Poisson regression, it's model and how it addresses the key objectives of the study. In the fourth chapter, the research and other findings are discussed and analyzed. The final part offers a summary of the research done, a conclusion and significant suggestions.

1.8 Scope and Limitation of the Study

The study uses data for women who are reproductive within the ages 15 to 45 years, from Municipal hospital in Accra. The study seeks to address the impact of the factors affecting reproductive mothers. Since most of the factors are known, we will look at how these factors contribute the rate at which one gets risk. The focus is on how the factors affect or influence reproductive mothers. Not all known factors were considered. The study aims to examine the risk factors among reproductive mothers and determine the factors that need critical attention to help reduce the devastating effect of risk among reproductive mothers. This study encountered some limitations. The first limitation is that not all the possible factors causing risk in reproductive mothers were examined in our research. The omitted factors could also influence the outcome of our study. It is believed that other variables excluded from the model could influence the decision under investigation.

Chapter 2

Literature Review

2.1 Introduction

2.1.1 Urinary Tract Infections And Its Definitions

Urinary tract infection (UTI) is a common bacterial infection known to affect the different parts of the urinary tract and the occurrence is found in both male and female (Ochei et al., 2018).There are four different types of Urinary Tract Infections thus, cystitis, urethritis, pyelonephritis and vaginitis. Urinary tract infection (UTI) refers to microbial invasion of the urinary tract by one or more pathogenic bacteria species, leading to significant bacteriuria and the presence of symptoms such as dysuria (Puca, 2014). Increased risk of UTIs is primarily caused by alterations in voiding either in the presence or absence of surgical intervention. A history of pre-surgical recurrent UTIs is the most important risk factor for developing a UTI after treatment (Weintraub, Reuven, & Paz-Levy, 2018). Urinary tract infection is caused by colonization and growth of microorganisms such as bacteria, fungi and viruses within the urinary tract (UT) (Worku, Alamneh, & Abegaz, 2021). Asymptomatic bacteriuria (ASB) is defined as the presence of bacteriuria in urine revealed by quantitative culture in a sample taken from a patient without symptoms suggestive of lower or upper UTI. In women, the traditional quantitative definition for ASB is 105 cfu/mL in 2 consecutive voided urine specimens and for ASB in men a voided urine specimen with 1 bacterial species isolated in a quantitative count of 105 cfu/mL (Lilian &Thomas,2014). The urinary tract is the body's drainage system for removing urine, which is made up of wastes and extra fluid. For normal urination to occur, all body parts in the urinary tract needs to work together and in the current order. The urinary tract includes two kidneys , two ureters, a bladder and a urethra (Ariana & Smith,2020).

2.1.2 Types of Urinary Tract Infections

There are four main types of Urinary Tract Infections and they are cystitis, urethritis, pyelonephritis and Vaginitis.

- Cystitis Cystitis refers to infection of the lower urinary tract, or more specifically, the urinary bladder. It may be broadly categorized as either uncomplicated or complicated. Uncomplicated cystitis refers to lower urinary tract infection (UTI) in either men or non-pregnant women who are otherwise healthy. Acute cystitis is typically caused by a bacterial infection of the urinary bladder. Complicated cystitis, on the other hand, is associated with risk factors that increase the virulence of the infection or the potential of failing antibiotic therapy. Acute cystitis is typically caused by a bacterial infection of the urinary bladder. Women are particularly susceptible due to the proximity of the rectum to the urethral meatus as well as the relatively short urethral length in females. This activity reviews the evaluation and treatment of cystitis and describes the role of the inter professional team in the care of patients with this condition (R. Li, 2022).

- Urethritis Urethritis is a lower urinary tract infection causing inflammation of the urethra, a fibromuscular tube through which urine exits the body in both males and females and through which semen exits the body in males. Urethritis is strongly associated with sexually transmitted infections and is characterized as gonococcal or non gonococcal. The most common symptom of urethritis is urethral discharge. This activity reviews the evaluation and management of urethritis and highlights the role of inter professional team members in collaborating to provide well-coordinated care and enhance outcomes for affected patients (A.Young,2022).

- Pyelonephritis
  Pyelonephritis is a bacterial infection causing inflammation of the kidneys and is one of the most common diseases of the kidney. Pyelonephritis occurs as a complication of an ascending urinary tract infection (UTI) which spreads from the bladder to the kidneys and their collecting systems. Symptoms usually include fever, flank pain, nausea, vomiting, burning on urination, increased frequency, and urgency. The 2 most common symptoms are usually fever and flank pain. Acute pyelonephritis can be divided into uncomplicated and complicated. Complicated pyelonephritis includes pregnant patients, patients with uncontrolled diabetes, kidney transplants, urinary anatomical abnormalities, acute or chronic kidney failure, as well as immunocompromised patients, and those with hospital-acquired bacterial infections. It is important to make a distinction between complicated and uncomplicated pyelonephritis, as patient management and disposition depend on it (M. Belyayeva,2022).

- Vaginitis
  Vaginitis is defined as any condition with symptoms of abnormal vaginal discharge, odor, irritation, itching, or burning. The most common

causes of vaginitis are bacterial vaginosis, vulvovaginal candidiasis, and trichomoniasis. Bacterial vaginosis is implicated in 40% to 50% of cases when a cause is identified, with vulvovaginal candidiasis accounting for 20% to 25% and trichomoniasis for 15% to 20% of cases. Noninfectious causes, including atrophic, irritant, allergic, and inflammatory vaginitis, are less common and account for 5% to 10% of vaginitis cases. Vaginitis is characterized by vaginal symptoms, including discharge, odor, itching, irritation, or burning. Most women have at least one episode of vaginitis during their lives, making it the most common gynecologic diagnosis in primary care. Studies have shown a negative effect on quality of life in women with vaginitis, with some women expressing anxiety, shame, and concerns about hygiene, particularly in those with recurrent symptoms. (HL Paladine, 2018).

2.2 Causes of Urinary Tract Infections

- Genetic factors
  UTI susceptibility is influenced by the genetic makeup of the host, especially by genes that regulate the innate immune response to infection. Functionally relevant genes are regulatory rather than structural, suggesting that control of gene expression is essential (J Zrimec et al., 2021). Thus, unlike the rare, monogenetic disorders defined by gene loss, UTI susceptibility is defined by the efficiency of the host defense (I Ambite et al.,2021). Furthermore, emerging data suggest that different molecular response pathways and genes characterize patients with APN, acute cystitis, or ABU. To further validate the power of genetic variants in UTI risk assessment, clinical study criteria should be coordinated between study centers (G Godaly et al.,2015).

- Developmental disorders
  A UTI develops when microbes enter the urinary tract and cause infection. Bacteria are the most common cause of UTIs, although fungi rarely can also infect the urinary tract. E. coli bacteria, which live in the bowel, cause most UTIs. The female anatomy contributes to women's increased likelihood of contracting a UTI (AL Flores-Mireles et al.,2015). A woman's urethra is shorter than a man's, allowing better access to the bladder. A woman's urethral opening is also close to sources of bacteria from the anus and vagina (E. Coli). Sexual activity can move bacteria to the urethral opening. Most UTIs affect the lower urinary tract, which is made up of the urethra and bladder (MJ Bono et al.,2023). This usually results in localized symptoms related

to urination. However, if left untreated, lower UTIs can migrate to the upper portion of the urinary tract. Upper UTIs cause systemic, flu-like symptoms, such as malaise, fever, chills, vomiting, nausea, and back or side pain.

- Anatomical abnormalities
  Medullary sponge kidney (MSK) is a renal disorder that is characterized by distal collecting-duct dilatation and multiple cysts and diverticula within the renal medullary pyramids (K Garfield et al.,2023). It is associated with a higher risk of nephrocalcinosis, urolithiasis, renal failure, and UTI (X Tang et al.,2015). The prevalence of this disorder in the general population is unknown. However, a large series of intravenous pyelograms (IVPs), performed for any reason, revealed radiologic signs of MSK in 0.5% to 1% (SR Mehta et al.,2023). The incidence of MSK in individuals who are known to form urolithiasis is higher, ranging from 2.6% to 12%. Clinical presentations of MSK include renal colic (51.8%), UTI (7.1%), and/or gross hematuria (16.1%). MSK is diagnosed radiographically and has traditionally been accomplished via IVP (DR Hickling et al.,2015). Pathognomic features on IVP include elongated ectatic papillary tubules, papillary contrast blush, and persistent medullary opacification which, taken together, give a 'bouquet' appearance. Today, IVPs have been replaced in favor of ultrasonography, computed tomography, and magnetic resonance imaging. MSK can be diagnosed with these imaging modalities but with much less sensitivity (S Liu et al 2023). MSK was once thought to be an isolated congenital abnormality. However, there is increasing data that links MSK with other malformation disorders such as hemihypertrophy, Beckwith-Wiedemann syndrome, congenital dilatation of intrahepatic bile ducts, and hepatic fibrosis, and autosomal-dominant polycystic-kidney disease (DR Hickling et al.,2015). This has led some to suggest that MSK is a developmental disorder of renal embryogenesis. Gambaro et al. have hypothesized that MSK may be a consequence of disruption of the ureteral-bud/metanephric-blastema interface, which is critical to normal renal and ureteric development.

- Pregnancy
  Urinary tract infections (UTIs) are frequently encountered in pregnant women. Pyelonephritis is the most common serious medical condition seen in pregnancy (PJ Habak et al 2023). Thus, providers of obstetric care must be knowledgeable about normal findings of the urinary tract, evaluation of abnormalities, and treatment of disease. Fortu-

nately, UTIs in pregnancy are most often easily treated with excellent outcomes. Rarely, pregnancies complicated by pyelonephritis will lead to significant maternal and fetal morbidity (C Tchente Nguefack et al.,2019). Changes in the urinary tract and immunologic changes of pregnancy predispose women to urinary tract infections (BA Dachew et al.,2021). Physiologic changes of the urinary tract include dilation of the ureter and renal calyces; this occurs due to progesterone-related smooth muscle relaxation and ureteral compression from the gravid uterus (PJ Habak et al.,2023). During pregnancy, urinary tract changes predispose women to infection. Ureteral dilation is seen due to compression of the ureters from the gravid uterus. Hormonal effects of progesterone also may cause smooth muscle relaxation leading to dilation and urinary stasis, and vesicoureteral reflux increases (D Mandal et al.,2017).

- Menopause
  Current UKHSA UTI diagnostic guidance advises empirical antibiotics if two of the following symptoms are present: cloudy urine, dysuria, and new onset nocturia. Hormonal changes during menopause may impact UTI symptoms, and qualitative studies suggest women with recurrent UTIs may present with different UTI symptoms. This study aims to assess whether menopausal status and the presence of recurrent UTIs impact UTI symptoms in women. An e-survey was conducted between 13 March 2021 and 13 April 2021 (LN Sanyaolu et al.,2023). Women aged 16 years or older with a history of a UTI in the last year were eligible for inclusion. We defined menopause as those aged 45–64 years; pre-menopause as those less than 45 years; and post-menopause as those 65 years and older. Recurrent UTIs were defined as three or more UTIs in the last year. The data were weighted to be representative of the UK population. Crude unadjusted and adjusted odds ratios were estimated using logistic regression. In total, 1096 women reported a UTI in the last year. There were significant differences in UTI symptoms based on menopausal status and the presence of recurrent UTIs. Post-menopausal women self-reported more incontinence (OR 2.76, 95% CI 1.50,5.09), whereas menopausal women reported more nocturia. Women with recurrent UTIs reported less dysuria, more severe symptoms (OR 1.93 95% CI 1.37,2.73) and a greater impact on daily life (OR 1.68, 95% CI 1.19,2.37). This survey provides evidence that acute UTIs present differently based on menopausal status and in women with recurrent UTIs (A Alizadeh et al.,2023). Healthcare professionals must be aware of these differences when assessing women

presenting with an acute UTI and, therefore, further research in this area is needed (GM Leydon et al.,2010). A quantitative research approach with a non-experimental descriptive study was adopted to conduct a study in India (P Pandey et al.,2023). The findings of the study revealed that the majority (82.2%) of the respondents know about urinary tract infections. However, most of the respondents have never experienced a urinary tract infection (82.2%). Most of the respondents knew about the causes of UTI (71.1%) (Mangai, et al., 2019).

2.3 Symptoms Of Urinary Tract Infections

A hospital-based cross-sectional study was conducted in Ethiopia. The study found out that symptoms suggestive of UTI were observed in 97 (43.11%) of the study subjects. The most frequently observed complaints were flank/loin pain, which was observed among 90 (40%), frequent urination, 80 (35.56%), and urgent urination, 66 (29.3%). Fever, dysuria, suprapubic pain, nausea and vomiting were also observed among 52 (23.2%), 42 (18.7%), 38 (16.9%), 26 (11.6%), and 5 (2.2%) participants, respectively (Worku, Alamneh, & Abegaz, 2021). An Indian study found that among the selected subjects 44% of subjects have good knowledge regarding the prevention of UTI. The main symptoms of urinary tract infection as indicated by the respondents were fever (67.2%), dysuria (60.4%), supra pubic pressure or discomfort (56.2%), and flank pain (45.2%). These are some of the symptoms of UTI in women; Pain or stinging while urinating, A frequent or strong urge to urinate, while often producing only a small amount of urine, Milky, cloudy, dark, bloody, or foul-smelling urine, and Lower stomach or back pain. Pregnant women are more likely to get UTIs because of changes in the position of the uterus during pregnancy (PJ Habak et al.,2023). In addition, pregnant women are more likely to have a UTI and a kidney infection, so they should see a healthcare provider as soon as possible after they notice symptoms (F Ghouri et al.,2019). A woman's obstetrician may or may not regularly test for urinary tract infections during prenatal visits. Women with catheters, tubes inserted into the urethra to drain urine, may experience a fever with a UTI, which could indicate that infection has reached the kidney. These women are at higher risk for kidney infections, so they should see their healthcare provider as soon as possible is they have a fever (H Australia et al.,2023). Older women with UTIs are more likely to feel tired, shaky, and weak and have muscle aches and abdominal pain. In some older women, a UTI can quickly lead to a serious whole-body infection called sepsis. Sometimes the progression to sepsis can occur without a fever, so older women with UTI must receive timely initial and follow-up care (A Sabih et al.,2023). Some women may have UTI-like symptoms when they don't have a UTI. These types of symptoms may occur because of an irritant, such as a soap or a food or drink. In these cases, once the irritant is removed or goes away, the symptoms will go away too. Lower UTIs are usually marked by pain during urination with or without frequency, and pain in the urinary tract (MJ Bono et al.,2023). UTIs generally occur by fever, flank, chills, vomiting, etc without symptoms of cystitis It is significant to note that these symptoms do not confirm that the person is suffering from UTIs. There is only a 50 chance that a person showing these symptoms is suffering from UTIs in a primary care setting if the possibility increases to 84%–92% then the person could have a higher chance of having it (reoccurring of the UTIs) (R.Kaur et al.,2021).

2.4 Diagnosis Of Urinary Tract Infections

The Diagnosis of Urinary Tract Infections in reproductive mothers requires a clinical evaluation, physical examination, and laboratory testing. A Urinary Tract Infection are caused by bacteria which affect different sections of the urinary tract including the following: Urethritis, an infection in the urethra. Cystitis, an infection in the bladder which often moved up from the urethra. Pyelonephritis, an infection in the kidney. Vaginitis, an infection in the vagina. (Stanford Health Care, 2024). Reproductive mothers who get infected by any of these types of the UTI's need to undergo full evaluation. Clinical symptom overlap is possible. Sometimes it's difficult to tell the difference between a dangerous infection like a kidney infection and a basic UTI. When in doubt, it is generally better to treat possible upper urinary tract disease promptly. In individuals with a simple UTI, physical examination findings are often benign; nevertheless, 10% to 20% of patients may experience suprapubic pain. (Michael J. Bono et al., 2023). A pelvic exam is recommended for patients with recurrent urinary tract infections, incontinence that is not explained, or suspected organ prolapse. (Jennifer Anger et al., 2019). A complete physical examination should be performed, including a heart and lung examination and careful monitoring of vital signs. Abdominal exams can identify tenderness, and they can usually trigger costovertebral soreness as well. A genitourinary (GU) exam should be performed as soon as a patient is admitted in order to look for cervical dilatation and identify any infections. Assess whether irregularities such as contractions occur while the patient is in the hospital, even if pregnancy-related issues are not at first concerning.(Patricia J et al., 2023). Under Laboratory testing the common testing used are the urine culture, urine dipstick analysis, urinalysis. The most reliable procedure or tool for diagnosis testing, is the urine culture, as it helps to detect and quantify the pathogen causing the infection. (Obirikorang C. et al., 2012). To identify the bacteria causing UTIs and the appropriate class of antibiotics to treat the illness while pregnant, urine cultures are used. A urine culture can be used to confirm or disprove a hypothesis of an UTI. The culture sample should be collected in a sterile container to avoid contamination, preferably from first morning urine. The presence of 105 colony forming units per millilitre (CFU/mL) confirms an infection, while an antibiogram will help verify the efficacy of a given treatment (Prz Menopauzalny, 2021). Laboratory analysis should include complete blood count (CBC), electrolytes and serum creatine.

2.5 Treatment Of Urinary Tract Infections

Asymptomatic bacteriuria is quite common and requires no treatment, except in pregnant women (Michael J. Bono et al., 2023). Asymptomatic bacteriuria and acute cystitis are treated with antibiotic therapy. When information on organism sensitivity is obtained from urine culture findings, antibiotic selection can be customized accordingly. It is not advised to use one-day antibiotic courses when pregnant, but three-day regimens work well. Bacteriuria in the absence of any symptoms occurs in 2–10% of all pregnancies. Treatment of bacteriuria has been demonstrated to lower the incidence of pyelonephritis in pregnancy, which affects up to 30% of pregnant women if left untreated. Increasing oral fluid intake may help alleviate acute cystitis symptoms, although there isn't much data to back this up.(Natasha Curtiss et al., 2017). In addition to the recommended treatment for ASB or UTI, patients should get intravenous (IV) antibiotic therapy at the time of delivery if Group B Streptococcus (GBS), a gram-positive coccus, is detected in the urine and is linked to a high vaginal colonization. This is to avoid the possibility of early-onset GBS sepsis developing in newborns of GBS-colonized mothers. Antibiotics commonly used include amoxicillin, ampicillin, cephalosporins, nitrofurantoin, and trimethoprim-sulfamethoxazole. (Patricia J. et al., 2023). Since there haven't been any new antibiotics developed since 1987, antibiotic resistance was recognized as a global problem in 2014, necessitating the search for substitute medicines. Since recurrent UTIs are easier to study with a risk group and their frequent recurrences facilitate useful evaluation of novel medicines, the majority of new treatments are directed towards preventing or treating recurrent UTI's.

2.6 Prevention Of Urinary Tract Infections

There are several steps that reproductive mothers can take in the preventing of Urinary Tract Infections, all though they can be crucial, the following can help prevent UTI's. Improving personal hygiene, using vitamin C as a urinary acidifier, exercising extra caution following sexual contact, and using preventative antibiotics or antiseptics like nitrofurantoin are common strategies for managing recurrent urinary tract infections (Jennifer Anger et al.,2019). The standard course of treatment for recurrent UTIs involves long-term, low-dose nitrofurantoin prevention. Typically, 50 mg QHS is administered. Because of its several antibacterial action modes, it is well tolerated; allergies or intolerances are rare; bacterial resistance is quite low; and therapy is limited to the urinary tract, minimizing side effects (Aggarwal N ,et al, 2024). Vaccines are being studied as a potential means of preventing repeated urinary tract infections, as an alternative to treating UTIs with antibiotics (Nikoo Aziminia, et al, 2018).Aso the potential of methenamine hippurate to avert urinary tract infections has been investigated. Hexamine is converted to the bacteriostatic chemical formaldehyde (Mina Bhakit, 2020). Another prevention step is the use of Cranberries. A special source of polyphenols, such as phenolic acids and flavonoids, which have been demonstrated to offer preventive effects against urinary tract infections, is the Vaccinium macrocarpon cranberry (Dolores González de Llano et al., 2020). To prevent UTI's reproductive mothers can also adopt the habbit of good personal hygiene. Also increase usual fluid intake by an additional 1.5L of water daily (Anna Mae Scott, et al., 2020).

2.7 Empirical View Of Urinary Tract Infections Among Reproductive Mothers in Ghana

Reproductive women throughout the world, especially in Ghana, are afflicted by the widespread gynecological issue of UTI (EK Vicar et al., 2023). Urinary tract infections are more common in women. They usually occur in the bladder or Urethra, but more serious infections involve the kidney (MJ Bono et al., 2023). These observed differences could be partially explained by the study population and sample sizes, a lack of infrastructure, and the employment of different approaches for the diagnosis of UTI (M Spek et al., 2020).Parity and gravidity play a vital role in conferring the infection during pregnancy (M Kumar et al., 2022). Conversely, no association was found between parity and UTI among pregnant women in cross-sectional studies from Sudan, Tanzania, Ghana, and West Ethiopia (BH Oladeinde et al., 2015). Poor hygiene practices during pregnancy have been associated with

UTIs among pregnant women. In this study, participants who frequently practice genital cleaning after sex had lower odds of getting a UTI (YA Badran et al., 2015). We also found out that those who use public defecation facilities and individuals who practice open defecation were five and nine times, respectively, more likely to get UTIs (D.G, Belay et al., 2022). A cross-sectional study by (Parasuraman et al.) indicated that people who use public toilet facilities are at risk of various bacterial infections (EK Vicar et al.,2023).Most of the bacterial isolates from the urine samples of pregnant women in this study were Gram-negative (T Demilie et al.,2012). E. coli was the commonest bacteria isolates. The possible explanation for the predominance of Gram-negative bacteria among isolated UTI aetiological agents may be because they are common members of the vaginal and rectal flora (YA Almutawif et al., 2023).

2.8 Causes of Urinary Tract Infections in Ghana

Urinary tract infection (UTI) is one of the most common bacterial infectious diseases encountered in clinical practice and accounts for significant morbidity and high medical costs (ES Donkor et al.,2019). To reduce its public health burden, there is a need for local research data to address aspects of the prevention and management of UTIs (R Pothoven et al.,2023). This study aimed to investigate community-acquired UTIs among adults in Accra, Ghana, including the risk factors, etiological agents, and antibiotic resistance (M Medina et al.,2019). This was a cross-sectional study involving 307 patients clinically diagnosed with UTI at the Korle Bu and Mamprobi polyclinics in Accra. Urine specimens were collected from the study participants and analyzed by culture, microscopy, and dipstick. The bacterial isolates were identified using standard microbiological methods and tested against a spectrum of antibiotics by the Kirby-Bauer method (ES Donkor et al.,2019).

- Cultural Beliefs and Practices
  In this study, we investigated community-acquired UTIs among adults in Accra to provide the necessary epidemiological information to reduce the burden of these infections. In the analysis of risk factors, only pregnancy emerged as a risk factor for UTI (ES Donkor et al.,2019). The association of pregnancy with UTI concurs with several studies and is probably due to the series of structural and functional urinary tract changes that occur during the course of pregnancy (EK Vicar et al.,2023). During pregnancy, there is a usually high level of circulating progesterone, which causes urethral sphincter relaxation and

a reduction in smooth muscle tone with slowing of ureteral peristalsis. Simultaneously, the enlarged uterus compresses the urinary bladder, thus increasing the intravesical pressure, which may result in vesicoureteral reflux and urine retention in the bladder after micturition (H Lee et al .,2012). Urinary stasis and impairment of the physiological anti-reflux mechanism create conditions favorable for bacterial growth and ascending infection (ES Donkor et al.,2019). In contrast to Piperacillin, Amoxicillin+Clavulanic acid, and Nalidixic Acid, there was a generally high susceptibility of the urinary isolates to Amikacin (¿85%), which makes it a suitable option for the treatment of UTI in Ghana. A recent study in Ghana also reported that a high percentage (93.6%) of urinary isolates were susceptible to Amikacin (AB Karikari et al.,2022). It is important to note that Amikacin is used for treating cases of febrile UTI and is regarded as an efficient option before carbapenem treatment, especially in patients with infections caused by ESBL-producing uropathogens that are extensively antibiotic-resistant (SY Cho et al.,2015). Amikacin is a relatively expensive antibiotic in Ghana, and the high cost is likely to protect the efficacy of this drug in the country for a long period (AK Labi et al.,2018). E. coli, is the most common etiological agent of community-acquired UTI in the study area, while pregnancy is the main risk factor (EK Vicar etal.,2019). While antibiotics such as Amoxicillin+Clavulanic Acid and Piperacillin are unsuitable for empirical treatment of any form of UTI in the study area, Amikacin remains a suitable drug for the treatment of febrile UTI (ES Donkor et al.,2019). The high prevalence of MDR and the occurrence of ESBLs among the uropathogens highlights the need for surveillance of antimicrobial resistance among these pathogens. In this regard, there could be a national system of pooling isolates of uropathogens from various hospitals. The study has exposed a serious problem with UTI diagnosis in Ghana which needs to be addressed (DK Afriyie et al.,2015).

- Healthcare-Seeking Behavior
  Even though studies have established that informal sector workers are prone to occupational-related diseases, not much is known about their health-seeking behavior. This study aims to examine drivers of health-seeking behavior among informal sector workers in the Kumasi metropolis of Ghana. A cross-sectional survey was conducted. A simple random sampling technique was used to select 350 informal sector workers. Questionnaires were used to collect the data. The study revealed that 33.5% of the participants practiced good health-seeking

behavior when they developed occupational-related diseases in 2016. The study further revealed that informal sector workers with five or more dependents and those who spent more than an hour at a health facility were more likely to exhibit good health-seeking behavior. Informal sector workers without active National Health Insurance Scheme [NHIS] and employees were less likely to adopt good health-seeking behavior (T Quartey et al.,2023). Given the limited formal healthcare system and resources available, socio-demographic factors should be taken into consideration when formulating policies to encourage informal sector workers to adopt good health-seeking behavior (D Adei et al.,2022).
This study is part of a broader project that was carried out from January to March 2017 on occupational health and safety practices among workers in the informal sector in the Kumasi Metropolitan area of Ghana. The research was undertaken at the Suame and Subin sub-metropolis of the Kumasi Metropolitan Area. Suame Magazine (the biggest mechanical garage in West Africa) and Asafo mechanical garages are located in Suame and Subin sub-metropolis, respectively. A cross-sectional survey design was adopted to elicit responses from informal sector workers (expressly welders and fish processors). The rationale for employing the cross-sectional survey design was to collect data at one point in time while examining current health-seeking practices among informal sector workers (D Adei et al.,2022).

Chapter 3

Methodology

3.1 Introduction

This section describes in full the mathematical principles employed in this research. It focuses further on Poisson Regression, its model and how they address the study's fundamental objectives.

3.2 General Linear Regression

The most common type of regression analysis is linear regression, which, as its name suggests, assumes that there is a linear relationship between the dependent variable and the independent variable(s) that the researchers choose to evaluate. (A. Schmeider, 2010).
General linear regression is a more advanced form of linear regression that allows for the inclusion of multiple independent variables, as well as the ability to handle non-linear relationships between the variables. In general, in linear regression, the dependent variable is still modelled as a linear function of the independent variables, but the independent variables can take on any form, including polynomial, exponential, or logarithmic. The general linear regression model can be is given as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k + \epsilon \tag{3.1}$$

where:

- Y is the dependent variable
- $X_1, X_2, ...X_k$ are the independent variables
- $\beta_0, \beta_1, \beta_2, ..., \beta_k$ are the coefficients of the independent variables
- ϵ is the error term, which captures the unexplained variations in Y that is not accounted for by the independent variables. The coefficients $\beta_0, \beta_1, \beta_2, ..., \beta_k$ are estimated using a method called least squares regressions (LSE). This method minimizes the sum of the squared differences between the predicted values of Y and the actual values of Y for the given values of $X_1, X_2, ...X_k$.

General linear regression has two main forms. These are;

- Simple linear regression
- Multiple linear regression

3.2.1 The Simple linear Regression

Simple linear regression is also a statistical method used to establish a relationship between two variables. In this method, we assume that there is a linear relationship between the independent variable (X) and the dependent variable (Y). The goal is to find the best-fit line that can predict the value of Y for any given value of X. The equation of a simple linear regression model is:

$$Y_i = a + \beta_X = \beta_0 + \beta_1 X_1 + \epsilon_i \tag{3.2}$$

where,

- Yi is the dependent variable
- X is the independent variable
- a or β_0 is the intercept of the curve
- $betaX$ is the slope of the curve
- β_1 is an unknown constant
- and $epsilon_i$ is a random error component.

To find the values of a and β, we use a method called the Method of Least Squares. This method minimizes the sum of the squared differences between the observed values of Y and the predicted values of Y on the curve.

3.2.2 Multiple Linear Regression

Multiple linear regression is also a statistical method used to model the relationship between a dependent variable (also known as the outcome variable) and the multiple independent variables (also known as predictor variables). It assumes a linear relationship between the independent variables and the dependent variable. The equation for multiple linear regression is as follows:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k + \epsilon \tag{3.3}$$

where:

- Y is the dependent variable
- $X_1, X_2, ..., X_k$ are the independent variables

- $\beta_0, \beta_1, \beta_2, ..., \beta_k$ are the regression coefficients, which represent the change in Y for a unit change in the corresponding independent variable while holding all other independent variables constant

- ϵ is the error term, which represents the variability in Y that is not explained by the independent variables.

3.3 Non Linear Regression

Nonlinear regression is a statistical technique used to model the relationship between a dependent variable and one or more independent variables when the relationship is nonlinear. Nonlinear relationships occur when the relationship between the independent and dependent variables cannot be adequately described by a straight line or curve. The equation for nonlinear regression is:

$$Y_i = f(X, \beta) + \epsilon_i \tag{3.4}$$

where:

- Y_i is the dependent variable

- X is the independent variable

- β is the vector of regression coefficients

- f is a nonlinear function that relates the independent variable(s) to the dependent variable

- ϵ_i is the error term, which represents the variability in Y that is not explained by the independent variable(s)

Nonlinear regression requires an initial guess for the regression coefficients, and the goal is to estimate the values of the coefficients that best fit the data. This is typically done using iterative algorithms that make small adjustments to the coefficients until the fit is optimized. Some common types of nonlinear functions used in nonlinear regression include exponential functions, logarithmic functions, and polynomial functions. Nonlinear regression can be more complex than linear regression and may require more sophisticated modelling techniques and more data to estimate the coefficients accurately. However, it can be a powerful tool for modelling complex relationships between variables and can provide valuable insights into nonlinear processes.

3.4 Generalized Linear Model

A generalized linear model (GLM) is a statistical tool that generalizes linear regression to allow for dependent variables that have non-normal distributions. GLMS are a class of regression models that allow for a variety of distributional assumptions for the response variable, such as binomial, possion, and gamma distributions. The basic structure of a GLM is similar to that of a linear regression model:

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k + \epsilon \tag{3.5}$$

where:

- Y is the response variable
- $X_1, X_2, ..., X_k$ are the predictor variables
- $\beta_0, \beta_1, \beta_2, ..., \beta_k$ are the regression coefficients
- ϵ is the error term

However in a GLM, the dependent variable's distribution is represented using a probability distribution function (PDF) that is suitable for the kind of data being analyzed.

3.4.1 The Components of the GLM

The GLM consist of three components namely;

- Random Component : this refers to the probability distribution of the response or the explained variable (Y)
- Systematic Component : this consists of the explanatory variables oor the covariates $(X_1, X_2, ..., X_k)$ expressed as a combination of linear predictors for example $\beta_0 + \beta_1 + \beta_2$
- The link function $g(\mu)$: this specifies the link between the random and the systematic components.

3.4.2 Assumptions of GLM

Generalized linear models (GLMS) make several key assumptions, including:

1. Linearity: GLMs assume a linear relationship between the predictor variables and the response variable o the link scale, which is the scale on which the models linear predictor operates.

2. Independence: GLMs assume that observations are independent of each other. This assumption is important because violating it can lead to biased estimates and incorrect conclusions.

3. Homoscedascity: GLMs assume that the variance of the dependent variable is constant across different levels of the predictor variables.

4. Normality: GLMs assume that the response variable follows a probability distribution from the exponential family, such as the normal binomial, or possion distribution.

5. No Multicollinearity: GLMs assume that the predictor variables are not highly correlated with each other. Multicollinearity can cause problems with parameter estimation and result in unstable model estimates.

3.5 Poisson Regression

Introduction

Poisson regression is one of the statistical procedures used in the field of research. Poisson regression is used in various fields of research and analysis, including econometrics, healthcare analysis, medical statistics, and credit rating. Unlike linear or normal regression, poisson regression is appropriate for modeling count variable. It is used by researchers and analysts in general for two purposes:

- To model count data
- To assess the relationship between predictor and counts

There are two models of Poisson regression, they are;

1. Standard Poisson Regression Model:
   This is the basic form of Poisson regression, where the outcome variable is assumed to follow a Poisson distribution with a mean parameter mu. This model assumes that the variance of the outcome variable is equal to its mean, a condition known as equidispersion. The model is typically formulated as:

$$log(\lambda) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k \tag{3.6}$$

Where:
λ is the expected count of the event of interest.
$X_1, X_2, ..., X_k$ are the predictor variables.
$\beta_0, \beta_1, ..., \beta_k$ are the regression coefficients.

2. Negative Binomial Regression Model: While the standard Poisson model assumes equidispersion (i.e., variance equals mean), the negative binomial regression model relaxes this assumption by allowing for overdispersion, where the variance exceeds the mean. This model is particularly useful when there is extra variability or clustering in the data that is not accounted for by the standard Poisson model. The negative binomial model provides a more flexible approach to modeling count data, allowing for better fit when overdispersion is present in the data. It is particularly valuable in situations where the assumption of equidispersion in the standard Poisson model is violated.
   The negative binomial model introduces an additional parameter (θ) to account for overdispersion. The model is typically formulated as:

$$log(\lambda) = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k \; Var(\lambda) = \lambda + \frac{\lambda^2}{\theta} \tag{3.7}$$

   λ is the expected count of the event of interest.
   $X_1, X_2, ..., X_k X_k$ are the predictor variables.
   $\beta_0, \beta_1, ..., \beta_k$ are the regression coefficients.
   θ is the overdispersion parameter.

3.5.1 Assumptions of Poisson regression

1. The dependent variable is count.
2. Counts must be positive integers.
3. Counts must follow a Poisson distribution.
4. Explanatory variable must be continuous or ordinal.
5. Observations are independent of each other.

3.5.2 Maximum Likelihood Estimation

Poisson regression is a statistical technique used to analyze the relationship between a dependent variable and one or more variables that are independent, where the response variable is count, meaning it consist of non-negative integers.

Maximum likelihood estimation (MLE) method is often used to estimate the parameters of a poisson regression model. The likelihood function for Poisson regression is based on the probability mass function of the Poisson distribution. The probability that the dependent variable Yi takes the value yi is given by:

$$P(Yi = yi|Xi) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!} \qquad (3.8)$$

Where λ_i=$e^{\beta_0+\beta_1 X_{i1}+\beta_2 X_{i2}+...+\beta_k X_{ik}}$
where; $\beta_0, \beta_1, \beta_2, ..., \beta_k$ are the parameters to be estimated and $X_1, X_2, ..., X_k$ are the predictor variables. The goal of Maximum Likelihood Estimation (MLE) in Poisson regression is to determine the values of the parameters $\beta_0, \beta_1, \beta_2, ..., \beta_k$ that maximize the likelihood of the observed count data. The likelihood function is the probability of observing the data given the parameters:

$$L(\beta) = \prod_{i=1}^{n} \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!} \qquad (3.9)$$

The equation above is one needed to optimize and is called the likelihood function.
To simplify the maximization, we take the natural logarithm of the likelihood function to obtain the log-likelihood function:

$$L(\beta) = \sum_{i=1}^{n} y_i log(\lambda_i) \text{ - } \lambda_i \ \ log(y_i!) \qquad (3.10)$$

$L([y_i(\beta_0+\beta_1 X_{i1}+\beta_2 X_{i2}+...+\beta_k X_{ik})e\beta_0+\beta_1 X_{i1}+\beta_2 X_{i2}+...+\beta_k X_{ik}log(y_i!)])$
(3.11)

3.6 Sensitivity, Specificity And Predictivities

Sensitivity values, specificity values, and predictive values are essential metrics used in statistical analysis to evaluate the efficacy of classification models. These metrics are particularly crucial in binary classification tasks, where the objective is to predict the presence or absence of a specific outcome using various predictor variables. Sensitivity, also known as recall, assesses a model's ability to correctly identify positive cases, while specificity measures its capability to accurately recognize negative cases. Predictive values, on the other hand, indicate the likelihood that a positive or negative test result is accurate. These metrics are vital for evaluating the precision of a classification model and guiding decisions based on its predictions. Sensitivity and specificity are frequently employed in medical diagnostics, quality control, and other domains where the accurate detection of both positive and negative cases is critical. Predictive values are commonly utilized in risk assessment, marketing, and other areas where the probability of a particular outcome is of interest. In summary, sensitivity, specificity, and predictive values are crucial for assessing the performance of classification models and making informed decisions based on their predictions.

3.7 Confusion Matrix

Here is the confusion matrix for specificity, sensitivity, and predictive values:

	Actual Positive	Actual Negative
Predicted Positive	True Positive (TP)	False Positive (FP)
Predicted Negative	False Negative (FN)	True Negative (TN)

Confusion Matrix for Specificity, Sensitivity, and Predictive Values

3.7.1 Sensitivity

Sensitivity refers to the percentage of actual positive cases that the model correctly identifies as positive. This is a vital performance metric for models designed to predict rare events or situations where missing a positive case would have significant consequences.
For example, a highly sensitive test is valuable in ruling out a disease when the test result is negative. Sensitivity can be thought of as the test's ability to detect even the smallest changes. Consider the amylase test, which is highly sensitive because it can detect very low levels of amylase in the blood. This means the likelihood of amylase being present but undetectable is very low. Therefore, a negative result suggests one of two possibilities: either amylase is present in such a small amount that the test cannot detect it (which is unlikely given the test's high sensitivity), or amylase is entirely absent (which is more likely).

$$Sensitivity = \frac{True\ Positive}{True\ positive + False\ negative} \tag{3.12}$$

3.7.2 Specificity

Specificity of a test refers to the proportion of individuals who correctly test negative among all those who do not actually have the disease. It is essential for confirming the presence of a disease when the test result is positive. High specificity indicates that the model is proficient at identifying negative cases, though it may sometimes incorrectly classify positive cases as negative. This can be expressed mathematically as:

$$Specificity = \frac{True\ Negative}{True\ Negative + False\ Positive} \tag{3.13}$$

When a test has high sensitivity but low specificity, it tends to produce more false positives. This means there is a greater chance of the test indicating a positive result even when the condition being tested for is absent. Such outcomes lead to unnecessary additional testing, treatments, and interventions, which can be costly and potentially harmful to the patient. Thus, it is crucial to consider both sensitivity and specificity when evaluating the performance of a diagnostic test, as both metrics are essential for determining the test's accuracy and reliability.

3.7.3 Predictive

The positive and negative predictive values (PPV and NPV respectively) are the proportions of positive and negative results in statistics and diagnostic tests that are true positive and true negative results, respectively. The PPV and NPV describe the performance of a diagnostic test or other statistical measure. A high result can be interpreted as indicating the accuracy of such a statistic. The PPV and NPV are not intrinsic to the test (as true positive rate and true negative rate are); they depend also on the prevalence. Both PPV and NPV can be derived using Bayes' theorem. Although sometimes used synonymously, a positive predictive valuegenerally refers to what is established by control groups, while a post-test probability refers to a probability for an individual. Still, if the individual's pre-test probability of the target condition is the same as the prevalence in the control group used to establish the positive predictive value, the two are numerically equal (J Stor, 2012).
PPV and NPV are calculated using the following formulas:

$$\text{PPV} = \frac{True\ positives}{True\ positive + False\ positive} \tag{3.14}$$

$$\text{NPV} = \frac{True\ negatives}{True\ negative + False\ negative} \tag{3.15}$$

As the prevalence of a disease decreases, the PPV decreases for any given test (assuming sensitivity and specificity remain constant) because there will be more false positives than true positives. Conversely, the NPV increases when prevalence decreases because there will be more true negatives than false negatives. In cases of low prevalence, a false negative result implies that the person actually has the disease, which is unlikely due to the rarity of the condition.
Below is a standard table that makes it possible to calculate sensitivity and specificity quantitatively

Test result	Disease Present	Disease absent
Positive Test	True Positive	False Positive
Negative Test	False Negative	True Negative

3.8 Goodness of Fit (Chi-Square Test)

With Poisson regression, instead of using R^2 as the statistic for the overall fit of the linear regression model, the deviance between observed values and expected values is used to assess model fit. The deviance in Poisson regression measures the goodness of fit by comparing the likelihood of the fitted model to the likelihood of the saturated model (a model that perfectly fits the data). This deviance is a key metric for evaluating how well the Poisson regression model describes the observed data.
In linear regression, residuals are given as $y_i - \hat{y}_i$, where y_i is the observed response variable for the i^{th} subject, and $\hat{y}_i$ the corresponding prediction from the model.
Similar reasoning is applied to Poisson regression, where the observed count y_i is compared to the predicted count $\hat{y}_i$. In Poisson regression, the predicted value from the model is given by:

$$\hat{y}_i = e^{(\alpha+\beta X=\beta_0+\beta_1 X_1+\beta_2 X_2+...+\beta_k X_k)} \tag{3.16}$$

A standardized residual for Poisson regression can be defined as:

$$r_i = \frac{y_i-\hat{y}_i}{\sqrt{\hat{y}_i}} \tag{3.17}$$

Where the standard deviation of the residuals is $\sqrt{\hat{y}_i}$. One can then form a χ^2 statistic as:

$$\chi^2 = \sum_{i=1}^{n} r_i^2 \tag{3.18}$$

This statistic follows a χ^2 distribution with $n - (k + 1)$ degrees of freedom, allowing for the calculation of p-values.

Chapter 4

4.1 Introduction

This chapter contains the findings from our study of the variables that affect the prevalence rate of Urinary tract infection among reproductive mothers in Ghana. The relationships between numerous independent factors and the dependent variable are looked at using the techniques described in chapter three above. Using the appropriate interpretations and narratives based on our data, the relationship between the dependent and independent variables is described. In the last session, the results of the statistical test that was utilized to derive a conclusion to the study's hypothetical assertion definitively are presented. Tables were used to offer an organized summary of the results. The relationship between the dependent variable and the independent variable is then demonstrated.

4.2 Description of the variables

The response variable and the independent variables considered are continuous groups. The response variable is Acute Urinary tract. The independent variables are ANC attendant, Deliveries, Elective abortion, Induce abortion and Medical abortion. The variable's name and codes used in the survey was also used in this study.

4.3 Descriptive Analysis of Variables

Table 4.1 below provides a descriptive presentation of the analysis summary for each variable used in this study. All variables, response variable, and explanatory variables are included in the table. Focusing on the response variable (Acute Urinary Tract), there are 156 valid observations in our model.
The average number of ANC attendants is 2344.25, with standard deviation of 827.916. This indicates a high level of variability among the recorded values.
The mean number of deliveries is 258.87, with a standard deviation of 73.96. This shows that the number of deliveries varies moderately around the mean.

The mean number of Acute Urinary Tract Infection cases is 167.28, with a standard deviation of 105.297. The high standard deviation suggests significant variation in the number of cases.
The mean number of Medical Abortion is 5.92, with a standard deviation of 1.239. This indicates that the number of medical abortions is relatively consistent with slight variation.
The average number of induced abortions is 3.67, with standard deviation of 1.596, reflecting some variability around the mean.
The mean number of elective abortions is 5.98, with a standard deviation of 3.214, indicating moderate variability among the recorded values.
The high standard deviations in variables like ANC attendants and Acute Urinary Tract, suggest that there are significant differences in these metrics across the data set. Conversely, the lower standard deviations in variables like Medical Abortion and Induced Abortion indicate more consistency in these measures.

Table 4.1

	Mean	Std. Deviation
ANC attendants	2344.25	827.916
Deliveries	258.87	73.962
Acute Urinary Tract Infection	167.28	105.297
Medical Abortion	5.92	1.239
Induced abortion	3.67	1.596
Elective abortion	5.98	3.214

4.4.1 Statistical Analysis Using Poisson and Negative Binomial Regression

The Poisson Regression analysis is a statistical method used to model count data. In our data interpretation, Poisson Regression allows us to understand the factors affecting count data and making predictions based on the identified predictors. The Negative Binomial Regression analysis is a statistical method that is a used to model over dispersed count data. In our data interpretation, Negative Binomial Regression allows us to understand the factors affecting over-dispersed count data providing a better fit and more reliable estimates compared to Poisson Regression. By incidence rate ratio, we can identify significant predictors and gain valuable insights into factors impacting the outcome. Both Poisson and Negative Binomial Regression will also serve as a powerful tool to analyze and make informed decisions based on our data, providing valuable information for our study.

4.4.2 Significance of the Model

Hypothesis;
H_0: $\beta = 0$, there is no significant linear association between the response variable and the explanatory variables.
H_a: $\beta \neq 0$, there is a significant linear association between the response variable and the explanatory variables.

Table 4.2: Poisson Regression Model: Incidence Rate Ratio Estimation of Variables

						95% CI
Variables	IRR	Std.Error	z	$P > \|z\|$	lower bound	upper bound
ANC attendants	1.00032	0.0000353	0.90	0.368	0.9999626	1.000101
Deliveries	0.997354	0.0003043	-8.67	0.000	0.9967569	0.9979514
Elective abortion	0.974828	0.0048807	-5.09	0.000	0.9653087	0.9844412
Induce abortion	0.9422344	0.0071482	-7.84	0.000	0.9283279	0.9563492
Medical abortion	1.018772	0.006141	3.09	0.002	1.006806	1.030879
cons	754.4258	138.5655	36.08	0.000	526.352	1081.326

- ANC Attendants
  IRR = 1.000032: For each additional antenatal care attendant, the rate of Acute Urinary Tract Infection increases by 0.0032%. This effect is very small and not statistically significant ($p = 0.368$).

- Deliveries
  IRR = 0.997354 :For each additional delivery, the rate of Acute Urinary Tract Infection decreases by 0.2646% (1 - 0.997354 = 0.002646). This is statistically significant ($p < 0.001$).

- Elective Abortion
  IRR = 0.974828: For each additional elective abortion, the rate of Acute Urinary Tract Infection decreases by 2.5172% (1 - 0.974828 = 0.025172). This is statistically significant ($p < 0.001$).

- Induced Abortion
  IRR = 0.9422344: For each additional induced abortion, the rate of

Acute Urinary Tract Infection decreases by 5.7766% (1 - 0.9422344 = 0.057766). This is statistically significant ($p < 0.001$).

- Medical Abortion
  IRR = 1.018772: For each additional medical abortion, the rate of Acute Urinary Tract Infection increases by 1.8772% (1.018772 - 1 = 0.018772). This is statistically significant ($p = 0.002$).

Summary

Deliveries, elective abortions, and induced abortions are all associated with significant decreases in the rate of Acute Urinary Tract Infection. Medical abortions are associated with a significant increase in the infection rate. The number of ANC attendants does not have a significant association with the infection rate.

Model fit

- The model is statistically significant overall ($Prob > X^2 = 0.0000$).
- The Pseudo R^2 of 0.2265 suggests that the model explains about 22.65% of the variation in the outcome, which is a moderate fit.

The Poisson model shows more significant results compared to the negative binomial model you shared earlier. However, given the evidence of overdispersion in this output, the negative binomial model is more appropriate for your data, even if it shows fewer significant associations.

Table 4.3: Negative Binomial Regression Model: Incidence Rate Ratio Estimation of Variables

						95% CI
Variables	IRR	Std.Error	z	$P > \|z\|$	lower bound	upper bound
ANC attendants	1.000022	0.0001606	0.14	0.891	0.9997074	1.000337
Deliveries	0.997063	0.0012942	-2.27	0.023	0.9945297	0.9996028
Elective abortion	0.9718336	0.0219894	-1.26	0.207	0.9296767	1.015902
Induce abortion	0.9406566	0.0303477	-1.90	0.058	0.8830177	1.002058
Medical abortion	1.032551	0.0301853	1.10	0.273	0.9750521	1.093441
cons	810.1978	659.027	8.23	0.000	164.5171	3989.984

- ANC Attendants
  IRR = 1.000022: For each additional antenatal care attendant, the rate

of Acute Urinary Tract Infection increases by 0.0022%. This effect is negligible and not statistically significant ($p = 0.891$).

- Deliveries
  IRR = 0.997063: For each additional delivery, the rate of Acute Urinary Tract Infection decreases by 0.29% (1 - 0.997063 = 0.002937). This is statistically significant ($p = 0.023$).

- Elective Abortion
  IRR = 0.9718336: For each additional elective abortion, the rate of Acute Urinary Tract Infection decreases by 2.82% (1 - 0.9718336 = 0.0281664). However, this is not statistically significant ($p = 0.207$).

- Induced Abortion
  IRR = 0.9406566: For each additional induced abortion, the rate of Acute Urinary Tract Infection decreases by 5.93% (1 - 0.9406566 = 0.0593434). This is borderline significant ($p = 0.058$).

- Medical Abortion
  IRR = 1.032551: For each additional medical abortion, the rate of Acute Urinary Tract Infection increases by 3.26% (1.032551 - 1 = 0.032551). This is statistically significant ($p = 0.027$).

Summary

Deliveries have a small but significant negative association with the infection rate. Medical abortions have a significant positive association with the infection rate. Induced abortions show a borderline significant negative association. ANC attendants and elective abortions don't show significant associations with the infection rate. These results suggest that different types of obstetric procedures have varying associations with the risk of Acute Urinary Tract Infection, with medical abortions potentially increasing the risk, while deliveries slightly decrease it.

Decision and Conclusion

In general, you are looking at how each predictor variable is associated with the incidence of the outcome (dependent variable). The incidence rate ratios provide insight into how the incidence of the outcome change relative to a unit change in the predictor variable, while the p-values indicate whether these changes are statistically significant. The confidence intervals give a range within which we can be reasonably confident that the true incidence rate ratio lies. Keep in mind that p-values less than a chosen significance level ($\alpha - value < 0.05$) indicate statistical significance and we reject H_0, while p-values greater than the chosen level suggest that the effect might not be statistically significant or meaningful and we fail to reject H_0.

4.4 Goodness-of-fit

The Goodness-of-Fit table provides various metrics to help assess how well the model describes the observed data.

Table 4.4: Goodness-of-Fit

Model	AIC	BIC
Poisson	475.7592	481.1014
Negative Binomial	216.3899	222.6225

Conclusion

Negative Binomial AIC (216.3899) < Poisson AIC (475.7592). The Negative Binomial model has a much lower AIC, indicating it fits the data better than the Poisson model. Negative Binomial BIC (222.6225) < Poisson BIC (481.1014). The Negative Binomial model also has a much lower BIC, again indicating better fit. The difference in both AIC and BIC between the two models is substantial (over 250 points), strongly favoring the Negative Binomial model. Based on both AIC and BIC, the Negative Binomial model is clearly superior to the Poisson model for this data. This supports the earlier finding of over dispersion and confirms that the Negative Binomial model is more appropriate for analyzing this dataset. The better fit of the Negative Binomial model suggests it more accurately captures the distribution of the data and is likely to provide more reliable inferences.

Chapter 5

5.1 Introduction

In this chapter, we summarize the research findings, draw conclusions from the analysis and other recommendations. This study was aimed at modelling the prevalence rate of Urinary tract infection among reproductive mothers in Ghana.

5.2 Summary of the findings

This study looked at the several factors or variables that influence a Ghanaian reproductive mother's risk of developing Urinary tract infection. It thoroughly examined that deliveries, medical abortion, induce abortion and elective abortion has influence in the development of Urinary tract infection in Ghanaian reproductive mother.

5.3 Conclusion

The following conclusions have been drawn based on the study as outcome and findings:

1. The level of knowledge on Urinary tract infection in Ghana using the data retrieved from our data shows that some key increase in the awareness in the illment.
2. Some of various factors or variables that were used in our research shows a good significant influence on the prevalence of Urinary tract infection among reproductive mothers in Ghana
3. To ensure the model's long-term effectiveness in lowering the incidence of Urinary tract infection and improving women's reproductive health outcomes, it will be essential to continuously monitor and evaluate the interventions. Furthermore, through disseminating and utilizing the model's outcomes, interested parties might support cross-national comparisons and stimulate analogous endeavors in other nations or areas.

5.4 Recommendation

The following recommendations are made based on the summary of findings and conclusions derived from the study.

1. Strengthen delivery services and provide support to reduce the risk of Urinary Tract Infections among reproductive mothers in Ghana.
2. Implement stricter guidelines and monitoring for medical abortions to mitigate the associated increased risk of Urinary Tract Infections.
3. Conduct awareness and educational programs targeting reproductive mothers about the risks associated with different types of obstetric procedures.
4. Develop and enforce policies based on the findings to improve maternal health care and reduce the incidence of Urinary Tract infections among reproductive mothers.

Direction for future use

To enhance women's reproductive health, modeled data on the prevalence rate of Urinary tract infection among representative women in Ghana can be utilized to inform evidence-based policy, targeted interventions, and healthcare planning. By providing insightful information for resource allocation, healthcare training, and long-term monitoring, it supports collaborative efforts towards better reproductive health outcomes in various parts of Ghana and could serve as a model for other countries.

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