A SURVEY OF PUBLIC KNOWLEDGE AND ATTITUDE RELATED TO ANTIBIOTIC USE AND ANTIBIOTIC RESISTANCE IN SOUTHWEST ALBERTA

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Dedication

I dedicate this thesis to God Almighty, thank you for the opportunity to undertake this project. A special dedication goes to my parents who sacrificed a lot to ensure I had a good education. I will always remember your sacrifice of love.

Abstract

Antibiotics changed the world and radically transformed diseases that were once deadly into manageable health problems. The aim of this study was to evaluate the public knowledge and attitude regarding antibiotics use and antibiotic resistance in southwest Alberta. A cross-sectional face to face survey of individuals aged 18 years and older and residents of Lethbridge, Coaldale, Coal Hurst, Fort Macleod, Raymond and Taber was conducted. Of the 219 respondents, the majority agreed that antibiotics can kill bacteria (81.4%), whereas a notable proportion (43%) agreed that antibiotics can kill viruses. About 55% of the respondents indicated that antibiotic was effective for treating most sore-throat while over 30% agreed antibiotics are used for treating most common cold and cough. Marital status, education, ethnicity and antibiotics resistance education were predictors of antibiotic knowledge. Marital status, age, education, ethnicity and antibiotics resistance education were predictors of antibiotic attitude.

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Chapter One

Introduction

Infectious diseases, as defined by the World Health Organization (WHO, 2014), are caused by pathogenic microorganisms which include viruses, parasites, bacteria and, fungi. An individual can transmit these diseases to another individual. About 90% of deaths from infectious diseases are caused by six disease processes: diarrhea, tuberculosis, acute respiratory tract infection, human immune deficiency virus (HIV), measles, and malaria (Demain & Sanchez, 2009). In developed nations, a drastic reduction of avoidable deaths from infectious diseases has been achieved because of a combination of factors such as improved sanitation, nutrition, housing, availability of antimicrobials, and comprehensive immunization programs (Shears, 2001). In resource-poor and tropical countries, infectious diseases are still the major source of morbidity and death (Wax, Lewis, Salyers, & Taber, 2007). The accomplishment of the WHO's 1981 goal of "health for all by 2000" required a combination of effective antimicrobial agents, immunization, and improved public health programs. This goal experienced a major setback because of the global emergence and spread of antimicrobial resistance (AMR; Wax, Lewis, Salyers, & Taber, 2007).

AMR is the resistance of a microorganism to an antimicrobial agent that was originally effective for the treatment of its associated diseases (WHO, 2014). AMR results in the therapeutic failure of standard treatment, and longer duration of treatment, leading to an increased risk in the spread of infections. Upon the development of resistance, the microorganisms can withstand an attack by antimicrobial agents such as antibiotics, antivirals, antifungals, and antimalarials (WHO, 2014). AMR is a broad term that includes resistance to all antimicrobial agents; however, within the context of this thesis, the focus will be on resistance to antibiotics.

Antibiotics are among the most commonly used medications globally and are of enormous importance to global health; despite their importance, the sustained effectiveness of antibiotics is endangered by the development of resistance. The excessive and unnecessary use of antibiotics has been reported as the main cause of antibiotic resistance (Albrich, Monnet, & Harbarth, 2004; Goossens, Ferech, Vander Stichele, & Elseviers, 2005; Väänänen, Pietilä, & Airaksinen, 2006). Forms of inappropriate use include physicians' antibiotic over-prescription, abuse of antibiotics by patients, use of antibiotics in animals for growth promotion, and use of antibiotics in nursing homes and long-term care facilities (Mah & Memish, 2000). It has been reported that the abuse of antibiotics by the public is an important risk factor for antibiotic resistance (Melander, Jonsson, & Molstad, 2000). There have also been reports that people are ignorant of the role of antibiotics in the management of common infections (Wise et al., 1998). Thus, it is crucial to gain an understanding of the public knowledge and attitude towards antibiotics. The aim of this research study is to enhance our understanding of how the public perceives antibiotics.

This chapter will start with a discussion of background information which may be useful in appreciating the context within which this research is grounded. The statement of the research problem and the philosophical stance of the researcher will be highlighted, followed by a brief description of the overall organization of the research proposal.

Background

Antibiotics: The Panacea for Bacterial Infections

In 1664, Anton Van Leeuwenhoek, a Dutch merchant, viewed minute creatures for the first time moving under his hand-made microscope. He reported this peculiar discovery in drawings and letters of the Royal Society of London in 1676. The existence of living organisms' invisible to the ordinary eye was opened to the world by his discovery. These microorganisms constitute an exotic previously unseen world that shares the environment in which we live (Levy, 2002).

In 1864, Louis Pasteur reported in the French Academy of Science journal that bacteria were not spontaneously produced but instead existed in the air and settled on an unprotected living tissue. His careful experiments and findings altered the view of diseases caused by bacteria and set the understanding of bacterial infections on a new path (Levy, 2002).

Bacteria are classified into two categories based on their ability to cause diseases: pathogenic and non-pathogenic bacteria. Pathogenic bacteria are harmful to animals, plants, and humans while non-pathogenic bacteria are relatively harmless. Some bacteria may be harmful to humans but not to plants or animals or vice versa. An example of a pathogen only in humans is Salmonella typhi; Salmonella typhi is the causal bacteria of typhoid fever in humans. A bacterial infection needs tens of thousands to millions of bacteria to develop into a disease state, and bacterial infections develop when bacteria multiply before they are destroyed and removed by the body's defense system (Levy, 2002). Bacteria can also synthesize toxic substances that are toxic to human tissues that enhance unfavorable interactions between the bacteria and the human body's defense system. An example of

such substances is toxins produced by bacteria that cause uncomfortable and sometimes severe diarrhea that happens when traveling to certain parts of the world.

Infections caused by bacteria led to an era in the 1800s where physicians and scientists searched for drugs that would kill the bacteria. The outcome of this search resulted in the discovery of antibiotics that are used in the management of bacterial infections (Levy, 2002).

Understanding the role of antibiotics in the management of bacterial infections will include the definition, the origin of discovery, and the classification of antibiotics.

Definition of antibiotics

Antibiotics are drugs of natural or synthetic source that can eradicate or inhibit the growth of bacteria. Chemotherapeutic agents used in the management of bacterial infections are antibiotics that are sufficiently non-injurious to the host (Serrano, 2005).

Origin and discovery of antibiotics

The discussion on the origin and discovery of antibiotics intends to examine the discovery of the first groups of antibiotics introduced to tackle bacterial infections. They include the sulphonamide, penicillin, streptomycin, and cephalosporin antibiotics.

Discovery of sulphonamide. The first sulfa drug, arsphenamine was initially identified by Sahachiro Hata (1873-1938), in the fall of 1909. He discovered this drug while working in the Paul Ehrlich's laboratory on several arsenic compounds. The introduction of arsphenamine in 1910 led to its use in the management of syphilis and trypanosomiasis. This organoarsenic compound, later called salvarsan, was the most used antimicrobial drug until the 1940s (Schwartz, 2004). The mechanism of action of this drug remained unclear which led other scientists into further investigation. Another scientist, Gerhard Domagk (1895-1964), was able to prove the antibiotic property of sulphonamides in a murine model

of Streptococcus pyrogens infection. This work led to the introduction of the first sulfa antibiotic in 1932 (Zaffiri, Gardner & Toledo-Pereyra, 2012). Other scientists, Forneau (1872-1949) and Trefouel (1897-1977), in 1935 demonstrated that a prodrug (prontosil) was metabolized to a sulfanilamide resulting in the use of sulfonamides even to this day (Laub, 1986). A prodrug is a biologically inactive compound that can be metabolized in the body to produce a drug.

Discovery of penicillin. Alexander Fleming (1881-1955) revolutionized the concept of treating bacterial infection. While working on the antibacterial properties of lysozymes, which he discovered earlier by adding his nasal mucus to a culture plate (Fleming, 1922), Fleming noticed the inhibition of the growth of common bacteria, including penicillium notatum, by the presence of a contaminating blue mold on an exposed old culture plate of Staphylococcus aureus. Fleming described in details the characteristics of the mold discovered and even evaluated the antimicrobial activity of other molds (Fleming, 1929). However, he was unable to demonstrate the therapeutic value of penicillin. Following a series of experiments using Fleming's articles on the antibacterial properties of molds, Howard Florey (1898 – 1968) and Ernst Chain (1906 – 1976) demonstrated the antibacterial properties of penicillin in 1930. They published their first paper on the antibacterial value of penicillin in the treatment of experimentally infected animals in August 1940 (Chain et al., 1940). The first patient affected by streptococcal septicemia was successfully treated in March 1942. Florey himself successfully tested the efficacy of penicillin on wounded soldiers in North Africa during the World War II (Florey, Adelaide, & Florey, 1943; Grossman, 2008). By the end of 1943, mass production of penicillin began in the US, UK, and Australia. The experiments conducted by Fleming and his colleagues opened the way for the antibiotic era.

Discovery of streptomycin. Throughout the 19th century, tuberculosis with all its clinical manifestations represented the most common cause of death in young adults. Unsuccessful attempts to discover an antibiotic for tuberculosis by Koch (1843-1910) in 1892 (Kaplan & Koch, 1965; Waddington, 2004), and Finsen (1860-1904) at the beginning of the 19th century, dimmed the hope for the treatment of Mycobacterium tuberculosis (Strandberg, 1924). Following the discovery of penicillin, a drug company, Merck, obtained the research of a soil microbiologist, Selman Waksman (1888-1973), Waksman essentially introduced the concept of antibacterial activities, describing it as the effect of small molecules made by bacteria that antagonize the growth of other bacteria. Between 1940 and 1952, Waksman isolated and reported on more than ten different chemical substances with antibacterial properties. One of these chemical substances, isolated in 1943, became the most famous and influential antibiotic called "streptomycin" (Comroe Jr, 1978). Streptomycin was the first drug used for a randomized control trial for the treatment of pulmonary tuberculosis, conducted by the Medical Research Council in the United Kingdom in 1946 (Pfuetze, Pyle, Hinshaw, & Feldman, 1955).

Discovery of cephalosporin. Chronologically, cephalosporins are the second class of the beta-lactam antibiotic to be discovered and developed following penicillin. Following an unsuccessful attempt by Guiseppe Brotzu (1895-1955) in July 1946, Edward Abraham (1913-1999), and Guy Newton (1919-1969) were able to isolate cephalosporin P in July 1949. Cephalosporin P was active against gram-positive bacteria (Burton & Abraham, 1951). A second compound, cephalosporin N, was isolated shortly after the discovery of cephalosporin P, which was effective against gram-negative bacteria. Cephalosporin N was renamed "penicillin N" as it was discovered to be penicillin with the D alpha aminoadipoyl side chain (Abraham, Newton, & Hale, 1954). Investigation of

penicillin N led to the discovery of a third compound, Cephalosporin C, with antibacterial properties, in 1961 (Hamilton-Miller, 2000). The first cephalosporin, cephalothin administered for clinical use was developed by Eli Lilly and company, in 1964, and was available in injectable forms. Cephalexin, the first oral cephalosporin, was produced shortly after the production of cephalothin (Wick, 1967). The introduction of cephalothin and cephalexin resulted in the discovery of many semisynthetic derivatives with increased antibacterial spectrum and potency.

The discovery of the pioneer antibacterial agents discussed above resulted in the development of the antibiotics in use today.

Classification of antibiotics

The discovery, as well as the development of antibiotics, that are safe and effective has helped the hosts of bacterial infections to attack the specific bacteria causing infections. This discovery has also resulted in the elimination of the bacterial infections being treated. The discovery of the pioneer antibiotics resulted in the simplification of antibiotic manufacturing processes as well as the development of newer formulations (Alanis, 2005). Currently, there are different methods for classifying antibiotics, for this thesis the classification of antibiotics will be based on their mechanism of action as shown in Table 1.1.

Table 1.1. Classification of Antibiotics

Mechanism of action	**Antibiotic class**	**Examples**
Inhibition of cell wall synthesis	Penicillins	Penicillin G, methicillin, ampicillin
	Cephalosporins	Cephalexin, cefacor, ceftriaxone
	Cabapenems	Imipenem, meropenem, ertapenem
	Monobactams	Aztreonam
	Cyclic Lipopeptides	Daptomycin
	Glycopeptides	Vancomycin, teicoplanin
Inhibition of protein synthesis	Aminoglycosides	Gentamicin, tobramycin, amikacin
	Tetracyclines	Minocycline, doxycycline
	Macrolides	Azithromycin, erythromycin, clarithromycin
	Lincosamides	Clindamycin
	Phenicols	Chloramphenicol
Inhibition of DNA synthesis	Quinolones	Ciprofloxacin, levofloxacin, norfloxacin, moxifloxacin
Inhibition of RNA synthesis	Rifamycins	Rifampicin
Folic acid synthesis inhibitor	Sulfonamides	Sulfasalazine, sulfamethoxazole
	Pyrimidines	Trimetoprim
Membrane disorganizing agent	Polymyxins	Polymyxin-B
	Cationic peptides	Colistin.
Mycolic acid synthesis inhibitor	Isoniazid	Isoniazid
Other mechanisms	Metronidazole	Metronidazole, secnidazole, tinidazole

Note. Mechanism of action = how the antibiotics work in the bacteria; Examples = the generic names of the antibiotics in the antibiotic class; DNA = deoxyribonucleic acid; RNA = ribonucleic acid. Adapted from "Resistance to antibiotics: are we in the post-antibiotic era?" by A. J. Alanis, 2005, Archives of Medical Research, 36(6), 697-705; "Update on the Antibacterial Crisis" by A. C. Croft, A. V. D'Antoni and S. L. Terzulli, 2007, Medical Science Monitor, 136(8), RA 103-RA 118; "Origins and evolution of antibiotic resistance"

by D. Davies and J. Davies, 2010, Microbiology and Molecular Biology Reviews, 74(3), 417- 433.

The discovery and development of these antibiotics (Table 1) radically changed the treatment of bacterial infectious diseases, transforming diseases that were once deadly into manageable health problems. However, the development of antibiotic resistance, as well as a reduction in the research and development of newer antibiotics, threatens a return to the era before the discovery of antibiotics (Cars et al., 2008).

Antibiotic Resistance

The ability of bacteria to resist the bacteriostatic or bactericidal effect of an antibiotic is referred to as antibiotic resistance (Lashley & Durham, 2007). The development of resistant bacteria as well as ineffective therapy, resource wastage, increased cost of therapy, increased risk of adverse drug reaction, and more importantly, the rising economic burden on national and global health systems are all consequences of excessive use of antibiotics (Edwin & Dy, 1997; Shehadeh et al., 2012). Antibiotic resistance is a global problem as reported by the U.S. Centres for Disease Control and Prevention reports (CDC, 2013).

Each year in the United States, at least 2,000,000 people acquire serious bacterial infections that are resistant to one or more of the antibiotics designed to treat them. At least 23,000 people die each year as a direct result of these antibiotic-resistant infections (CDC, 2013). Although in Canada the rates of antibiotic resistance are lower than most parts of the world, approximately 220,000 to 250,000 people are infected with nosocomial infections every year, and of these people, 8,000 – 12,000 people die from being infected with resistant strains (Canadian Antimicrobial Resistance Alliance, 2013). In Africa, there have been reports of resistance to first-line antibiotics such as penicillin, co-trimoxazole,

ampicillin, and erythromycin used in the management of bacterial infections. In a study conducted by Kariuki, Muyodi, Mirza, Mwatu, and Daniels (2004) in Kenya, 43% of the streptococcus pneumonia isolate was resistant to penicillin, while 94% of the isolates were resistant to co-trimoxazole. In another study conducted by Asrat (2008) in Ethiopia, 100% of the Shigella isolate was resistant to erythromycin, while greater than 75% of the isolates were resistant to chloramphenicol, ampicillin, and tetracycline. Antibiotic resistance threatens the effective management and prevention of bacterial infections and the use of antibiotics have been reported to be responsible for antibiotic resistance (WHO, 2014).

Relationship between antibiotic use and antibiotic resistance. Establishing a causal relationship between the amount of antibiotics used and the development of antibiotic resistance is not easy to analyze (Barbosa & Levy, 2000). However, there are underlying assumptions that explain the association between antibiotic use and antibiotic resistance. Levy's (1994) 'threshold' hypothesis suggests that antibiotic resistance could be reduced if the entire antibiotic usage in an environment remains below a level. This proposal has its basis in the natural competition that occurs among bacteria that enables bacteria to regress back to being susceptible to an antibiotic in the absence of the antibiotic treatment. The control of antibiotic use increases the rate at which the bacteria return to this susceptible state (Levy, 1994). A measure of the ability of bacteria to regress back to being susceptible to an antibiotic in the absence of the antibiotic treatment is referred to as the fitness cost of bacteria (Laxminarayan & Brown, 2001).

Aside from the threshold hypothesis, the mathematical models of Austin, Kristinsson, and Anderson (1999), and Levin et al. (1997) explain the relationship between antibiotic use and antibiotic resistance. Both models use the population genetics theory of natural selection which defines the fitness of an organism as the probability of survival and

reproduction in an environment. The models examined the association between the quantity of antibiotic used in the community, and the rate at which the bacteria develop resistance. The models described how the frequency of antibiotic-resistant cells in a bacterial population is directly related to the rate of antibiotic treatment in the host. Hence, the drop in the use of antibiotics would result in a reduction in the frequency of resistant bacteria. The models suggest that the frequency of antibiotic-resistant bacteria, the trends, and the rates of alterations in these frequencies, are all closely tied to the extent of antibiotic use (Austin, Kristinsson, & Anderson, 1999; Levin et al., 1997).

Findings from epidemiological studies (Arason et al., 1996; Albrich, Monnet, & Harbarth, 2004; Oduyebo, Onwuezobe, Olayemi, & Akintunde, 2008) have demonstrated a positive correlation between antibiotic use and antibiotic resistance. These researchers concluded that an increase in antibiotic use through misuse and overuse increased the prevalence of antibiotic resistance. They suggested the control of antibiotic use as a measure to address the problem of antibiotic resistance, which further supports the assumptions from the threshold hypothesis and mathematical models discussed above.

Factors influencing antibiotic resistance. Various factors are highlighted as being responsible for antibiotic resistance. These factors can be classified into two categories: the bacterial factor and the human factor. The bacterial factor involves the ability of bacteria to change its genetic make-up. Following this change, the bacteria develop resistance to the antibiotics by producing biological activity that results in the antibiotics losing its antibacterial property (Alanis, 2005). The bacterial factor is a natural process for the bacteria and cannot be prevented.

The human factor involves the misuse of antibiotics. This misuse of antibiotics results in selective antibiotic pressure which is the process whereby antibiotics kill

susceptible bacteria, allowing antibiotic-resistant bacteria to survive and multiply. This is regarded as the most important factor stimulating the development of antibiotic resistance (Mah & Memish, 2000). A form of antibiotic misuse is inappropriate antibiotic prescriptions by physicians in which antibiotics are prescribed based on experience without conducting a pathogen test to identify if the pathogen involved is bacterial, viral, or fungi. Also, these antibiotics are prescribed without carrying out an antibiotic sensitivity test to determine which antibiotic is appropriate in the particular situation (Micheal, Dominey-Howes, & Labbate, 2014). Another form of antibiotic misuse involves the general public. Substantial global evidence has shown that the general community plays a role in the increase and spread of antibiotic resistance (Davey, Pagliari, & Hayes, 2002; Hawkings, Butler, & Wood, 2008; McNulty, Boyle, Nichols, Clappison, & Davey, 2007a, 2007b; You et al., 2008). The WHO identified three key issues for public involvement: improving access to medical facilities, decreasing unnecessary use of antimicrobials, taking a full course of treatment, and not giving out medication to other people or keeping left-over medication for future needs. The WHO also urged member countries to initiate educational interventions for patients and the general population aimed at rationalizing the use of antibiotics to combat resistance (WHO, 2001). Thus, improving public knowledge and changing the publics' attitudes towards antibiotic use will be a crucial early strategy to maintain antibiotic effectiveness. The third form of antibiotic misuse is the frequent use of antibiotics in animals; the feeding of antibiotics to animals is associated with the elimination of infectious microorganisms in the intestines of the animals. The removal of infectious microorganisms from the guts of the animals helps to increase the intestinal absorption of nutrients, resulting in a reduction in the nutrient cost of maintenance because a larger portion of consumed nutrient enhances the growth of the animals (Serrano, 2005).

These forms of antibiotic misuse need to be addressed because of the positive relationship that exists between antibiotic use and antibiotic resistance (Austin, Kristinsson, & Anderson, 1999; Levin et al., 1997).

Problem Statement

Most antibiotics used by humans in Canada are available by prescription only. In 2014, 23 million antibiotic prescriptions were dispensed with 93% dispensed by community pharmacies. Overall, expenditure on antimicrobials in Canada was reported as $786 million with community dispensing accounting for 87% and hospital purchases accounting for 13% of this amount. Antibiotics were most often recommended for treating respiratory infections of which 82% were for acute sinusitis, 77% for acute bronchitis, and 74% for pneumonia (Canadian Antimicrobial Resistance Surveillance System Report, 2016). Several studies have shown that a patient's expectation of antibiotic therapy or the perceived expectation by the doctor is one of the determining factors for irrational antibiotic prescriptions (Cockburn & Pit 1997; Mangione-Smith, McGlynn, Elliot, Krogstad, & Brook 1999; Stivers, Mangione-Smith, Elliot, Mc-Donald, & Heritage, 2003). Apart from a patient's obvious request for antibiotics, physicians have reportedly been shown to form their perception of an individual's expectation for antibiotics from certain communication behaviors. These behaviors include presenting a health problem to the physician by uttering a possible diagnosis rather than stating the symptoms, resisting a diagnosis which can involve questioning the physicians' physical examination findings or questioning the actual diagnosis, and posing resistance to physicians' non-antibiotic recommendations. Physicians appear to recommend antibiotics for members of the public who use these communication practices as indicating an expectation and a desire for antibiotic treatment. However, these individuals may not always be intending to communicate pressure or

expectation for antibiotics and inappropriately recommending antibiotics in these scenarios may result in antibiotic resistance (Stivers et al., 2003).

A major strategy recommended for controlling antibiotic resistance is the education of the public about the role of antibiotics and its appropriate use (Finch, Metlay, Davey, & Baker 2004; Ranji, Steinman, Shojania, & Gonzales 2001). The government of Canada has developed educational tools to educate the public on appropriate antibiotic uses as well as ways to minimize the exposure to bacterial infections. This information can be found on the Health Canada website, information regarding antibiotic use can also be assessed on the Canadian Institute for Health Information (CIHI) website. Other programs such as programs as *Do bugs need drugs?* (DBND) *and Choosing Wisely* are involved with educational campaigns for the public and healthcare professionals.

DBND is a community education program about handwashing and responsible use of antibiotics. They provide educational materials to healthcare professionals and the public that explain why antibiotic resistance is an issue and steps to prevent antibiotic resistance from developing. Handwashing education is a key component of DBND's educational campaign which is very important because this prevents infections and the need for treatment.

Choosing Wisely Canada is a national campaign that helps clinicians and patients engage in conversations about unnecessary tests and treatments, and make smart and effective care choices. *Choosing Wisely Canada* inspires and engages healthcare professionals to take leadership in reducing unnecessary tests, treatments and procedures, and enables them with simple tools and resources that make it easier to choose wisely. A component of this campaign is the *Antibiotic Wisely* that focuses on providing education and recommendations on using antibiotics more wisely.

One of the rationales for educating the public about antibiotic resistance is to help influence the public demand for antibiotic prescriptions as well as minimize antibiotic misuse (Eng et al., 2003). However, there is a wide variation in people's understanding of antibiotic use (Deschepper et al., 2008), hence the need to tailor educational interventions to address these variations as well as their learning needs. Unfortunately, there is a limitation in knowledge or studies assessing the educational needs of the public in Canada about antibiotic use. To my knowledge, there are no population-based studies that have investigated the public's knowledge and attitude about antibiotic use. Studies conducted internationally (Awad & Aboud 2015; Belkina et al., 2014; Cals et al., 2007; Eng et al., 2003; Godycki-Cwirko et al., 2014; Gonzales 2012; Igbeneghu 2007; Nambatya et al., 2011; Shehadeh et al., 2012) are restricted in their ability to be applied to the Canadian context, because they are conducted in a different socio-cultural, political and healthcare setting. There is a great need for research that investigates the public attitude and knowledge of antibiotics in Canada.

Purpose of the Study

The purpose of this study was three-fold: (1) to understand the public knowledge of antibiotics and antibiotic resistance; (2) to understand the attitudes that the public has towards antibiotic use: (3) to explore the predictors of adequate antibiotic knowledge and good antibiotic attitude among the public. The following research questions were used to guide the study:

1) What is the knowledge of antibiotic treatment and antibiotic resistance among the public in southwest Alberta?
2) What attitudes does the public have towards antibiotic use?

3) What are the predictors of adequate antibiotic knowledge and good antibiotic attitude among the public in southwest Alberta?

Philosophical Paradigm

As a researcher, I am influenced by my cultural, historical and societal backgrounds which form my worldview. These make it difficult to reach a definite conclusion on my view of the nature of reality and truth. However, I have been exposed to various philosophical paradigms which afford the opportunity to choose the paradigm that fits the purpose of the study.

My perspective for investigating this study aligns with the positivist paradigm, which is based upon the assumption that the social world and reality is objective and measurable using properties which are independent of the researcher and instrument (Antwi & Hamza, 2015). The positivist paradigm enables the adoption of scientific methods as well as, the organization of the knowledge generation process using quantitative approaches that enhance precision in the description of variables and the relationship among them (Antwi & Hamza, 2015). Positivism is concerned with the discovery of truth, and these truths are presented using empirical means (Antwi & Hamza, 2015). This perspective will be of value for generating information on antibiotic knowledge and the attitude that the public has toward antibiotic use.

Thesis Organization

This thesis is presented in five chapters. Chapter 1 includes the background of the study, statement of the problem, the purpose of the study, research questions, and the philosophical stance of the researcher.

Chapter 2 presents a review of the literature, providing a description of available research on public attitude and knowledge of antibiotics, as well as the conceptual framework for this study.

Chapter 3 presents a description of the quantitative research design that was used in the study. This section covers the setting, sample size, data collection techniques, data analysis strategies, validity and specific ethical considerations of the study.

Chapter 4 presents the results obtained in this study.

Chapter 5 discusses the significant findings of the study, as well as limitations, conclusions, implications for practice, and recommendations for future research.

Summary

This chapter has highlighted the background information of this research study, including the definition and discovery of antibiotics as well as, the effect of antibiotic resistance on the continued efficacy of antibiotics. To provide a foundation for the study, this chapter also described the statement of the problem, the purpose of the study, research questions, and the philosophical viewpoint of the researcher.

Chapter Two

Literature Review

This chapter provides a review of the available literature regarding how antibiotics are sourced by the public as well as, the public's knowledge and the attitude towards antibiotic use. It is important to mention that the literature search on the public's antibiotic knowledge and attitude (search terms: public antibiotic knowledge, public antibiotic attitude, public antibiotic perception, public antibiotic behaviour, antibiotic use, antibiotic knowledge, antibiotic attitude, antibiotic perception) in various databases (google scholar, ProQuest, PubMed, MEDLINE, JSTOR) revealed the unavailability of Canadian studies. Hence, the review will focus on studies conducted in other regions of the world and only studies conducted in America will be reviewed for the North American area. The chapter concludes with an examination of the conceptual framework that inspired this study.

Sources of Antibiotics

In some parts of the world, antibiotics are available as an over the counter medication and are being sold like other commodities. They are also being sold on the street in some countries. Non-prescription use of antibiotics is associated with little or no guidance on the appropriate use as well as the required safety practices to minimize adverse drug effect (De Guzman, Khaleghi, Riffenberg, & Clark, 2007; Llor & Cots, 2009; Wachter, Joshi, & Rimal, 1999). Non-prescription use of antibiotics has been speculated to play an essential role in driving antibiotic misuse among the public in these countries (Hawkey, 2008; Kumarasamy et al., 2010; Rossolini, D'andrea, & Mugnaioli, 2008). The availability of antibiotics without a prescription also provides the worst scenario for the emergence of antibiotic resistance.

In developed nations like Canada, Europe and the United States of America a prescription is required to obtain an antibiotic. There are patient characteristics such as patient expectation and physician characteristics that predict inappropriate antibiotic prescribing. Although there are very few studies that have investigated physician characteristic associated with antibiotic prescribing, four hypotheses have emerged to explain the differences in antibiotic prescribing among physicians. The first hypothesis is that there is a lack of physician knowledge on when antibiotics should be prescribed (Ben-David et al., 1999; Gill & Roalfe, 2001). The second hypothesis is that a physician's time in practice is responsible for the differences in antibiotic prescribing (Steffensen, Schonheyder, & Sorensen, 1997). Increased antibiotic prescribing over time may be due to physicians succumbing to patients demand for antibiotics (Butler, Rollnick, Maggs-Rapport, & Stott, 1998). The third hypothesis suggests that physician training environment, possibly through professional tradition, cultural expectations or pharmaceutical detailing is responsible for differences in antibiotic prescribing. The fourth hypothesis is that inappropriate antibiotic prescribing is the result of the avoidance of time-consuming patient education (Butler, Rollnick, Maggs-Rapport, & Stott, 1998). Physicians with higher practice volumes are more likely to prescribe antibiotics inappropriately. The inappropriate prescriptions of antibiotics by physicians contribute to antibiotic misuse among the public which promotes antibiotic resistance (Perz et al., 2002; Kotwani et al., 2010). Hence there is a need for increased understanding of the factors that influence this.

Public Knowledge and Attitude Regarding Antibiotic Use

Studies assessing antibiotic knowledge and attitudes provide a tool for identifying problems as well as possible solutions associated with antibiotic use. A knowledge and attitude study expose what the respondents know about a topic area as well as how they

feel about the topic. Within the context of this study, antibiotic knowledge is defined as what is known about antibiotics while antibiotic attitude is defined as how antibiotics are perceived. Understanding the level of antibiotic knowledge and attitude among the public will enable a more efficient public health education on antibiotic use because it will facilitate the generation of data useful for developing programs that are tailored to the needs of the public.

There is a considerable body of evidence that has shown widespread problems in the knowledge and attitude of the public which regarding their antibiotic usage (Emslie & Bond, 2003; Eng et al., 2003; Hawkings et al., 2008; McNulty et al., 2007a, 2007b; Parimi, Pereira, & Prabhakar, 2012; You et al., 2008). The lack of adequate antibiotic knowledge and good antibiotic attitude among the public can result in inappropriate antibiotic use and ultimately antibiotic resistance (Chan et al., 2012).

Public antibiotic knowledge and attitude in Africa

To assess the knowledge and attitude of consumers regarding antibiotic use Auta, Banwat, and Francis (2011) conducted a cross-sectional survey in Jos, Nigeria. Reports from this study showed that respondents demonstrated a positive attitude regarding checking expiry dates of antibiotics. About 93% of the sample stated that they checked the expiry dates of antibiotics before using them. On the other hand, one in three respondents had low antibiotic knowledge. Seventy percent of the respondents demonstrated low knowledge in the use of antibiotics for the treatment of viral infections. About 61% of the sample stated they take antibiotics for a cold and since most common colds are caused by a virus which does not respond to antibiotics treatment, this can result in the development of resistance to strains of pathogens (Filipetto, Modi, Weiss, & Ciervo, 2008). Sixty-six percent of the respondents also expected to be prescribed an antibiotic by their doctor when

they had a cold. Participants of this study also lacked knowledge differentiating other commonly used over the counter medications from antibiotics. Antibiotic sharing behavior was found to be very common among the respondents, about 48% of the participants stated that they gave antibiotics to their family members when they felt that their family members had similar illnesses to theirs. Auta et al. (2011) concluded that most of the respondents had inadequate antibiotic knowledge and negative attitude towards antibiotic use. Although a lack of knowledge and poor attitude regarding antibiotic use was reported among the respondents, these findings may not be an exact representation of the public in this community. This is because the survey was conducted among the literate members of the community. Also, only respondents who obtained antibiotics from community pharmacies were recruited for the study. This study excluded the perspectives of the non-literate members of the community and those who acquire antibiotics from other sources such as patent medicine vendor (PMV). PMVs are informal community-based providers of healthcare in Nigeria, who are permitted to sell certain over-the-counter medications for the treatment of common ailments. Although antibiotics are prescription only medication in Nigeria, deficiencies in enforcing prescription medicine regulations have resulted in PMVs becoming a familiar source of antibiotics in Nigeria (Auta, Omale, Folorunsho, David, & Banwat, 2012).

Igbeneghu (2007) reported that among Nigerian university students where knowledge and practices towards antibiotic use were evaluated, there was a high rate of irrational antibiotic use among the respondents. Irrational antibiotic use included the use of antibiotics for the wrong indication, the incomplete course of treatment and self-medication. For example, more than a fifth of the participants used antibiotics indiscriminately in the treatment of diarrhea: The treatment of diarrhea in most cases does

not need antibiotic therapy as most acute diarrhea is self-limiting. This form of irrational use indicates that the respondents did not know the difference between bacterial and viral infections and hence used antibiotics for both kinds of infections. One-third of the sample stopped taking their antibiotics when they felt better or when the symptoms of their infections appeared to have stopped. Most of the respondents (79%) engaged in self-medication by keeping left-over antibiotics and keeping the antibiotics with the intention of using them for new infections. This study concluded that there was a high rate of antibiotic consumption among the undergraduates, and most of the antibiotics were sourced without a physician's prescription. Incorporating compulsory courses on the proper use of antibiotics into university course curriculums was recommended as a way of improving antibiotic knowledge and attitude. Igbeneghu (2007) excluded respondents from the faculty of pharmacy, health sciences, and microbiology. This exclusion assumed that students from these departments had adequate knowledge and attitude which may not be true.

In another study, Nambatya et al. (2011) evaluated antibiotic use, knowledge, and behavior among two groups of university students (group A: students studying health sciences courses and group B: students studying non-health sciences courses). They reported that there was no statistically significant difference between the two groups' knowledge of the role of antibiotics in the treatment of colds. Sixty-five percent of the respondents started antibiotics without a prescription when they felt ill, and there was a statistically significant difference between the groups (85% in group A and 63% in group B). This significant difference was reported to be due to the participants in the college of health sciences having confidence when it comes to knowledge on potentially effective antibiotics for illnesses as well as easier drug access. Also, 17% of the participants believed that when they were ill, starting antibiotics available at home was the best thing to do.

Although both groups strongly agreed that antibiotic courses should be completed, they did not act on this antibiotic knowledge during their last antibiotic use, and the reason for this was not provided in the study.

In Namibia, a cross-sectional survey was conducted to evaluate the public knowledge, attitudes, and behavior toward antibiotic usage. Pereko, Lubbe, and Essack (2015) reported that 72% of the respondents correctly agreed with the statement "unnecessary use of antibiotics makes them ineffective." In this study, younger respondents (< 30 years old) showed the least knowledge of the relationship between antibiotic overuse and the development of resistance. Forty-one percent incorrectly agreed that when they have a cold, they should take an antibiotic to get better quicker. Also, 47% believed that they should take an antibiotic for a cold to prevent it from getting worse and 44% stated that when they were sick enough to visit a doctor, they expected an antibiotic would be prescribed. Reported correlations from this study showed a positive correlation between agreeing to the statement "antibiotics kill viruses" and agreeing to the statement "I take antibiotics when I have a cold to recover fast." There was also a positive correlation between agreeing to the statement "I take antibiotics when I have a cold to prevent it from getting worse" and agreeing to the statement "I expect an antibiotic prescription from a doctor when severely sick with a cold." There was an association between age, level of education and agreement with these statements. Younger respondents (18-24 years) and those with a lower level of education (less than grade 11) agreed with these statements. This test of correlation may not go far enough to explain the role of age and education. Conducting a regression analysis may have been able to explain how age and education predict agreement with the statements.

Public antibiotic knowledge and attitude in Asia

In a study conducted among the public in Malaysia to evaluate knowledge, attitude, and practices about antibiotic use, approximately 50% of the study's participants incorrectly agreed that antibiotics might be used to treat common colds and fevers (Islahudin, Tamezi, & Shah, 2014). This report is similar to findings from other studies (Awad & Aboud 2015; Kim, Moon, & Kim 2011; Moienzadeh, Massoud, & Black 2015; Oh et al., 2010; Shehadeh et al., 2012; Widayati, Suryawati, DeCrespigny, & Hiller 2012). Public attitudes toward antibiotics play an important role in treatment outcomes for bacterial infections (Oh et al., 2010). Findings from this study showed that many of the respondents were uncertain about what attitudes were associated with antibiotic resistance, as 70% of those who used antibiotics more than once during the previous year of the study failed to complete the course of the antibiotics. Similar findings were reported from Jordan, South Korea, Qatar, Yemen, Saudi Arabia, and Uzbekistan (Belkina et al., 2014; Kim et al., 2011 Moienzadeh et al., 2015; Shehadeh et al., 2012). Failing to complete the recommended course of an antibiotic regimen can result in the insufficient eradication of infections, which increases the risk of antibiotic resistance (McNulty et al., 2007a). Islahudin et al. (2014) conclusion are somewhat misleading: Although they concluded that the frequency of antibiotic use was related to the knowledge about antibiotics, the results from the study stated otherwise. The results show that there was no significant association between the frequency of antibiotic use and antibiotic knowledge. A binary logistic regression may have been helpful in explaining the relationship.

In a cross-sectional study conducted among teachers in Yemen, Saudi Arabia, and Uzbekistan, Belkina et al. (2014) reported that knowledge about allergies and adverse effects associated with antibiotic use was the highest when compared with other statements

of knowledge; about 57% of the respondents expected adverse reactions. The prevalence rate for taking antibiotics without a prescription was highest in Yemen and Uzbekistan and lower in Saudi Arabia. Almost 46% of respondents reported that they store antibiotics at home regardless of how they obtained the antibiotics. This is similar to findings from Qatar and Kuwait (Moienzadeh et al., 2015; Awad & Aboud 2015). A significant relationship was found between storage of antibiotics at home, country, and age. Being younger and less educated in Saudi Arabia and Yemen was associated with storing antibiotics at home. In contrast, older participants in Uzbekistan reported appropriate responses to storage of antibiotics at home. Antibiotic knowledge was found to increase with age in all the three countries, however, more educated respondents were less knowledgeable about bacteria resistance in Yemen. Belkina et al. (2014) concluded that there was a high prevalence of self-medication and inappropriate use of antibiotics among the well-educated populations of Yemen, Saudi Arabia, and Uzbekistan. However, this study was conducted among teachers, and although they are an educated group, their views cannot be generalized for the well-educated population in these countries.

In Qatar, Moienzadeh, Massoud, and Black (2015), conducted a study to evaluate the general public's knowledge, views, and practices relating to appropriate antibiotic use. Eighty-one percent of the participants correctly answered that most colds, coughs and flu illnesses were caused by viruses. About 40% of the study's population believed that not receiving an antibiotic for colds, coughs and flu symptoms lengthened the duration of the illness. A positive association was found between having a higher level of education, higher income, having children and having adequate antibiotic knowledge scores. Also, many of the respondents (about 61%) stated that if their physician did not prescribe an antibiotic for their infection, they would consult another physician for an antibiotic prescription. Thirty-

seven percent of the respondents stated they would consider giving their antibiotics to a family member if they developed an infection. Moienzadeh et al. (2015) concluded that the population in Qatar had several misconceptions particularly relating to the use of antibiotics for treatment of viral infections. In Qatar, individuals from low-income groups (< 5000 QR) primarily fill prescriptions from government-funded primary care clinics, where costs of medications were lower and this study was conducted in two pharmacies in the city that seldom provide services to this group. Hence the antibiotic knowledge and attitude of individuals with low income were not fully represented.

Awad and Aboud (2015) in Kuwait also conducted a cross-sectional study to evaluate knowledge, attitudes, and practices towards antibiotic use among the public. The majority of the respondents correctly agreed on two statements related to antibiotic safety and one statement about the use of antibiotics. Eighty-three percent of the respondents correctly agreed that if side effects developed during a course of antibiotic treatment, the antibiotics should be stopped as soon as possible. Seventy-eight percent of the participants correctly agreed that if a skin reaction developed during antibiotic use, the same antibiotic should not be used again, and 74% correctly agreed that different antibiotics are needed to treat different types of bacterial infections. About 77% of the respondents expressed positive attitudes towards obtaining antibiotics from relatives or friends without medical consultation, which is higher than findings (31%) reported by Belkina et al. (2014). There was confusion about antibiotics being effective against bacteria or viruses given that 34% of the participants did not agree that antibiotics were effective against bacteria. About 41% of the respondents incorrectly disagreed that antibiotics can cause an imbalance in the body's bacterial flora. Fifty-one percent of the participants incorrectly disagreed that the unnecessary use of antibiotics can increase the resistance of the bacteria to them, and 56%

incorrectly agreed that humans could become resistant to antibiotics. This study concluded that there were some knowledge and attitude gaps among the respondents. Policies that involve auditing antibiotic prescriptions in healthcare facilities, and investigating the consultation behavior and other behavioral components engaged in patients' expectations for antibiotics were recommended.

In South Korea, Kim, Moon, and Kim (2011) evaluated the public knowledge and attitudes regarding antibiotic use. The results from this study showed that the majority of the respondents (about 77%) had correct knowledge regarding the cause of common colds and coughs. About 57% of the participants understood that antibiotics could kill bacteria that normally live on the skin and in the gut which is similar to findings from Awad and Aboud (2015). Two-third of the respondents were unaware of the spread of antibiotic-resistant bacteria. Kim et al. (2011) concluded that many of the participants had misconceptions about antibiotic effectiveness and resistance despite a national educational campaign. The conclusions from this study may not reflect the impact of the national educational campaign, as well as the changes over time, because they only examined antibiotic knowledge and attitudes after the campaign.

In Indonesia, a cross-sectional survey evaluating the knowledge and beliefs about antibiotics was conducted by Widayati, Suryawati, De Crespigny, and Hiller (2012). Findings from this study showed that 85% of the participants were aware that the indiscriminate use of antibiotics leads to antibiotic resistance. Furthermore, most of the participants (about 76%) were able to correctly answer that bacterial infections can be treated with antibiotics. Seventy-six percent of the respondents correctly agreed that humans can be allergic to antibiotics while 50% correctly agreed that antibiotics must not be used as soon as they have a fever. A fever indicates that something out of the ordinary

is going on in the body but does not always mean that there is a bacterial infection. Fevers generally go away within a couple of days and there are a number of over-the-counter medications that helps to lower fevers (Baraff, 2000). Also 74% believed that antibiotics can prevent any disease from becoming worse. In addition, 40% believed that antibiotics could cure any illness while 37% believed that antibiotics can cure skin injuries quickly when they are poured onto wounds. In this study, there was a statistically significant association between knowledge and beliefs which suggests that the more appropriate knowledge the public has about antibiotics, the fewer misconceptions they will have regarding the effectiveness and use of antibiotics. Widayati et al. (2012) concluded that there were misconceptions regarding antibiotics use among the respondents. They recommended improving appropriate knowledge regarding antibiotic use.

Shehadeh et al. (2012) conducted a cross-sectional survey in Jordan to evaluate the knowledge, attitude, and behavior regarding antibiotic use and misuse. One out of four participants believed that antibiotics are less likely to be useful in the future if taken too often and 36% did not agree that antibiotics resistance is due to unnecessary use. Also, 31% of the respondents reported using left-over antibiotics for sore-throats which in most cases is due to a virus and not commonly of bacterial origin. One-third of the respondents also reported requesting an antibiotic prescription from their physician. Shehadeh et al. (2012) concluded that the knowledge of when antibiotics should be used, the efficacy of antibiotics, as well as the risk of antibiotic resistance were inadequate among the respondents.

Public antibiotic knowledge and attitude in Europe

To evaluate the attitude, beliefs and knowledge concerning antibiotic use in different European regions (North/Western; Austria, Netherlands, Sweden, United

Kingdom and Belgium: Southern; Italy, Malta, Israel and Spain: Eastern; Czech Republic, Lithuania and Croatia), a large face to face structured interview was conducted by Grigoryan et al. (2007). Results from this study showed that there were significant differences in the level of public attitude, knowledge, and beliefs across the regions. Inadequate knowledge was reported about the effectiveness of antibiotics on viruses with an average of 54% of the respondents answering incorrectly. This report is similar to findings from other studies (McNulty, Boyle, Nichols, Clappison & Davey 2007a; Andre, Vernby, Berg & Lundborg 2010). A lack of awareness regarding antibiotic resistance was reported among the participants (about 50%) with a wide variation between countries from 87% in Malta to 29% in Belgium. This is higher than findings reported by McNulty et al. 2007a and Andre et al. 2010. The lack of awareness of the adverse effects of antibiotics was also reported (48%) with less variation between countries. The findings from this study showed that while inappropriate attitude and knowledge were clustered in a few countries (especially southern and eastern European countries), the lack of awareness of antibiotic resistance and adverse effect was a problem in all the participating countries. Grigoryan et al. (2007) concluded that there were clear cultural differences in the levels of public attitudes, beliefs and knowledge concerning antibiotic use, self-medication and antibiotic resistance. Hence, they recommended a public education campaign.

In another cross-sectional survey to assess the attitudes towards antimicrobial drugs among the general population in six European countries (Croatia, Former Yugoslav Republic of Macedonia (FYROM), Greece, Hungary, Slovenia and Serbia), Radosevic et al. (2009) reported that the respondents from Slovenia showed the best knowledge about antibiotics, followed by Croatians. The willingness to self-medicate with antibiotics was reported among participants from FYROM, Hungary, and Greece while self-medication

was not prevalent in Slovenia. More than half of the respondents from FYROM had an antibiotic at home, while only 15% of the participants from Hungary had an antibiotic at home. One-third of the respondents from FYROM answered that they did not always take the prescribed antibiotics and one-fifth did not always give it to their children. This study also reported that respondents from Croatia showed the highest level of compliance with taking prescribed antibiotics. Radosevic et al. (2009) recommended the education of healthcare professionals as well as patients on rational antibiotic use as a way of improving antibiotic use and containing the emergence of resistance. They also recommended the consideration of national differences and characteristics when planning educational activities.

In another face to face survey conducted by McNulty, Boyle, Nichols, Clappison, and Davey (2007a) that examined public knowledge of and attitude to antibiotic use in Britain (England, Wales and Scotland), 97% of the respondent knew that antibiotics should not be used unnecessarily and 79% were aware that antibiotic resistance was a problem in British hospitals. However, there was a significant lack of knowledge about both the effectiveness and harmful effects of antibiotics. Forty-three percent of the respondents did not know that antibiotics can kill bacteria that live on the skin and in the guts. Groups with lower educational qualifications, within the age groups 16 – 24, > 75 and of Asian and black Caribbean ethnicity were reported to be less knowledgeable about antibiotics. McNulty et al. (2007a) concluded that there was no simple relationship between increased knowledge and prudent antibiotic use. To facilitate the judicious antibiotic use, they recommended antibiotic campaigns that targeted a defined audience. In this survey, situations involving households with more than one person resulted in an individual being

randomly selected. This approach may have introduced selection bias into the study because the selected individual's view may not be a representation of the household.

In Sweden, Andre, Vernby, Berg, and Lundborg (2010) conducted a survey evaluating public knowledge and awareness related to antibiotic use and resistance. The results showed that knowledge about when antibiotic treatment should be used as well as, the risk of antibiotic resistance was good. On the other hand, the survey showed that the respondents were confused about whether antibiotics were effective against bacteria or viruses. There was also confusion regarding antibiotic resistance. A large proportion of the respondents believed that humans could become resistant to antibiotics rather than bacteria becoming resistant to antibiotics. This confusion regarding antibiotic resistance may indicate that the public is aware of the term antibiotic resistance but unaware of the biological mechanism behind it (Andre, Vernby, Berg, & Lundborg, 2010). Andre et al. (2010) concluded that the awareness of antibiotic resistance as a serious public health problem combined with a high level of trust in physicians should be thoroughly examined as determinants for rational antibiotic prescribing. They recommended public health campaigns that not only focuses on keeping total antibiotic prescribing at a low level but also targets the public by aiming to increase awareness of resistance and improving trust in the professionals doing the prescribing.

Mitsi, Jelastopulu, Basiaris, Skoutelis, and Gogos (2005) conducted a questionnaire-based survey to assess adult and parental knowledge, attitudes and experiences regarding antibiotic use in Greece. The findings from this study suggest that both adults and parents represent an important source of antibiotic misuse. Among the adults, a high utilization (75%) of non- prescribed antibiotics was observed. Also, participants who were women had higher education and older adults used non-prescribed

antibiotics more frequently. About half of the respondents stopped therapy early once their symptoms subsided without consulting their physician. One-third of the sample population admitted using left-over antibiotics without a prescription, and about one-tenth did not follow recommended dosage instructions. Overall, only 69% of the respondents completed their most recent course of antibacterial treatment, and 24% saved part of the antibiotic course for future use. Also, only 29% of the participants admitted applying pressure to their doctor for an antibiotic prescription. Among the parents, 23% of the respondents used non-prescribed antibiotics on their children, while 7% administered left-over antibiotics. In addition, 79% of the parents did not discontinue antibiotic therapy once their children's symptoms subside and none of the parents admitted to applying pressure on their pediatrician for antibiotic prescription. This study concluded that adults were likely to show poor compliance with antibiotic dosages and to use non-prescribed antibiotics, while parents were less likely to use non-prescribed antibiotics for their children and were more compliant. They recommended policy changes in prescription and drug control as well as, the creation of general awareness regarding antibiotic use and consequences of misuse among the public.

In Italy, a cross-sectional survey was used to investigate the knowledge, attitude and behavior regarding antibiotics among the general population (Napolitano, Izzo, Di Giuseppe, & Angelillo, 2013). For the assessment of the level of knowledge amongst the participants, only 10% correctly knew the definition of antibiotics resistance, 21% knew the appropriate situations for antibiotic use while 50% and 83% respectively knew that antibiotics lose their effectiveness if the treatment is interrupted and non-compliance with a prescription. The attitudes towards antibiotic use indicated that approximately one-quarter of the respondents were of the opinion that they were willing to take an antibiotic

without a prescription from a physician. Regarding self-medication with antibiotics, 33% of the respondents self-classified themselves as people who self-medicate with antibiotics especially when experiencing sore-throats. This study concluded that primary care physicians and other healthcare providers are important and trustworthy components of any health education and promotion program that seeks to improve rational antibiotic use. They recommended that physicians' especially general practitioners strengthen health education by making information on antibiotic treatments and importance of antibiotics available to the public.

In the Netherlands, an internet-based study to evaluate public belief on antibiotics and respiratory tract infections was conducted by Cals et al. (2007). Findings from the study showed that 45% of the respondents accurately identified antibiotics as being effective against bacteria but not viruses. Female respondents, previous use of antibiotics and recent information on antibiotics were independently associated with having adequate knowledge on the effectiveness of antibiotics. In addition, respondents with chronic pulmonary diseases did not have more accurate knowledge of antibiotics, despite recurrent visitations to physicians and frequent reception of antibiotic treatments. Cals et al. (2007) concluded that public misconception on the effectiveness of, and indication for, antibiotics exist. They recommended a consideration of public beliefs and expectations when developing interventions targeting antibiotic misuse.

In Poland, a cross-sectional survey was conducted to explore the differences in the perception of antibiotic use for respiratory tract infections between people living in the rural and urban areas (Godycki-Cwirko et al., 2014). Results from this study showed that 26% (27% in rural vs. 26% in urban) correctly answered that antibiotics were effective against bacteria and not viruses. Seventy-two percent (73% in rural and 70% in urban) indicated

that their knowledge about antibiotics came primarily from their physicians and medical centers. Other reported sources of information were mass media (television, radio, newspapers, internet and public campaign) and from individuals such as family members, friends or neighbors. With regards to the respondent's attitudes towards antibiotics, 53% of the participants from rural and 61% from urban areas indicated that they usually knew when they needed antibiotics. Most the respondents indicated that they would leave the decision to prescribe antibiotics to their doctor. In addition, participants living in rural areas more often believed that antibiotics improved resolution of symptoms such as sore throat (45% and 37% for rural and urban respectively), cough with clear phlegm (56% and 49% for rural and urban respectively), cough with yellow/green phlegm (67% and 65% for rural and urban respectively) and cough with fever (70% and 62% for rural and urban respectively). In addition, 39% of the respondents believed that antibiotics improved common cold symptoms (42% rural vs. 36% urban), while 88% (88% rural vs. 87% urban) believed that antibiotics aided recovery in acute bronchitis and 91% (91% rural vs. 91% urban) in pneumonia. The predictors of accurate antibiotic knowledge from this study were recognition of the problem of antibiotic resistance, high level of education and being a parent. This study concluded that there were no significant differences in beliefs and knowledge about antibiotics between urban and rural population. However rural respondents were slightly less confident in their knowledge about antibiotics and self-reported greater use of antibiotics.

Public antibiotic knowledge and attitude in Latin America and the Caribbean

In Brazil, Del Fiol, Barberato-Filho, Clopes, Bergamaschi, and Barreto (2013) conducted a cross-sectional survey to gather information on the behavior and perception of the Brazilian people with regards to antibiotic use. Findings from this study showed that

the respondents had a uniform and adequate information on the knowledge statement "physician should not prescribe antibiotics when not needed". However, majority of the studied population incorrectly agreed that antibiotic use could damage the teeth. In addition, a large portion of the study population falsely agreed that antibiotics could help with common colds and flu. There was also a lack of information especially among women regarding the interaction between specific antibiotic and oral contraceptives. Penicillin, rifampicin, and tetracycline have been shown to reduce the effectiveness of oral contraceptives which can increase the risk of pregnancy (Dickinson, Altman, Nielsen, & Sterling, 2001). This study also reported that women, and respondents under 40 years regardless of educational level had better knowledge about the use of antibiotics. Del Fiol et al. (2013) recommended educational campaigns for improving health education and increasing patients' compliance to treatment among the public. This study was conducted among respondents who received an antibiotic prescription from primary health centres; hence the data obtained was limited to antibiotic knowledge and attitudes associated with antibiotic prescriptions.

In another cross-sectional study conducted in Ecuador by Quizhpe, Gassowski, Encalada, and Barten (2013) to evaluate the differences in antibiotic use and knowledge between adolescent and adult mothers, findings showed that adolescent mothers frequently used antibiotics incorrectly and had less antibiotic knowledge compared to adult mothers. Previous antibiotic use without consulting a physician was common in both groups, accounting for 25% of the adolescent mothers and 29% of the adult mothers and there was no statistically significant difference between the groups. Regarding the adherence to antibiotic treatments, 84% of the adult mothers stated that they always gave the complete antibiotic course to their children while 75% of the adolescent mothers adhered to antibiotic

treatment course. There was a statistically significant difference between the groups. In addition, the most occurring reason for non-adherence was that the child was feeling better which was reported by 61% of the adolescent mothers and 55% of the adult mothers. A statistically significant difference was reported between adult mothers and teenage mothers with regards to the risk associated with antibiotic use. About 29% of the adult mothers stated that they were aware of the risk associated with irrational antibiotic use such as antibiotic resistance and allergy compared to 15% of the adolescent mothers. There was also a statistically significant difference regarding prior exposure to information on antibiotic resistance. Twenty percent of the adolescent mothers and 29% of the adult mothers agreed to have heard of antibiotic resistance. The majority in both groups (56% of adolescent mothers and 68% of the adult mothers) credited the source of their current knowledge on antibiotic resistance to their physician. Quizhpe et al. (2013) concluded that there were differences in the knowledge and use of antibiotics between teenage and adult mothers. They recommended that it was crucial to understand the factors causing the differences in the knowledge and use of antibiotics between teenage and adult mother. There were limitations to the data that could be statistically analyzed for this study because there were only four questions assessing the knowledge and use of antibiotics among the respondents.

Gonzales et al. (2012) conducted a cross-sectional survey in Mexico to evaluate antibiotic knowledge and self-care for acute respiratory tract infections. Findings from the study showed that there was a wide variation inaccurate antibiotic knowledge across a range of cold and cough medications. Sixty-nine percent of the respondents incorrectly reported at least one non-antibiotic medication as an antibiotic and 48% identified three or more non-antibiotics incorrectly. In contrast, 74% of the participants correctly classified the true

antibiotics on the list and only 23% incorrectly classified a true antibiotic as a non-antibiotic. In addition, 26% of the respondents reported using antibiotics that were not antibiotics. Overall, antibiotic knowledge scores were substantially lower among participants younger than 40 years compared with older adults but did not vary significantly by gender or educational level. Approximately 47% of the respondents had used an antibiotic for an illness before receiving treatment from a physician. Gonzales et al. (2012) concluded that there were antibiotic self-treatments and misconceptions regarding antibiotic use among medically insured adults in Mexico. Although antibiotic self-medication was reported among the respondents, the level of self-medication may have been under-reported because of the exclusion of individuals without health insurance, as well as non-government workers. This study was conducted among government employees in Mexico who had access to health insurance.

In Trinidad and Tobago, Parimi, Pereira, and Prabhakar (2002) conducted a telephone survey to assess the general public's perceptions and use of antibiotics. Results from the survey showed that 93% of the respondents had heard of the term antibiotics. Of these participants, 28% provided a non-specific description of an antibiotic such as something you were asked to buy by the doctor. Eighty-three percent of the respondent correctly identified penicillin as an antibiotic while 80% correctly identified tetracycline and 78% correctly identified amoxicillin/clavulanic acid. Ten percent of the participants incorrectly identified Tylenol (acetaminophen) as an antibiotic and 9% for aspirin. Thirty-six percent incorrectly identified Benadryl (diphenhydramine), an over-the-counter cough and cold medication as an antibiotic. Twenty-four percent of the respondents believed that antibiotics could cure all infection, while 15% felt that all antibiotics were safe and 12% stated that antibiotics were free of side effects. Twenty-one percent of the respondents also

stated that they hoarded antibiotics, storing them at home for emergency purposes. In addition, 19% reported that they self-medicated with antibiotics obtained from private pharmacies and 25% admitted to demanding an antibiotic prescription even if the physician felt the antibiotic was unnecessary. Respondents between 41 and 50 years correctly identified penicillin as an antibiotic, as were participants with tertiary education. Tertiary education was significantly associated with correct antibiotic knowledge regarding their safety, ability to cure infections and having no side effects. In addition, age was significantly associated with storing antibiotics at home, with older respondents being less likely to keep antibiotics at home for emergency purposes. Parimi et al. (2002) concluded that the inappropriate use of antibiotics results from self-medication, over the counter availability at community pharmacies, on-demand prescriptions and lack of regulatory control. They recommended stricter control on the dispensing of antibiotics at private pharmacies, education of the public/healthcare professionals and community-based surveillance of antimicrobial resistance trends.

Public antibiotic knowledge and attitude in Northern America

Eng et al. (2003), conducted a telephone-based survey in the United States of America (Connecticut, Minnesota, Oregon, California, Georgia, Maryland and New York) to examine consumer's attitude and use of antibiotics. In this study, about 53% of the respondents reported at least one misconception that put them at unnecessary risk for infection with resistant bacterial pathogens. About 58% of the respondents were not aware of the health dangers associated with inappropriate antibiotic use, and 48% of the sample indicated that they expected antibiotics to be prescribed when they visited a doctor. Results from this study also indicated that participants with lower socioeconomic status (earnings < $ 30,000), lower educational status (not college educated), males, and younger age group

(18-24 years) had higher levels of misconceptions and lower level of knowledge about the potential adverse impact of antibiotics. Eng et al. (2003) concluded that peoples' knowledge and attitude regarding antibiotic use could be substantially improved. They stated that improved knowledge might be important for efforts to reduce misconceptions and misguided expectations contributing to inappropriate antibiotic use.

Belongia, Naimi, Gale, and Besser (2002), conducted another telephone survey to assess the knowledge, attitudes, and experiences of adults and parent of children in the United States of America (Wisconsin and Minnesota) regarding antibiotic use for respiratory tract infections. The results from the study demonstrated that many of the respondents were misinformed regarding antibiotic use for bronchitis or purulent nasal discharge, and there was confusion regarding the role of antibiotics for viral infections. Among the parents, factors that were independently associated with adequate antibiotic knowledge were white race, older age, female gender and exposure to three or more information sources on antibiotic resistance. Among the adults, being a Minnesota resident, having four or more years of college education, white race and exposure to one or more information sources on antibiotics resistance in the past six months were the factors associated with adequate antibiotic knowledge. Regarding attitudes and beliefs on antibiotic use, many respondents believed that they knew when an antibiotic was needed for themselves or their children, although few participants expected to ask for an antibiotic or seek care from another physician if they did not receive an antibiotic for upper respiratory tract illnesses. Six percent of the adults and 3% of the parent reported that they had used an antibiotic for themselves or children in the past six months without first consulting a physician. Similarly, 2% of the adults and 4% of the parents stated that a physician had prescribed a new antibiotic for themselves or their children over the

telephone without an office visit for physical examination or laboratory test. In addition, 61% of the parents agreed with the statement "before seeing a doctor; I believe that my child needs an antibiotic for the current illness" while 72% of the adults agreed with the statement referring to their expectation for an antibiotic. Belongia et al. (2002) concluded that the public had misconceptions regarding antibiotic use and may contribute to inappropriate antibiotic prescribing. A recommended solution was the provision of multiple and varied antibiotic-related information which may increase the knowledge of appropriate antibiotic prescribing and decrease patient demand for antibiotics. In this study, a higher proportion of the respondents were college educated. This may have resulted in the under-representation of individuals within lower socioeconomic groups, and the findings may not be a reflection of the entire population.

In an online survey conducted by Carter, Sun, and Jump (2016) to evaluate the perceptions and knowledge of Americans about antibiotic-resistant bacteria or antibiotics misuse; findings revealed that the majority of the respondents (93%) agreed that inappropriate antibiotic use contributes to antibiotic resistance and 69% stated that using fewer antibiotics will decrease antibiotic resistance. Approximately 75% of the participants agreed that resistance to antibiotics is a problem in American hospitals and that resistant bacteria could infect them or a family member. However, only 30% agreed that antibiotic resistance is a serious problem. This may indicate that the respondents consider other health problems more important or that they do not perceive their role or influence on antibiotic resistance (Hawkings, Wood, & Butler, 2007). Other knowledge gaps found among the respondents include 30% of the survey population incorrectly agreeing that antibiotics kill viruses and approximately 40% agreeing that antibiotics were the best choice to treat cold symptoms such as a runny nose and sore throat. Notably, although 71% of the participants

agreed that physicians or nurses overprescribe antibiotics and 55% believed that doctors or nurses might not have sufficient education about antibiotic resistance, about 72% indicated that they trusted their physician's or nurse's advice about their need for antibiotics. Carter et al. (2016) concluded that the public did not consider antibiotic resistance an important health problem although there was awareness about antibiotic misuse contributing to antibiotic resistance.

In a mixed design study conducted by Harts Research Associates and Public Opinion Strategies (2012) to evaluate Americans knowledge of and attitude towards antibiotic resistance, the key research findings include that Americans have a basic understanding of antibiotics and the consequences of over-using antibiotics. Eighty-seven percent of the study participants believed that antibiotics were effective for treating bacterial infections such as strep throat and some sinus infections. In addition, the majority of the respondents (86%) understood that it was important to complete the full course of antibiotic prescriptions. Most of the participants (79%) also understood that when an individual ingests antibiotics when they were not needed, antibiotics could become less effective at treating that person's future bacterial infections. Another important insight from this study was that the participants did not always apply their knowledge of how to take antibiotics appropriately. Respondents in both the cross-sectional survey and focus groups gave the correct response in many cases as to how to appropriately use antibiotics. However, the focus group discussions made clear that many did not follow these best practices and the reason for this discrepancy was not provided in the study. There was also a knowledge gap regarding antibiotic efficacy, and how an individual who over-uses can impact the health of others in the community. Most respondents correctly reported that antibiotics are effective in treating bacterial infections, while 42% indicated that antibiotics

are not effective at all for treating viral infections. About 36% incorrectly agreed that antibiotics are effective for treating viral infections such as common colds. In addition, 47% of the participants believed that when someone takes antibiotics when not indicated, this behavior could weaken the effectiveness of antibiotics for other people in the community. In contrast, 39% of the respondents believed that an individual's use of antibiotics does not make a difference for how antibiotics affect others in the community. The results of the study also revealed that the respondents did not recognize antibiotic resistance as a major health issue neither did they believe that the problem of antibiotic resistance would affect them personally. About 81% believed that antibiotic resistance is less of a public health problem compared to child malnutrition, food contamination or outbreak of new diseases such as H1N1. In addition, only 52% of the participants believed that they or someone they know would contract an illness that is resistant to antibiotics. This study concluded that there were some misunderstandings regarding antibiotic use among the public.

Public antibiotic knowledge and attitude in Oceania

In Australia, Fredericks et al. (2015) conducted a cross-sectional survey to explore consumer's knowledge and attitude about upper respiratory tract infections and antibiotics, as well as to identify factors contributing to antibiotic misuse. Findings from the survey revealed that 68% of the participants agreed that antibiotics cure most bacterial infections and 63% also agreed that resistant bacteria would be difficult to treat with antibiotics. However, 18% of the study's subject incorrectly agreed that antibiotics cure all viral infections. About 54% agreed with the statement "I know that I need antibiotics before I visit my doctor," while 36% agreed with the statement "I will get better faster if I take antibiotics when I have a cold or flu." Regarding the completion of antibiotic courses, about

95% of the respondents stated that they had the intention to complete their courses of antibiotics. Frederick et al. (2015) concluded that there was a lack of knowledge among consumers about the efficacy of antibiotics in treating viral infections despite educational campaigns, although they did not mention how the impact of the campaign was measured. They recommended that pharmacists and other healthcare practitioners elicit consumers' beliefs and understanding of antibiotics and tailor their advice appropriately.

In a mixed design study conducted by Gaarslev, Yee, Chan, Fletcher-Lartey, and Khan (2016) to understand patients' expectations of antibiotics for upper respiratory tract infections in Australia, most respondents (70%) agreed that antibiotics kill bacteria. However, 33% also agreed that antibiotics kill viruses while only 37% correctly identified antibiotics as effective against bacteria and not viral infections. Overall, 70% of the participants reported having heard of the term antibiotic resistance, while 10% were unsure regarding this question. Sixty-four percent correctly agreed with the statement "bacteria can become resistant to antibiotics" and this was associated with age and educational level. About 74% of the respondents were aware that taking antibiotics when not needed means that they are less likely to work in the future. The awareness of this information was associated with age, such that awareness increased with age. Regarding the expectation of antibiotic prescriptions, only 20% of the participants reported that they expected their doctor to prescribe an antibiotic if they have a cold or flu, with the statistically significant predictors being speaking a language other than English at home and younger age groups. Most of the focus group participants perceived antibiotic resistance as a change in the human body rather than in bacteria. The focus group consisting of individuals with low socio-economic characteristics believed that antibiotics are more efficacious and cheaper compared to over the counter cold and flu medications. They did not understand why they

would not ask for antibiotics if they were ill. They also expressed that if the physician withheld antibiotics, it was because the physician disliked antibiotics or wanted to save the governments' money and not because of medical reasons. Gaarslev et al. (2016) concluded that the public did not have a strong incentive to consider the impact of their use of antibiotics on antibiotic resistance. They recommended health campaigns that explained and reframed the issue of antibiotic resistance as an immediate health issue with dire consequence. The qualitative part of this study provided an in-depth understanding of the cultural and social norm surrounding public expectation of antibiotics.

Norris, Va'ai, Fa'alau, Churchward, and Arroll (2011) conducted another mixed design study to explore the public interpretation and use of antibiotics in Samoa and New Zealand. Results from the study revealed that although some respondents correctly reported that antibiotics treated bacterial infections, there were many contradictory views. Some respondents reported some interesting ideas about antibiotics, for example; antibiotics are strong medicines which immediately attacks the inflammation or the disease through direct ingestion into the bloodstream. There was also some confusion among the participants who understood that antibiotics treat infections with regards to bacterial and viral infections. For example, a respondent gave the following definition of an antibiotic "It's those medicines that kill bacteria, like when you have flu, you get the bacteria that causes it." There was also confusion about the role of antibiotics particularly about whether antibiotics killed bacteria or strengthened the immune system. From the structured interviews, only 32% of the participants correctly answered that antibiotics kill bacteria. The notion that antibiotics are painkillers was very common, and some respondents defined antibiotics as a drug that is used to ease pain. From the structured interviews, 13% of the respondents thought that acetaminophen was an antibiotic. The semi-structured interview revealed that the

participants in Samoa had come to expect antibiotic prescriptions for colds and flu and saw the use of antibiotics in this scenario as normal and unproblematic. The structured interview also showed that the view about antibiotics being useful for colds and flu was common among the New Zealand respondents as 81% of them believed that antibiotics were effective for managing coughs and colds, while this opinion was expressed by 70% of the Samoan participants. Norris et al. (2011) concluded that the efforts to promote rational antibiotic use might fail in some communities if they are developed based on the assumption that every individual share western beliefs about what antibiotics are; what they do; and which illness have a microbial, bacterial or viral origin. The study participants were recruited from health-care centers; hence the perspective of individuals who do not frequently visit clinics may be under-represented.

In a cross-sectional survey conducted by Norris et al. 2010 to evaluate the knowledge and reported use of antibiotics amongst immigrant ethnic groups (Indian, Egyptian and Korean) in New Zealand; results showed that 73% of the respondents correctly agreed that antibiotics kill bacteria. All incorrect responses such as for relieving pain, strengthening the immune system and killing viruses were particularly common amongst Korean respondents. Only a few Korean respondents (20%) correctly identified the role of antibiotics, while the Indian respondents had the highest percentage (79%) correctly identifying the role of antibiotics. Most of the Indian and Egyptian participants correctly identified Amoxicillin and Augmentin as antibiotics. However, 28% of the Indians and 41% of the Koreans incorrectly believed that Acetaminophen was an antibiotic. Although most respondents correctly believed that colds and flu are caused by viruses, nearly half of the participants (43%) thought that colds and flu were caused by bacteria. The belief regarding bacteria being the causative organism for colds was common in all the

ethnic groups (from 30% of Koreans to 62% of Indians). The groups did not differ significantly in their ability to correctly identify viruses as the sole cause of cold and flu. Regarding the knowledge of adverse effects of antibiotics, 61% of the participants stated that antibiotics could have bad effects with antibiotic resistance being the most common (34%) adverse effects mentioned. Awareness of antibiotic resistance varied between the ethnic groups with the highest among the Egyptians (55%), Koreans (36%) and was particularly low among the Indians (12%). Most of the Korean participants (71%) reported that they would stop taking antibiotics when they felt better, rather than when they finished the course. This view was also common among the Indian (41%) and Egyptian (21%) respondents. Another common trend was the keeping of left-over antibiotics for future use which was predominant among the Egyptian and Korean respondents while less than 20% of each of the ethnic groups reported they would return leftover antibiotics to a pharmacy. Norris et al. (2010) concluded that interventions to improve antibiotic use need to be pitched at a basic level of knowledge as well as targeted towards ethnic groups, particularly those in whose home countries antibiotics were widely available without a prescription.

Table 2.1 Summary of Key Concepts Regarding Antibiotic Knowledge and Attitude Across Different Geographical Regions

Concepts (correct response %)	**Africa**	**Asia**	**Europe**	**Latin America & Caribbean**	**Northern America**	**Oceania**
Use of antibiotics for treating viral Infections	Nigeria (30%) Namibia (59%)	Malaysia (33%) Qatar (53%) Kuwait (54%) South Korea (30%) Indonesia (29%)	England, Wales, Scotland (62%) Italy (81%) Netherland (52%) Sweden (73%)	Trinidad& Tobago (76%)	United States of America (79%)	Australia (67%) New Zealand (73%)

		Jordan (45%)				
Expectation of antibiotics from physician	Nigeria (29%) Namibia (56%)	Jordan (67%) Qatar (53%) Kuwait (70%) South Korea (70%)	Netherland (40%)	Trinidad & Tobago (75%)	United States of America (52%)	Australia (81%)
Inappropriate use of antibiotic as a cause of antibiotic resistance	Nigeria: (76%) Namibia (72%) Uganda (83%)	Jordan (36%) Malaysia (78%) Qatar (78%) Kuwait (49%) South Korea (70%) Indonesia (87%)	Sweden (85%) Italy (9.8%) Netherland (92%) Poland (77%)		United States of America (42%)	Australia (63%) New Zealand (34%)
Completion of antibiotic treatments	Nigeria (43%) Uganda (64%)	Malaysia (26%) Qatar (70%) Kuwait (55%) South Korea (22%)	England, Wales, Scotland (89%) Sweden (96%) Greece (53%)	Ecuador (79%)	United states of America (86%)	Australia (62%) New Zealand (39%)
Storage of antibiotics for future use	Uganda (87%)	Malaysia (48%) Qatar (45%) Kuwait (56%) South Korea (53%) Jordan (72%)	Sweden (92%) Greece (76%)	Trinidad & Tobago (79%)		New Zealand (39%)

Conceptual Framework

The role of intention has been assessed with respect to understanding the role of humans in certain health-related activities such as the knowledge and attitudes regarding antibiotic use. The value of intention in understanding diverse health behaviour in various populations has received a lot of support, with many researchers recognizing intention as a key predictor of actual behavior (Ajzen & Fishbein, 2005).

This study was inspired by the theoretical framework based on the Theory of Planned Behavior (TPB) (Ajzen, 1991). TPB defines intention as a central factor in the performance of behavior. Intention is said to capture the motivational factors that influence a behavior: it is the indication of how individuals are willing to try or how much effort they plan to exert in order to perform the behavior. In effect, if intention is a key indicator of behavior then the factors that predict intention may be influential in the performance of the behavior. According to the TPB, the performance of a behavior is influenced by the individuals' intentions which consist of the attitude, subjective norm, and perceived behavioral control as shown in Figure 1. TPB asserts that an individual's behavior is impacted by behavioral intentions, and the beliefs and attitudes about this behavior dictate the individual intention to engage in a particular behavior such as antibiotic use.

Attitude is the views individuals have about a behavior, and they are formed by associating the behavior with certain attributes. Attributes linked to behavior are valued in a positive or negative way. Hence, individuals favor behavior they trust will yield desirable outcomes and form negative attributes towards behavior that they associate with undesirable outcomes. Subjective norm is concerned with the likelihood that important groups such as family or friends approve or disapprove of engaging in a behavior such as antibiotic use.

Perceived behavioral control is defined as a person's estimate of how easy or difficult it will be to carry out a behavior (Ajzen & Madden 1986). It is based on the availability of resources such as the information about a behavior which may arise from experience or second-hand information from other sources. In this study, perceived behavioral control was investigated as antibiotic knowledge. This is because if people think that they are knowledgeable about antibiotic use, they are more likely to estimate that they can use antibiotics appropriately. Although their knowledge may not always be adequate especially if the source of their knowledge is from inappropriate sources.

An individual's attitude and subjective norm together with perceived control can be directly utilized to determine the intention to engage in a behavior such as rational or irrational antibiotic use (Ajzen, 2005). Because attitudes, subjective norms and perceived behavioral control are assumed to be based on corresponding set of beliefs which according to TPB ultimately guide the performance of a behavior. This study aims to identify the accessible behavioral, normative and control beliefs regarding antibiotic use. The responses generated can be used to identify personal, accessible beliefs i.e., the unique beliefs of the research participants regarding antibiotic use which may then be addressed with specific public health education interventions. Within this study, the factors of attitude and subjective norm were merged together and investigated as attitude.

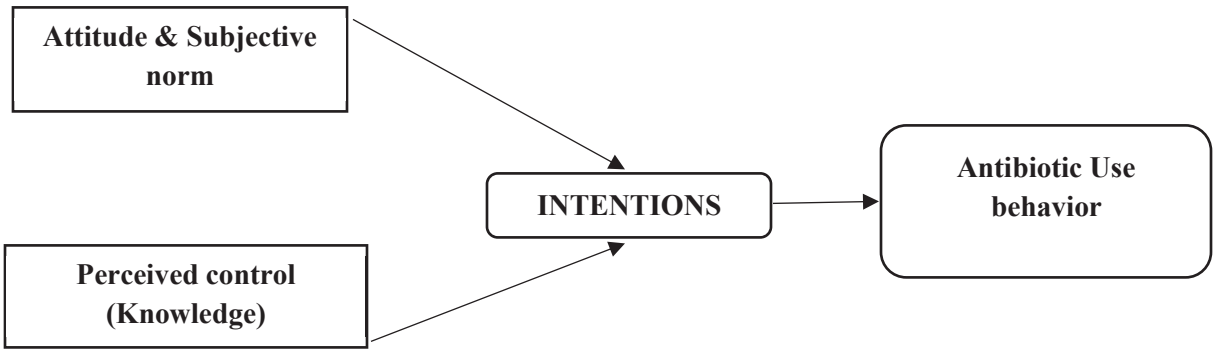

Fig 1.1 Factors influencing antibiotic use. Adapted from Ajzen (1991) Theory of Planned Behavior.

Summary

As mentioned at the beginning of this chapter, I was unable to locate any Canadian study where public knowledge and attitude regarding antibiotic use was explored. Consequently, there is a need for research exploring what the public knows about antibiotics as well as, their attitudes towards antibiotic use since the information generated may be effective in developing effective public education materials targeted towards addressing irrational antibiotic use and antibiotic resistance.

In Europe, Asia and the USA, research has shown that there are various knowledge gaps regarding antibiotic use that needs to be addressed among the public. Many of the respondents across the various studies had incorrect views about antibiotics and its uses. There is a great need to protect currently available antibiotics from being rendered ineffective by irrational antibiotic use and antibiotic resistance hence the need for conducting more research on the role of the public focusing on their knowledge and attitude towards antibiotic use, especially in Canada. This research study aimed to fill this gap in understanding the public knowledge and attitude regarding antibiotic use from a quantitative design perspective. This chapter also discussed the conceptual framework for the study developed from Ajzen's theory of planned behavior. Chapter Three will explain the research design and methodology for this study.

Chapter Three: Research Design and Methodology

The purpose of this chapter is to describe the research design and methodology that was utilized for this research study. I will begin with a description of the chosen research design, followed by an outline of the research setting and sample size, data collection techniques, ethical considerations, data management, data analysis as well as, how rigor was achieved.

Quantitative Research Design

A research design has the central task of generating answers to research questions (Van de Ven, 2007). A quantitative research design was chosen for this study. Quantitative research has been defined in very broad terms as the type of research that entails the collection of numerical data, a deductive relationship between theory and research and an objective conception of social reality (Bryman, Teevan, & Bell, 2009). Quantitative research, therefore, involves a range of methods concerned with the systematic investigation of social phenomena, using statistical or numerical data. It may be considered as a way of thinking about the world. It is essentially deductive: measurements are made, analysis is applied, and conclusions are drawn (Watson, 2015).

The decision to choose a quantitative research design was primarily guided by the philosophical assumptions and research questions of the study, as well as an examination of the available literature on the topic area. Looking at the nature of the three research questions of this study, choosing a quantitative design provided the tools to answer these questions. The unavailability of Canadian studies on this topic area was also considered, hence a quantitative research design that would provide baseline information on this topic area was required. It would have been difficult to understand as well as, interpret the

phenomenon antibiotic knowledge and attitudes without acquiring data that measured these concepts (Bryman, Teevan, & Bell, 2009).

There are two broad categories of designs in quantitative research namely experimental and survey designs (Watson, 2015). For this study, a cross-sectional survey design was employed. Cross-sectional survey designs involve the distribution of questionnaires, or may be conducted by interview or observation. This design allows for standardization in the asking of questions and the categorization of the answers provided (Bryman, Teevan, & Bell, 2009).

Setting and Sample

This study was a cross-sectional face-to-face survey of residents in south-west Alberta. The participants were selected using a convenient sampling method. Participants were recruited across southwest Alberta (The University of Lethbridge, parking lots, Afro-Caribbean festival Lethbridge, Rib Fest Lethbridge and Dominion Gateway Church). The sample size estimated for this study was 200, and a total of 222 participants were recruited. However, 3 participants were disqualified due to incomplete data leaving 219 respondents for analysis and a response rate of 99%. The following numbers of participants were selected from one city and five neighboring towns taking into consideration the population size: Lethbridge, 158; Coaldale, 17; Coalhurst, 8; Fort Macleod, 10; Raymond, 8; Taber, 18 participants. The participants were adults aged 18 and older irrespective of age and gender.

Data collection

The questionnaire used in this study was adapted from the one used by Kim et al. (2011) *Public Knowledge and Attitudes Regarding Antibiotic Use in South Korea* (see Appendix C). This scale asked a series of questions that assessed the publics' beliefs

regarding antibiotic use that are readily accessible in memory. Measuring these beliefs provides a snapshot of the publics' antibiotic use behavior at a given point in time. TBP asserts that behavioral interventions must try to change beliefs which ultimately guides the performance of behavior such as inappropriate antibiotic use. In addition, Kim et al.'s scale was chosen because the questionnaire was developed by researchers with reference to the US Centers for Disease Control and Prevention (CDC) clinical guidelines (2010) on appropriate antibiotic use for the treatment of upper respiratory tract infections (URI). The scale was also validated by four experts, such as one physician, one pharmacy professor and two nursing professors and the knowledge scale had a Cronbach's alpha of 0.80 while the attitude scale had a Cronbach's alpha of 0.64. Kim et al.'s (2011) scale contained 15 questions that measured knowledge of the cause of common cold and antibiotic use for treatment of symptoms associated with URI. Participants responded to these statements from the following 3 options: yes, no, and do-not-know (Kim, Moon & Kim 2011). The questionnaire also had seven questions that measured attitude regarding antibiotics use in the management of common colds. Participants responded to this statement by checking off which response best captures their attitude: agree or disagree. The Kim et al. (2011) scale was adapted by adding six additional statements. Two statements "*I can differentiate between bacterial and viral infection"* and *"Antibiotics are the same as the medications used to relieve pain and fever (e.g., aspirin, Tylenol)"* were added to the knowledge section while four statements *"I expect antibiotics to be prescribed by my doctor if I suffer from common cold symptoms", "If my family member is sick I usually give my prescribed antibiotic to them", "I normally keep an antibiotic stock at home in case of an emergency"* and *"I take antibiotics according to the instructions on the label*' were added to the attitude section. Another adaptation of this scale was constructing the response of the attitude scale

on a 5-point Likert scale. Adaptation of the questionnaire facilitated asking questions and understanding certain aspects of the topic area that were not addressed by the Kim et al. (2011) scale.

The adapted questionnaire was pilot tested among 20 respondents. The knowledge scale on the adapted questionnaire had a Cronbach's alpha of 0.81 while the attitude scale had a Cronbach's alpha of 0.75.

A demographic data section and data assessing antibiotic use was included at the beginning of the questionnaire (see Appendix C). Information in this section included age, gender, ethnicity, education, marital status, medical care training, occupation, healthcare professional status, the presence of chronic disease, current antibiotic use, awareness of antibiotic information and awareness of antibiotic resistance information. These characteristics were chosen because existing research has shown that these factors were associated with knowledge and attitude about antibiotic use (Eng et al., 2003; McNulty, Boyle, Nichols, Clappison & Davey 2007a; Moienzadeh, Massoud & Black 2015; Pereko, Lubbe & Essack 2015).

Data management

In most research, there is a potential for the generation of large volume of data (Creswell & Clark, 2011). Thus, there was the need for a clear data management and organizational plan. For this study, all completed questionnaires were kept in color coded file folders. There were different colored folders for the different locations (Lethbridge, Coaldale, Coalhurst, Fort Macleod, Raymond, and Taber) where the data was generated. These paper documents were stored in a locked filing cabinet in the researcher's office at the U of L, and only the researcher had access to these paper documents. The electronic version of the data was stored on a password protected computer and hard drive.

All data pertaining to this study will be retained for five years following the completion of the research. This retention period was approved by the U of L office of research ethics.

Ethical considerations

This research followed the ethical guidelines outlined in the Tri-Council Policy Statement: Ethical Conduct for Research Involving Humans (2010). Ethics approval (Internal file: 2016-005) was obtained from the University of Lethbridge Ethics Board before commencing the study. The respondents provided consent to participate in the study by completing the questionnaires (see Appendix B). Informed consent is "the potential participant's agreement to participate voluntarily in a study, which is reached after an understanding of essential information about the research" (Burns & Grove, 2005). On the first page of the questionnaire, participants were: (i) introduced to the research activities involved in the study; (ii) provided with descriptions of risks and benefits of the study; (iii) assured of their anonymity and confidentiality; and (iv) informed of their right to withdraw from the study at any time (see Appendix B). To ensure confidentiality, respondents were assigned a code on the questionnaires so that they could not be identified and any identifying information about participants such as names was not recorded.

Data analysis

The data generated in this study was analyzed using the IBM SPSS 24 (Statistical Package for the Social Sciences) computer software (IBM SPSS Inc. 2016). Descriptive statistics was used to describe the percentages, frequencies, median and mean antibiotic knowledge and attitude scores obtained from the public in southwest Alberta. The use of inferential statistics provided an opportunity to assess differences between groups based on certain demographic variables as well as, determine the factors that predict adequate

antibiotic knowledge and good antibiotic attitude. For assessment of the differences based on demographic variables, a chi-square test was utilized. Phi test was used to assess the relationship between antibiotic knowledge and antibiotic attitude. Binary logistic regression was used to evaluate factors associated with adequate antibiotic knowledge and good attitude. The regression analysis had antibiotic knowledge and attitude as dependent variables while age, location, marital status, education, ethnicity, occupation, gender and antibiotic resistance education were independent variables. These independent variables were selected because they had the potential to serve as explanatory variables that differentiated individuals who demonstrated adequate antibiotic knowledge and attitude from those who did not. The reports for the regression analysis includes the odds ratio (OR), 95% confidence interval (CI), classification table, Hosmer Lemshow test and Nagelkerke R^2. OR is used to compare the relative odds of the occurrence of the outcome of interest, given exposure to the variable of interest. When the OR is equal to one, the exposure does not affect the odds of outcome. When OR is greater than one the exposure is associated with higher odds of the outcome. When OR is less than one, the exposure is associated with lower odds of the outcome. CI is used to estimate the precision of the OR. A large CI indicates a low level of precision of the OR, whereas a small CI indicates a higher precision of the OR (Szumilas, 2010). The classification table shows how the regression analysis correctly predicts the dependent variable. Hosmer Lemshow test explains if the model is a good fit for the data. Nagelkerke R^2 is defined as the proportion of the variance explained by the regression model. The statistical significance for all the analysis was assessed using the p-value. A p-value less than 0.05 was considered significant.

Rigour

In quantitative research, the criteria of reliability, measurement validity, and objectivity are used to ensure the quality of the research (Davies & Dodd, 2002; Thomas & Magilvy, 2011).

Reliability. This is concerned with the consistency of measures (Bryman, Teevan, & Bell, 2009). It can be defined as the "degree of consistency with which it measures the attribute it is supposed to be measuring" (Polit & Hungler, 1995). One of the most widely accepted tests for measuring the reliability of a scale is the Cronbach's alpha coefficient (Gillis & Jackson, 2002; Macnee, 2004; Polit & Hungler, 1995). The values for Cronbach's alpha coefficient varies from 1 (indicating perfect internal reliability) to 0 (indicating none). This coefficient tests how closely the responses to items on the scale are related and a value of over 0.7 is typically used to mark the minimum acceptable level of internal reliability (George & Mallery, 2003; Gillis & Jackson, 2002; Macnee, 2004; Nunnely, 1978; Santos, 1999). The scale in this study obtained Cronbach's alpha values of 0.805 for the test of antibiotic knowledge and 0.756 for the attitude test regarding antibiotic use. The scale was also pilot tested among 20 respondents.

Measurement validity. This refers to whether an indicator (or set of indicators) designed to gauge a concept measures that concept (Bryman, Teevan, & Bell, 2009). As described in the data collection section, the scale that was adapted for this study was developed based on the US Centers for Disease Control and Prevention (CDC) clinical guidelines (2010) and was validated by four experts comprising of one physician, one pharmacy professor, and two nursing professors.

Objectivity. This can be defined as the extent to which two different researchers could arrive at similar conclusions (Bryman, Teevan & Bell, 2009; Polit & Hungler, 1995).

To facilitate objectivity during the data entry process, I double-checked the data entry into SPSS to ensure that they matched the responses on each of the questionnaires. To ensure objectivity during the data analysis process, I confirmed my procedures and results with my supervisor who is a statistician by profession with interest in the application of statistics in Education, Health and Social Sciences.

Summary

In this chapter, I have explained the quantitative research design that was utilized to explore this phenomenon in the study. The sample was adults over the age of 18 years recruited across one city and five towns in south-west Alberta. The reliability of the questionnaire used was validated by a pilot test and Cronbach's alpha test. The following chapter will present the research findings from the study.

Chapter Four: Research Findings

The aim of this chapter is to present the results that were generated through this study. The theory of planned behavior describes the variables perceived behavioral control, attitude and subjective norm as critical determinants of a behavior such as antibiotic use. This study examined these variables among the public in southwest Alberta. Perceived behavioral control was investigated as antibiotic knowledge while attitude and subjective knowledge was investigated as antibiotic attitude. This chapter begins with a description of the demographics and characteristics assessing antibiotic use among the participants. I will then present the findings of the study organized in terms of these variables antibiotic knowledge and antibiotic attitude. In addition, the findings regarding the predictors of antibiotic knowledge and attitude will also be presented

Demographics and Characteristics Assessing Antibiotic Use of the Participants

Table 4.1 and 4.2 describes the demographics and characteristics assessing antibiotic use of the study's participants. Respondents ranged in age from 18 to over 50 years (Median = 2, SD = 1.4), the majority (48.4%) of participants were in the age range 18 - 29. Females comprised a larger portion of the group at 58.0%, whereas 42.0% were males. Also, a large number of study's sample were Northern (Canadian/American) or Latin American (39.3%), followed by European (23.9%), other ethnicities (13.7%), African/Middle east (11.8%), Asian (6.1%) and First Nations (5.1%). Majority of the respondents were students (38.7%), followed by non-government employment (26.7%), government employment (12.4%), other (11.6%) and self-employed (10.6%). The survey was conducted in various locations categorized into two groups with Lethbridge having the highest number of participants (73.1%) followed by the other locations (26.9%). Highest educational background ranged from Elementary/high school (39.4%), College/University

(50.6%) to a postgraduate degree (10%). Of the 219 participants 54% were single, 37.9% were married and 8.1% made up the other marital status. 87.6% did not have any chronic disease, while 9.7% had a chronic disease and 2.8% were not aware if they had a chronic disease. 75.7% of the study's population had no previous medical training and 24.3% had one form of medical training. Within the context of this study, medical training refers to having an educational background in a health-related field for example medicine, nursing, pharmacy, physical therapist, health sciences, microbiology, and public health. A large proportion of the respondents (99%) had heard about antibiotics while only 0.5% stated that they were unaware of information regarding antibiotics.

Only 29.5% of the participants had previous exposure to information on antibiotic resistance with more than half (70.5%) having no prior exposure to antibiotic resistance education. Most of the respondents (86.2%) were members of the public who were not healthcare professionals. However, nurses (5.8%) and other healthcare professional (6.0%) made up the majority of the healthcare professionals represented. Regarding antibiotic use, 91.4% of the participants had used an antibiotic in the past with the last antibiotic use being six months or more prior to completing the survey having the highest percentage (29.1%). The majority of respondents (95.2%) were not using antibiotics at the time of the study. When asked about the names of the antibiotics that the respondents were familiar with 19.6% mentioned penicillin, 16.6% gave more than one antibiotic name while 9.3% stated the wrong names such as Tylenol and Benadryl. Study's participants mentioned they were most likely to get antibiotics from physician (40.1%) and pharmacist (37.1%).

Table 4.1. Demographic Characteristics of Respondents

Participants' Characteristics	Response Options	N = 219	%
Age	18 – 29	106	48.4
	30 – 39	30	13.6
	40 – 49	26	11.8
	50 and above	57	26.2
Gender	Male	92	42.0
	Female	127	58.0
Ethnicity	First Nations	11	5.1
	African and Middle East	26	11.8
	Asian	13	6.1
	European	52	23.9
	North and Latin American	86	39.3
	Other	30	13.7
Occupation	Student	85	38.7
	Self-employed	23	10.6
	Employed (government)	27	12.4
	Employed (non-government)	59	26.7
	Other (unemployed, retired)	25	11.6
Location	Lethbridge	160	73.1
	Other (Coaldale, Coalhurst, Fort-Macleod, Raymond, Taber)	59	26.9
Education	Elementary/High School	86	39.4
	College/University	111	50.6
	Postgraduate	22	10.0
Marital Status	Single	118	54.0
	Married	83	37.9
	Other (separated, widowed, divorced)	18	8.1
Chronic Diseases	Yes	21	9.7
	No	192	87.6
	Don't Know	6	2.8
Previous medical Training	Yes	53	24.3
	No	166	75.7
Healthcare Professional	Yes	30	13.8
	No	189	86.2
Healthcare Profession	Non- healthcare professional/not provided	191	87.1
	Physician	1	0.4
	Nurse	13	5.8
	Veterinarian	1	0.4
	Medical laboratory technologist	1	0.4
	Other (AHS worker, recreational therapist, biomed, EMT, HCA, public health specialist)	13	6.0

Table 4.2. Characteristics Assessing Antibiotic Use

Antibiotic use Characteristics	Response Options	N= 219	%
Current Antibiotic Use	Yes	8	3.8
	No	208	95.2
	Dont know	2	1.0
Previous Antibiotic Use	Yes	200	91.4
	No	12	5.7
	Dont know	7	3.0
Antibiotic Information	Yes	217	99.0
	No	1	0.5
	Don't know	1	0.5
Antibiotic Resistance Information	Yes	65	29.5
	No / Don't know	154	70.5
Names of Antibiotic Provided	Not provided	91	41.7
	Penicillin	43	19.6
	Amoxicillin, Amoxicillin/clavulanic acid	16	7.4
	Doxycycline / Tetracycline	4	2.0
	Ampicillin	2	1.0
	Ciprofloxacin	1	0.4
	Septrin (co-trimoxazole)	1	0.5
	Flagyl (metronidazole)	1	0.4
	Keflex (cephalexin)	2	1.0
	More than one name	36	16.6
	Gave wrong names (e.g. prednisone, motrin, tylenol, advil, benadry)	20	9.3
Last Antibiotic Use	Not applicable	8	3.8
	< 6months	5	2.3
	> 6months	64	29.1
	> 12months	41	18.8
	> 2years	46	20.9
	> 5years	55	25.2
Antibiotic Sources	Not provided	29	13.1
	Pharmacy	81	37.1
	Doctor	88	40.1
	Hospital/clinic	17	7.7
	Dentist	4	2.0
Source of Antibiotic Resistance Education	Not provided/not exposed to antibiotic resistance campaign	169	77.1
	Pamphlet	2	0.9
	Internet e.g. Facebook	3	1.2
	Television	10	4.6
	More than one source	18	8.4
	School/educational institution	9	4.1
	Pharmacy	3	1.4
	Work place (e.g. AHS, cattle veterinary seminar)	3	1.3
	Doctor	1	0.4
	Do bug need drugs	1	1

Antibiotic Knowledge (Perceived Behavioral Control)

The first research question that guided this study was "*What is the knowledge of antibiotic treatment and antibiotic resistance among the public in southwest Alberta*?" Seventeen questions were utilized to evaluate knowledge related to antibiotic use and resistance. A knowledge score was determined by calculating the number of correct answers to these 17 questions. The mean knowledge score was 10.3 (SD=3.6), and the median was 11.0. Inadequate and adequate knowledge was defined as a total knowledge score of 0-11 and 12-17, respectively. A large proportion (71%) of respondents knew that viruses cause the majority of colds and coughs. About 44.6% of participants correctly disagreed by saying no with the statement that antibiotics work on most sore throats and 63.8% of respondents correctly answered no the question about using antibiotics to treat coughs and colds. 56.7% of the participants correctly disagreed by saying no to the statement that antibiotics can kill viruses. Over half (53.7%) did not know that antibiotics can kill bacteria that normally live on the skin and in the gut. 86.0% of respondents had correct knowledge of the meaning of antibiotic resistance. Some of the respondents were also misinformed regarding the reduced effectiveness of treatment if the full course of antibiotic treatment was not completed and the potential to spread antibiotic-resistant bacteria. A surprising finding from the respondent's responses was the misunderstanding of how antibiotic resistance happens. Although 86% of the participants correctly agreed by saying yes to the statement, if antibiotics are taken for a long-time bacteria can become resistant, about 60% of the respondents incorrectly agreed by saying yes to the statement, if antibiotics are used less than the prescribed dose bacteria become less resistant. This may indicate that the respondents do not understand the concept of antibiotic resistance. Both prolonged antibiotic use and using less than the prescribed doses of antibiotics can be

classified as antibiotic misuse, and antibiotic resistance can result from any form of inappropriate antibiotic use (Table 4.2).

Assessment of the difference between groups in their knowledge of antibiotics. A chi-square test was conducted to evaluate whether groups (Location, Marital status, Education, Ethnicity, Occupation, Age, and Gender) differed in their knowledge of antibiotics.

A significant chi-square was obtained for Marital Status, $\chi^2_{(2,N=219)} = 25.8$, $p < 0.001$. Follow up pairwise comparisons using Bonferroni correction found significant differences between single and married in their knowledge of antibiotics (more adequate antibiotic knowledge in married, more inadequate antibiotic knowledge in single) $\chi^2_{(1,N=201)} = 24.37$, $p < 0.001$. Also between married and others (separated, widowed, divorced) (more adequate antibiotic knowledge in married, more inadequate antibiotic knowledge in other) $\chi^2_{(1,N=100)} = 6.87$, $p = 0.009$.

A significant chi-square was obtained for Education, $\chi^2_{(2,N=219)} = 17.53$, $p < 0.001$. Follow up pairwise comparisons using Bonferroni correction found significant differences between elementary/high school and college/university in their knowledge of antibiotics (more adequate antibiotic knowledge in college/university, more inadequate antibiotic knowledge in elementary/high school education) $\chi^2_{(1,N=197)} = 16.59$, $p < 0.001$. Also between elementary/high school and postgraduate (more adequate antibiotic knowledge in postgraduate, more inadequate antibiotic knowledge in elementary/high school). $\chi^2_{(1,N=107)} = 6.29$, $p = 0.012$.

A significant chi-square was obtained for Ethnicity, $\chi^2_{(5,N=219)} = 17.12$, $p = 0.004$. Follow up pairwise comparisons using Bonferroni correction found significant differences

between people with Asian and European ethnicity in their knowledge of antibiotics (more adequate antibiotic knowledge in European, more inadequate antibiotic 6knowledge in Asian) $\chi^2_{(1,N=65)}$ = 12.06, p = 0.001.

A significant chi-square was obtained for Age, $\chi^2_{(3,N=219)}$ = 14.59, p = 0.002. Follow up pairwise comparisons using Bonferroni correction found significant differences between 18-29 and 40-49 in their knowledge of antibiotics (more inadequate antibiotic knowledge in 18 – 29, more adequate antibiotic knowledge in 40 – 49) $\chi^2_{(1,N=132)}$ = 9.49, p = 0.002. Also between 18 – 29 and 50 and above (more inadequate antibiotic knowledge in 18 – 29, more adequate knowledge in 50 and above age) $\chi^2_{(1,N=163)}$ = 8.66, p = 0.003.

Table 4.3. Antibiotic Knowledge among the Public in Southwest Alberta

	Questions Assessing Antibiotic Knowledge	Correct Response N=219 (%)	Incorrect Response N=219 (%)
1.	I can differentiate between bacterial and viral infection	107 (49%)	112 (51%)
2.	Viruses cause most cold and cough	156 (71%)	63 (29%)
3.	Antibiotics are prescribed for most cold and cough	140 (64%)	79 (36%)
4.	Antibiotics are effective for most sore throat	98 (45%)	121 (55%)
5.	Antibiotics can kill bacteria	178 (81%)	41 (19%)
6.	Antibiotics can kill viruses	124 (57%)	95 (43%)
7.	Bacteria that live normally on the skin and in the guts, are good for the health	166 (76%)	53 (24%)
8.	Antibiotics does not kill the bacteria that live normally on the skin and in the guts	101 (46%)	118 (54%)
9.	Antibiotics are the same as the medications used to relief pain and fever (e.g. aspirin, Tylenol)	189 (86%)	30 (14%)
10.	Antibiotics resistance means that bacteria will not be killed by antibiotics	169 (77%)	50 (23%)
11.	Infections caused by antibiotic resistant bacteria cannot be easily cured or cannot be cured	119 (54%)	100 (46%)
12.	If antibiotics are taken for long period of time, bacteria become resistant to antibiotics	188 (86%)	31 (14%)
13.	If antibiotics are taken less than the prescribed dose, bacteria becomes less resistant to antibiotics	88 (40%)	131 (60%)
14.	If twice the prescribed dosage of antibiotic is taken, the effects of antibiotics are more rapid	141 (64%)	78 (36%)
15.	The prescribed dose and duration of antibiotics can be terminated if the symptoms improve	140 (64%)	79 (36%)
16.	Antibiotic resistance can spread between bacteria	97 (45%)	122 (56%)
17.	Antibiotics have no side effects	165 (75%)	54 (25%)

Antibiotic Attitude (Attitude and Subjective Norm)

The second research question was "*What attitudes do the public have towards antibiotic use*?" Eleven questions assessed attitudes toward antibiotic use. Questions 1 through 6 as well as questions 9, 10, and 11 measured negative attitudes, while questions 7 and 8 measured positive attitudes. An attitude score was determined by calculating the number of appropriate responses to these 11 questions. The mean attitude score was 7.2 (SD 2.4), and the median was 8. Poor and good antibiotic attitudes were defined as a total attitude score of 0-7 and 8-11, respectively. About 34.7% of the participants expected antibiotics to be prescribed if they suffer from common cold symptoms while 28.8% respondents said that they requested antibiotics to prevent cold symptoms from getting worse. 14. 6% of the participants said they had taken unconsumed antibiotics from previously filled prescriptions without first consulting a doctor, and 33.3% of respondents stopped taking antibiotic courses when they felt better. Additionally, 26.7% of respondents confirmed that they stock antibiotics at home in case of an emergency and 42.8% were aware of which of the prescribed drugs was an antibiotic when they take cold medications (Table 4.3).

Assessment of the difference between groups in their attitudes regarding antibiotic use. A chi-square test was conducted to evaluate whether the groups (Location, Marital status, Education, Ethnicity, Occupation, Age, and Gender) differ in their attitude towards antibiotics.

A significant chi-square was obtained for Marital Status, $\chi^2_{(2,N=219)} = 17.72$, $p < 0.001$. Follow up pairwise comparisons using Bonferroni correction found significant differences between single and married respondents in their attitude towards antibiotics

(more poor antibiotic attitude in singles, more good antibiotic attitude in married) $\chi^2_{(1,N=201)}$ = 17.63, p < 0.001.

A significant chi-square was obtained for Education, $\chi^2_{(2,N=219)}$ = 12.73, p = 0.002. Follow up pairwise comparisons using Bonferroni correction found significant found differences between elementary/high school and college/university in their attitude towards antibiotics (more poor antibiotic attitude in elementary/high school, more good antibiotic attitude in college/university) $\chi^2_{(1,N=197)}$ = 12.73, p < 0.001.

A significant chi-square was obtained for Ethnicity, $\chi^2_{(5,N=219)}$ = 17.82, p = 0.003. Follow up pairwise comparisons using Bonferroni correction found significant differences between people with Asian and European ethnicity in their attitude towards antibiotics (more poor antibiotic attitude in Asian, more good antibiotic attitude in Europeans) $\chi^2_{(1,N=65)}$ = 11.218, p = 0.001. Also, there was a significant difference between people with Asian and North and Latin American ethnicity (more poor antibiotic attitude in Asian, more good antibiotic attitude in North and Latin American) $\chi^2_{(1,N=99)}$ = 12.64, p < 0.001.

A significant chi-square was obtained for Occupation, $\chi^2_{(4,N=219)}$ = 12.64, p = 0.013. Follow up pairwise comparisons using Bonferroni correction found significant differences between student and self-employed in their attitude towards antibiotics (more poor antibiotic attitude in students, more good antibiotic attitude in self-employed) $X^2_{(1,N=107)}$ = 8.69, p = 0.003.

A significant chi-square was obtained for Age, $\chi^2_{(3,N=219)}$ = 21.58, p < 0.001. Follow up pairwise comparisons using Bonferroni correction found significant differences between age group 18-29 and 40-49 in their attitude towards antibiotics (more poor attitude in 18-

29, more good attitude in 40-49) $\chi^2_{(1,N=131)} = 13.88$, $p < 0.001$. Also between people within the 18 – 29 and people in the age group 50 and above (more poor attitude in 18-29, more good attitude in 50 & above) $\chi^2_{(1,N=163)} = 13.12$, $p < 0.001$.

Association between Knowledge of and Attitudes toward Antibiotic Use

A Phi (ϕ) test was conducted to evaluate the strength of the relationship between antibiotic knowledge and attitudes regarding antibiotic use. A significant positive association was obtained, phi $\phi = 0.42$, $p < 0.01$, indicating that certain antibiotic knowledge is positively associated with certain attitudes regarding antibiotic use.

Table 4.4. Antibiotic Attitude among the Public in Southwest Alberta

	Questions Assessing Antibiotic Attitude	Appropriate Response N=219	Inappropriate Response N=219
1.	I expect antibiotics to be prescribed by my doctor if I suffer from common cold symptoms	143 (65%)	76 (35%)
2.	If I catch a cold, I ask for antibiotic prescription to prevent my symptoms from getting worse	156 (71%)	63 (29%)
3.	I believe that antibiotics cure my cold faster	128 (58%)	91 (42%)
4.	I take left-over antibiotics when I have flu or other symptoms	187 (85%)	32 (15%)
5.	I stop taking the prescribed antibiotics once I get better	146 (67%)	73 (33%)
6.	I prefer a shot (injection) to an oral medication if antibiotics are needed	124 (57%)	95 (43%)
7.	I check to see if the antibiotics are included within the prescribed cold medicine	46 (21%)	173 (79%)
8.	I know which medication is an antibiotic when I take cold medicines	94 (43%)	125 (57%)
9.	If my family member is sick, I usually give my prescribed antibiotic to them	185 (84%)	34 (16%)
10.	I normally keep antibiotic stock at home in case of an emergency	161 (73%)	58 (27%)
11.	I take antibiotics according to the instructions on the label	203 (93%)	16 (7%)

Predictors of Antibiotic Knowledge and Attitude

The third research question was: "*What are the predictors of adequate antibiotic knowledge and good antibiotic attitude among the public in southwest Alberta*?"

A SPSS binary logistic regression investigated characteristics differentiating people with adequate antibiotic knowledge from people with inadequate antibiotic knowledge. Seven predictor variables were used: Age, Location, Marital status, Education, Ethnicity, Occupation, Gender, and Antibiotic resistance education. All variables with more than two levels were dummy coded, entry of variables into the equation was stepwise (Forward Wald), variable entry order was determined by the size of the Wald statistics, with a minimum entry level of p = 0.10 and removal level of p = 0.15. Data from 219 people were available for analysis, 127 with adequate knowledge and 92 with inadequate knowledge. Maximal discrimination between the groups occurred with a constant and only five predictor variables. A test of the full model was statistically significant, $\chi^2_{(5,N=219)}$ = 72.69, p < 0.001, indicating that the five predictors reliably distinguished people with adequate knowledge and people with inadequate knowledge (Table 4.5.), the variables that were not statistically significant are shown in Table 4.6. The Nagelkerke R^2 = 38%, which suggests that the model explains roughly thirty-eight percent of the variation in the antibiotic knowledge outcome. The classification table from the regression analysis showed that this approach of predicting the respondents with antibiotic knowledge is correct 78.7% of the time with 72.4% of the respondents with adequate antibiotic knowledge correctly classified and 83.3% of the respondents with inadequate antibiotic knowledge correctly classified. The Hosmer & Lemeshow test of the goodness of fit suggests the model is a good fit to the data as p=0.330 (> 0.05). Respondents who were married (OR = 3.30, CI = 1.63- 6.69)

were 3.30 times more likely to have adequate antibiotic knowledge. Respondents of European ethnicity (OR = 3.85, CI = 1.75 – 8.49) were 3.85 times more likely to have adequate antibiotic knowledge. Respondents who had exposure to antibiotic resistance education (OR = 5.25, CI = 2.54 – 10.87) were 5.25 times more likely to possess adequate knowledge of antibiotics. On the other hand, participants with an elementary/high school as the highest level of education (OR = 0.33, CI = 0.16 – 0.67) and of African/Middle-east ethnicity (OR = 0.32, CI = 0.11 – 0.96) were less likely to have adequate antibiotic knowledge (Table 4.5.).

A SPSS binary logistic regression investigated characteristics differentiating people with good antibiotic attitude from people with poor antibiotic attitude. Seven predictor variables were used: Age, Location, Marital status, Education, Ethnicity, Occupation, Gender, and Antibiotic resistance education. All variables with more than two levels were dummy coded, entry of variables into the equation was stepwise (Forward Wald), variable entry order was determined by the size of the Wald statistics, with a minimum entry level of $p = 0.10$ and removal level of $p = 0.15$. Data from 219 people were available for analysis, 115 with good antibiotic attitude and 104 with poor antibiotic attitude. Maximal discrimination between the groups occurred with a constant and only six predictor variables. A test of the full model was statistically significant, $\chi^2_{(6,N=219)} = 57.25$, $p < 0.001$, indicating that six predictors reliably distinguished between people with good attitude and people with poor attitude (Table 4.7.), the variables that were not statistically significant are shown in Table 4.8. The Nagelkerke $R^2 = 31\%$, which suggests that the model explains roughly thirty-one percent of the variation in the antibiotic attitude outcome. The classification table from the regression analysis showed that this approach of predicting the

respondents with antibiotic attitude is correct 68.4% of the time with 78.1% of the respondents with good antibiotic attitude correctly classified and 57.7% of the respondents with poor antibiotic attitude correctly classified. The Hosmer & Lemeshow test of the goodness of fit suggests the model is a good fit to the data as p=0.473 (> 0.05). The respondents within the age group 40 – 49 years (OR = 5.17, CI = 1.47 – 18.14) were 5.17 times more likely to possess good attitude regarding antibiotic use. Respondents with a college/ university degree (OR = 2.10, CI = 1.14 – 3.87) were 2.10 times more likely to have a good antibiotic attitude. Respondents who had exposure to antibiotic resistance education (OR = 2.95, CI = 1.45 – 5.99) were 2.95 times more likely to have a good antibiotic attitude. On the other hand, Respondents who were single (OR = 0.45, CI = 0.23–0.85) and of First Nations/Asian (OR = 0.17, CI = 0.05 – 0.56) or African/middle east ethnicity (OR = 0.25, CI = 0.09 – 0.67) were less likely to have good attitude towards antibiotic use (Table 4.6.).

Table 4.5. Predictors of Adequate Antibiotic Knowledge in Southwest Alberta

Predictors	**Odds Ratio Exp(B)**	**95% Confidence interval for Exp (B)**	**P values**
Married	3.299	1.626 – 6.691	0.001
Elementary/High school	0.325	0.158 – 0.667	0.002
African/Middle east	0.321	0.108 – 0.956	0.041
European	3.848	1.745 – 8.486	0.001
Antibiotic Resistance Education	5.254	2.540 – 10.866	0.000

Table 4.6. Variables That Were Not Statistically Significant Predictors of Antibiotic Knowledge

Variables	**P values**
18 – 29	0.837
30 – 39	0.850
40 - 49	0.441
50 and above	0.339
Single	0.596
Other (separated, widowed, divorced)	0.596
College / University	0.766
Post graduate	0.766
Students	0.432
Self-employed	0.903
Employed (government)	0.969
Employed (non-government)	0.631
Other (unemployed, retired)	0,653
Aboriginal or Asian	0.226
North and Latin American	0.359
Other	0.989
Location	0.779
Gender	0.756

Table 4.7. Predictors of Good Attitudes Regarding Antibiotic Use in Southwest Alberta

Variables	Odds Ratio Exp (B)	95% Confidence interval for Exp (B)	P values
Single	0.445	0.233 – 0.849	0.010
40-49	5.166	1.471 – 18.141	0.014
College/university	2.103	1.141 – 3.873	0.017
First Nations/Asian	0.166	0.049 – 0.557	0.004
African/middle east	0.250	0.093 – 0.670	0.006
Antibiotic resistance education	2.948	1.449 – 5.999	0.003

Table 4.8. Variables That Were Not Statistically Significant Predictors of Antibiotic Attitude

Variables	P values
18 -29	0.678
30 – 39	0.373
50 and above	0.211
Married	0.517
Other (separated, widowed, divorced)	0.517
Elementary / High school	0.695
Postgraduate	0.695
Students	0.546
Self-employed	0.886
Employed (government)	0.767
Employed (non-government)	0.249
Others (unemployed, retired)	0.670
European	0.886
Other	0.477
Gender	0.159

Summary

The findings regarding antibiotic knowledge indicated that the respondents had some knowledge regarding antibiotic use although there were some knowledge gaps. Regarding antibiotic attitude, findings indicated that there was a significant variation in the respondent's attitude towards antibiotic use. The results also revealed that marital status, education, ethnicity, and antibiotic resistance education were predictors of antibiotic knowledge. Marital status, age, education, ethnicity and antibiotic resistance education were predictors of antibiotic attitude.

An integrative discussion of the research findings and how they are situated in previous literature will follow in the next chapter.

Chapter Five: Discussion, Recommendations, Conclusion

Discussion of Study Findings

The use of antibiotics by the public is a common practice around the world (Kardas et al., 2005) and antibiotics easily available to the public can contribute to antibiotic resistance. The rise of antibiotic resistance over the past decade (Ntagiopoulos et al., 2007), has resulted in the need to curb inappropriate antibiotic use. It is important to mention that low levels of understanding and misconceptions regarding antibiotic use have been found among lay people from previous studies (Curry et al., 2006; Davey et al., 2002; Eng et al., 2003; Hong et al., 1999). The theory of planned behavior (Figure 1.1) explains the influence of behavior determinants investigated as antibiotic knowledge and antibiotic attitude in determining appropriate or inappropriate antibiotic use. Within the context of the research questions that guided the research, I will begin this chapter with a discussion of the key findings of the study and how they relate to the available literature on this topic area. This will be followed by a discussion of my recommendations, limitations of the study and plans for knowledge translation.

Regarding antibiotic use, 25% of the respondents used antibiotics greater than five years ago, while 21% had their last antibiotic use greater than two years ago. About 2% of the participants used antibiotics greater than six months ago, and about 29% of the respondents used antibiotics in the last six months. The most mentioned antibiotics in the study was penicillin. This finding is consistent with previously reported findings from Sweden (Svensson, Haaijer-Ruskamp, & Lundborg, 2004). However, our findings contradict results from other studies in Greece and Indonesia which reported amoxicillin as

the most frequently used antibiotics (Skliros et al., 2010; Widayati, Suryawati, De Crespigny, & Hiller, 2011). Other antibiotics mentioned include doxycycline, ampicillin, ciprofloxacin, and cephalexin. Regarding where people got their antibiotics, most of the respondents obtained antibiotic prescriptions from their physician. In Canada, although some efforts to promote judicious prescribing began in the mid-1990s, a systematic effort began only in 1997 following a consensus conference entitled controlling antimicrobial resistance: An integrated action plan for Canada (Health Canada and the Canadian Infectious Disease Society, 1997). At this meeting, national goals included reducing the number of antibiotic prescriptions for respiratory infections by 25%. Although many regions and provinces in Canada have initiated programs to promote judicious antibiotic prescribing, there are still records of inappropriate prescribing among physicians (Blondel-Hill et al., 1999; Hutchinson & Foley, 1999; Stewart, Pilla, & Dunn, 2000). As mentioned earlier, there is the need to understand the factors that drive inappropriate antibiotic prescription because inappropriate antibiotic prescription can promote antibiotic misuse among the public. Participants were asked if they were aware of antibiotic resistance. The findings show that only 30% of the respondents were aware of this term. Hence it is important that more is done to build awareness around this topic.

Variations in antibiotic knowledge among the public

The first research question that guided this study was "what is the knowledge of antibiotic treatment and antibiotic resistance among the public in south-west Alberta". Findings from this study show that there are variations in what the public know about antibiotics.

Findings showed that 71% of the respondents had appropriate knowledge regarding viruses being the cause of common colds/coughs, a result which is lower than findings from New-Zealand (74%; Norris et al., 2010), South Korea (77%; Kim et al., 2011) and Qatar (81%; Moienzadeh et al., 2015) respectively. Common colds and coughs are prevalent during the fall and winter months, and there are public health education initiatives to prevent and manage these symptoms. In Canada, most public restrooms and facilities have educational materials such as posters about hand-washing to prevent the transmission of flu viruses. In addition, some of these educational materials also state viruses as the cause of coughs and colds. The repetitive access to this information every fall and winter may be responsible for the good level of knowledge in this area.

Regarding the appropriate use of antibiotics, 81% of the participants knew that antibiotics kill bacteria which is comparable to 84% in a study conducted by Cals et al. (2007) and higher than the proportion (46%) reported from South Korea (Kim et al., 2011). On the other hand, 43% of the respondents did not know that antibiotics were not effective against viruses which is lower than the proportions (47-70%) reported from Britain, Europe, Denver, Wisconsin, Minnesota, Republic of Georgia, New Jersey, Netherlands, South Korea, Malaysia, Qatar, and India. (Belongia et al., 2002; Cals et al., 2007; Filipetto et al., 2008; Grigoryan et al., 2007; Kandelaki et al., 2015; Kim et al, 2011; McNulty et al., 2007a; Moienzadeh et al., 2015; Oh et al., 2010; Rao, 2016; Wilson et al., 1999). A possible reason for this knowledge gap among the participants may be due to the words used (‘viruses’ or ‘bacteria’). Respondents may lack adequate knowledge to differentiate between these groups of organisms, hence it may be beneficial to educate public on the differences between viruses and bacteria and the disease they cause.

On the role of antibiotics in the management of common colds and coughs, only 36% of the respondents did not know that antibiotics were not effective for most coughs and colds which is comparable to a United Kingdom (UK) (McNulty et al., 2007a) and Malaysian (Oh et al., 2010) study that found the proportion to be 38% and 38% respectively. The result from this study was lower than the proportions 40%, 57%, 70%, 83% reported in Britain (McNulty et al., 2007a), Qatar (Moienzadeh et al., 2015), South Korea (Kim et al., 2011) and Mongolia (Togobaatar et al., 2010) respectively, and higher than those reported in the United States of America 27% (Eng et al., 2003), Hong Kong 17% (McNulty et al., 2007a) and Sydney 3% (Raz, Edelstein, Grigoryan & Haaijer-Ruskamp, 2005). The frequent use of antibiotics for common colds and coughs which are mostly viral infections and self-limiting has influenced how the public think about the effectiveness of antibiotic in treating these illnesses (Belongia & Schwartz, 1998; Gonzales, Steiner & Sande, 1997; Pechere, 2001). This irrational use of antibiotics could subsequently become repeated which is dangerous in an era of increasing resistance to antibiotics (Belongia & Schwartz, 1998).

Regarding the effectiveness of antibiotics for most sore-throats, more than half (55%) of the participants did not know that antibiotics are not effective for many sore throat infections which is higher than the proportions 40% reported from an online survey (Carter et al., 2016) and less than the 70% reported from a study conducted by WHO in Barbados, China, Egypt, India, Indonesia, Mexico, Nigeria, the Russian Federation, Serbia, South Africa, Sudan and Vietnam (WHO, 2015). On the other hand, the finding from this study is lower than the report of 74% from Mongolia (Togobaatar et al., 2010). Most sore-throats are caused by viruses, although there is the sore-throat infection caused by bacteria which

is commonly referred to as strep throat. Hence, it is important that the public is aware that not all throat infections are of bacterial origin.

A good proportion of the participants had appropriate knowledge on completing a course of antibiotic treatment. Sixty-four percent of the study population stated that the prescribed dose and duration of antibiotics should not be terminated when symptoms improve which is lower than findings (70%) from Qatar (Moienzadeh et al., 2015), and higher than reports from other surveys which reported 34% (Rao, 2016), 53% (Chen et al., 2005), 58% (You et al., 2008), and 50% (Belongia et al., 2002). An understanding of this concept is important because premature discontinuation of antibiotics puts individuals at risk of infection relapse, colonization with antibiotic-resistant organisms and complicated disease outcomes (Carey & Cryan 2003; Liu et al., 2002). Concentrations of antibiotics in the body that are sub-inhibitory resulting from incomplete dosage regimen may lead to the development of antibiotic resistance (Sarkar & Gould 2006).

With regards to differentiating antibiotics from other medications only 14% of the respondents confused antibiotics with other medications such as aspirin an anti-inflammatory /antipyretic and an analgesic agent which is lower than the reports from studies conducted in Taiwan 51% (Chen et al., 2008) and Malaysia 21% (Oh et al., 2010). There are other studies that have reported some misunderstandings between cold medicines, analgesics and antibiotics (Chandler & Dugdale 1976; Hong et al., 1999). The mix-up of these medications may be a possible reason for the public's belief regarding the use of antibiotics for common colds and other non-bacterial illnesses.

Eighty-six percent of the respondents were aware of antibiotic resistance which is higher than findings from a study in Europe (Grigoryan et al., 2007) and two studies in the United States of America (Corbett et al., 2005; Eng et al., 2003) which reported that 50%, 58% and 73% of the respondents respectively were aware of antibiotic resistance. You et al. (2008) reported findings (65%) that were lower than the result from this study. The awareness of the danger of antibiotic resistance among the public may be instrumental in curbing irrational antibiotic use.

Variations in antibiotic attitude among the public

The second research question that guided this study was "what is the attitude towards antibiotic treatment and antibiotic resistance among the public in south-west Alberta". Findings from this research indicate that there are variations in the attitude of the public towards antibiotics.

Antibiotics are formulated in various dosage forms which can be oral, intravenous or intramuscular. In most mild to moderate bacterial infections that are not widespread, oral antibiotics are usually preferred because of the side effects associated with injectable such as injection site reactions. Injectable antibiotics are usually indicated for serious infections that require immediate treatment because they are quickly absorbed by the body and rapidly relieves symptoms. In this study, about 43% of the study participants preferred an injectable antibiotic to oral antibiotics which are similar to findings 46% by Sirijoti, Hongsranagon, Havanond, and Pannoi (2014). A possible reason for this may be the perception among the public that injectable antibiotics work faster. Hence there is a need to discuss the differences and role of the various dosage forms of antibiotics among the public.

More respondents (67%) in this study complied with completing an antibiotic treatment course when compared with findings from other similar studies 58%, 45%-59% and 50% (Belongia et al., 2002; Chen et al., 2005; You et al., 2008). An important reason for completing antibiotic treatment is that bacteria can become resistant when they are under-treated. Bacteria usually undergo a multiplication process where they can change their deoxyribonucleic acid (DNA), which empowers their ability to become resistant to antibiotics. Following this multiplication, a host of bacteria that no longer responds to antibiotics is generated in the presence of less than required strength of antibiotics. WHO advises that individuals should always take the complete prescription even if they feel better earlier (WHO, 2015).

Forty-two percent of the participants believed that taking antibiotics would result in a quicker recovery which is similar to findings 48% from Kim et al. (2011) and higher than the reports from a United Kingdom 32% and Swedish 19% study (Andre et al., 2010; McNulty et al., 2007a). A possible reason for this perception about antibiotics may be because when antibiotics are recommended for bacterial infections, there is usually speedy recovery of symptoms once the bacteria gets in contact with antibiotics. However, this is not applicable to all diseases because symptoms associated with an etiology that is not bacterial will not produce the same response.

About 35% of the respondents reported their expectations of an antibiotic prescription from a physician for flu-like symptoms which is higher than the 15% reported from the study by Chen et al. (2005). On the other hand, the findings from this study were lower than reports 47% and 48% from Malaysia and the United States of America (Eng et al., 2003; Oh et al., 2010). Various studies have revealed the pressure from patients as a

frequently cited factor influencing the prescription of antibiotics (Barah, Morris, & Goncalves, 2009; Bradley, 1992, Edwards, Dennison, & Sedgwick, 2013; Macfarlane, Lewis, Macfarlane, & Holmes, 1997; Oh et al., 2010; Ong et al., 2007; Parimi et al., 2002; Parimi, Pereira, & Prabhakar, 2004, Rouusounides et al., 2011; Virji & Britten, 1991; Web & Lloyd, 1994; Weiss, Deave, Peters, & Salisbury, 2004). Evidence has also suggested that patients may influence antibiotic prescriptions from their physician through overt requests for antibiotics or non-overt pressure (Davey, Pagliari, & Hayes, 2002; Finch, Metlay, Davey, & Baker, 2004; Scott et al., 2001). The pressure from patients to prescribe antibiotics particularly for common cold symptoms has also been identified as the most common reason for physician's discomfort with their prescribing decisions (Bradley, 1992; Ong et al., 2007; Rouusounides et al., 2011). Ultimately, the prescription of antibiotics for the treatment of flu-like symptoms facilitates the belief that antibiotics are effective and can result in increased antibiotic consumption (Orr, Scherer, Macdonald, & Moffatt, 1993).

About 16% of the respondents' report sharing antibiotics with family members which is higher than the reports from other studies 8%, 13% (Chen et al., 2005; You et al., 2008) and lower than findings 17%, 31%, 37% from Lim and Teh (2012), Rao (2016) and Moienzadeh et al. (2015) respectively. The sharing of antibiotics with others can promote the exposure of the community to the problems of antibiotic misuse. This is because the sharing of antibiotics results from inappropriate use where the person who the antibiotics was originally prescribed for did not finish the course of treatment. The shared antibiotics may not also be appropriate for the family member or friend's illness, or used in the right dose or for the correct duration. Hence, this should be discouraged to delay or decrease the development and spread of antibiotic resistance.

Regarding the storage of antibiotic stock at home for future use, 27% of the respondents agreed that they keep antibiotics at home in case of an emergency which is lower than 48%, 55%, 88% reported in other studies (Arshad, Ijaz, & Hussain, 2007; Moienzadeh et al., 2017, Rao, 2016). On the other hand, this report is higher than findings 17% and 20% from Lim and Teh (2012) and Oh et al. (2010). Inappropriate antibiotic use can be encouraged by the disposal and storage of unused antibiotics by respondents. Accessibility to left-over antibiotics especially those stored in unlocked drawers can increase the tendency for misuse not only by the person who stored it but also by other people within the household (Igbeneghu, 2013).

Adherence to instructions on antibiotic labels is important as it ensures that the medication is used appropriately. In this study, 7% of the respondents stated that they do not take antibiotics according to the instructions on the label. This finding is higher than reports 4%, 7% and 5% from other studies (Chen et al., 2005; Lim & Teh, 2012; Oh et al., 2010) and lower than 14% reported by Sirijoti et al. (2014). It is important to mention that, the risk of adverse events associated with antibiotics can be reduced by checking and complying with label instructions containing dosage instructions as well as auxiliary labels such as taking medication with or without food.

Predictors of Antibiotic Knowledge and Attitude towards Antibiotic use

In this study, education was identified as a major predictor of antibiotic knowledge. Compared to those with a college education and higher, respondents with elementary/high school education were less likely to have good knowledge about antibiotics. The lack of knowledge among those with lower educational level has been stated in other studies

conducted in various countries (Andre et al., 2010; Eng et al., 2003; McNulty et al., 2007a; McNulty et al., 2007b; Oh et al., 2010; Rouusounides et al., 2011; You et al., 2008). In addition, individuals with low level of education seem to have the greatest misconceptions regarding antibiotic use (Chan, 1996; Mainous, Zoorob, Oler, & Haynes 1997). Findings also show that respondents with a college/university education were more likely to have a good antibiotic attitude which is similar to the findings from other studies (You et al., 2008; Kim et al., 2011; Oh et al., 2010). A possible reason for this is that individuals with this level of education are usually exposed to a wide variety of information including antibiotic information which consequently influences their attitudes.

Respondents within the age group 40-49 were more likely to have a good attitude towards antibiotic use which is similar to findings from Oh et al. (2010). However, findings from other studies show the opposite, respondents within the age group 18 – 29 were reported to have a better attitude regarding antibiotic use (Kim et al., 2011; McNulty et al., 2007a; Rouusounides et al., 2011). A possible reason for this difference may be a variation in the age group of individuals across different countries that have access to public health education on antibiotics.

Respondents who acknowledged to have been exposed to antibiotic resistance education were more likely to have good antibiotic knowledge and attitude which is similar to findings from Cals et al. (2007) and Godycki et al. (2014). Given the scale of the problem of antibiotic resistance, it is essential that the public is educated about this topic, the consequences and what they can do to tackle it as this may be helpful in improving antibiotic knowledge.

Reports from this study show ethnic differences in the levels of knowledge and attitude regarding antibiotic use which aligns with findings from Corbett et al., (2005). Respondents in the African/Middle Eastern ethnic group were less likely to have good antibiotic knowledge, while respondents in the European ethnic group were more likely to have good antibiotic knowledge. In addition, respondents in the First Nations/Asian and African/Middle east ethnic group were less likely to have good attitudes towards antibiotic use. Mangione-Smith et al. (2004) reported that Asians were more likely to think that antibiotics were required for cold symptoms. This might be explained by varying cultural belief system with regards to the role of antibiotics in the management of diseases.

Apart from the variables that were significant predictors of antibiotic knowledge and attitude, there were other variables such as gender and occupation that were not statistically significant predictors of antibiotic attitude and knowledge. This is similar to findings from Kim et al. (2011) and Oh et al., (2010). However, findings from You et al. (2008) revealed that the male gender was a predictor of poor attitude towards antibiotic use. There is a need to explore the role of these variables in predicting antibiotic knowledge and attitude.

Implication for Health Promotion and policy

This study proposes several implications for health promotion and policy interventions that could improve rational antibiotic use among the public.

The theory of planned behavior, explains that the variables perceived behavioral control, attitude and subjective norm are good guides for targeting an intervention. Intervention designed to change inappropriate antibiotic use can be directed at one or more

these determinants. Hence, findings from this study may be helpful in drafting effective public education materials to address antibiotic misuse and resistance.

Inadequate antibiotic knowledge and poor attitude towards antibiotics were observed among the age group 18 – 29 years, hence it is recommended that educational interventions should be made accessible to this group. For example, most people in this age group are very familiar with the internet and are increasingly using the internet for entertainment and to obtain information (Forsyth, Kennedy, & Malone, 2013). Hence, public health education on antibiotics and antibiotic resistance should be channeled through this medium to ensure that this group of people is effectively reached. This might help facilitate improved knowledge and attitude towards antibiotic use. In addition, public health education media on antibiotics at educational institutions such as universities and colleges, should be intensified to raise awareness of rational antibiotic use.

The findings of this study indicate that individuals with elementary/high school level of education had poor antibiotic knowledge and attitudes. It is likely that improvement in the public health literacy concerning antibiotics among this group may potentially improve knowledge and attitudes. The content of public health educational messages should be developed and designed specifically to meet the needs of this target audience. For groups with lower educational levels repeated information using short, tailored slogans and cues to action would generate knowledge on antibiotics (Marx, Nedelmann, Haertle, Dieterich, & Eicke, 2008). Equally important is addressing the specific beliefs associated with antibiotic use. For example, the belief that supports antibiotic injections over oral antibiotics was predominant. Although this beliefs and attitude may be difficult to change, tailored educational messages may successfully improve antibiotic knowledge and attitude.

Previous exposure to antibiotic resistance education was a strong predictor of both antibiotic knowledge and attitude. It is important that community oriented activities are developed that focus mainly on antibiotic resistance. This may involve the use of pamphlets that give a simple explanation on antibiotic resistance. These pamphlets can be distributed to clinics, pharmacies as well as shopping malls. Educational posters on antibiotic resistance can also be developed, and this can be posted in clinics and community organizations.

Ethnicity was also a strong predictor of both antibiotic knowledge and attitude. The concept of cultural competency may be helpful in improving antibiotic knowledge and attitude, especially among minority ethnic groups. Cultural competency is used to describe a variety of interventions that aim to improve the accessibility and effectiveness of healthcare services for people from racial/ethnic minorities (Saha, Beach, & Cooper, 2008). Hence, the process of developing culturally safe interventions addressing antibiotic misuse should involve acknowledging the importance of culture and the presence of cultural differences and culturally unique needs with regards to the use of antibiotics. It is also important to recognize that cultural competence for one ethnic group does not necessarily translate into competence for another (Kim, Kim, & Kelly, 2006). Hence there is the need for competence to be developed in specific intercultural contexts. In addition, cultural competence requires that healthcare professionals identify and challenge their cultural assumption, values, and beliefs and strive to understand antibiotics through others cultural lens (Tervalon, Murray-Garcia 1998). In western countries where antibiotics are available as a prescription only medication, it is important to understand that this is not the case in some other countries. For individuals whose country of origin have antibiotics accessible

over the counter, the long wait times for physician in western countries can be a barrier to appropriate antibiotic use and can result in antibiotic hoarding. Hence members of the public should be informed of other healthcare professionals such as pharmacists who are licensed to recommend antibiotics which means they still get to be assessed by a healthcare professional before using antibiotics without the long wait times at the clinic.

Other findings from this study also indicate that several health policy interventions are needed to address the changes required to positively influence antibiotic knowledge and attitude. Antibiotics were reportedly sourced from physician, dentist, pharmacy, and hospitals hence strong physician-patient relationships can encourage positive antibiotic knowledge and attitude. This relationship builds trust in the healthcare system, which may then serve as an effective tool for the dissemination of public health education on antibiotics to the public. In addition, physician and other healthcare professional recommendation appear to be an important, influential factor in antibiotic use. Thus, physicians and other healthcare professionals should be encouraged to recommend rational antibiotic use during encounters with the public.

Beyond public health education intervention, further research should be funded to investigate alternative non-antibiotic treatments for common primary problems, e.g., non-antibiotic urinary bacterial inhibitors and symptomatic relief of upper respiratory tract symptoms. In addition, research can also focus on ways to structurally modify older narrow-spectrum antibiotics for new problems such as methicillin-resistant Staphylococcus aureus (MRSA) infection.

Limitations of the Research Study

Despite the novel results obtained from this study, there are several limitations that are worth discussing. First, this study used a cross-sectional design, which impedes any specific conclusion regarding causal relationships between the dependent and independent variables.

Another limitation is that as with most surveys that are conducted with a self-administered questionnaire, there is the possibility that respondents may over report behaviors that are socially desirable or under-report behaviors that are socially undesirable. There was no instrument to objectively assess the honesty and recall ability of the participants, as well as their understanding of the questionnaire. To minimize this bias, the adapted scale used for the study was pilot tested among 20 participants as well as had a Cronbach alpha of 0.81 for the statements assessing antibiotic knowledge and 0.76 for the statements assessing antibiotic attitude. The questionnaire was also void of identifying data for the assurance of confidentiality.

Thirdly, this study was conducted within south-west Alberta which consists of mostly rural population except for Lethbridge, which is the only city in the region. Hence the findings may not reflect the actual situation across Canada.

Fourthly, this study majorly relied on the reports or answers provided by the respondents who may be limited by recall bias. When people remember past events or information, they may not always have the complete or accurate picture. In this study, the limitation of recall bias was minimized by giving the respondents adequate time to think about the questions while filling out the questionnaire.

Finally, an additional limitation is the use of convenience sampling for recruiting the participants of the study. Respondents who volunteered may have been more interested in the research topic and consequently more interested in sharing their perspective which might facilitate selection bias. Although there were certain limitations to this research study, several steps were taken to ensure the quality of the research findings.

Recommendations for Future Research

During the process of gathering information for literature review, I recognized that there are limited studies evaluating this topic area in Canada. Conducting a national survey will be beneficial in understanding the knowledge and attitude of antibiotics among Canadians. This will also provide an insight into the variations and knowledge gaps that may be peculiar to a particular region. In addition, there is also a need for a national longitudinal study to evaluate changes in attitude, knowledge, and perception of antibiotics.

It may be beneficial also to conduct a qualitative study to explore an in-depth understanding of this topic area from various individual perspectives. Qualitative approaches allow for an in-depth exploration and generation of new insight into a topic interest. In addition, the role of ethnicity in predicting antibiotic knowledge and attitude can also be explored.

Plans for Research Dissemination

This thesis can be viewed as one method of disseminating the findings from this study. However, I intend to participate in other dissemination activities. I intend to disseminate the research findings at relevant scholarly conferences. This will include both the presentation of abstracts as well as oral presentation. I will also be presenting the

findings of my study to the management of Do Bugs Need Drugs. I will also present the findings of the research at the various public occasions and location where I recruited participants for the study, they include Rib-fest, Dominion gateway church and Afro-Caribbean festival. I also plan to submit the findings of this research to scholarly, peer-reviewed journals for potential publication. Examples of journals that may be suitable for publishing are *Health Affairs, African Journal of Health Sciences, Human Resources for Health and The Lancet Infectious Diseases.*

Conclusion

Antibiotics are important for the management of bacterial infections. To ensure effective disease management by antibiotics, measures need to be taken to limit the exposure of the bacterial population to antibiotics through antibiotic misuse. Antibiotic resistance is strongly associated with improper antibiotic usage. The prudent use of antibiotics is crucial for protecting their clinical effective, hence rational antibiotic use may be useful in decreasing antibiotic resistance (You et al., 2008).

Besides the role of prescribers, the public use of antibiotics is also crucial to the control of antibiotic use and antibiotic resistance (Davey et al., 2002). Patient's behavior associated with their attitudes, beliefs, and knowledge may influence the prescription of antibiotics (Davey et al., 2002; Mangione-Smith et al., 2001). Most of the strategies for controlling antibiotic resistance such as educational programmes, policies and guidelines have focused on both physicians and the public to promote the prudent use of antibiotics. The perception of the public on ailments requiring antibiotic therapy, their compliance with treatment course and the channels for obtaining antibiotics are fundamental to any efforts

to control antibiotic use and resistance. A considerable body of evidence has shown widespread problems in knowledge, attitude, beliefs, and behaviors among consumers which influences antibiotic usage. However, there has been limited research in Canada that investigates the public knowledge and attitude regarding antibiotic use.

The purpose of this study was threefold: (1) to examine the public knowledge of antibiotic treatment and antibiotic resistance in southwest Alberta; (2) to determine the public's attitude towards antibiotic use; and (3) to explore the predictors of antibiotic knowledge and attitude among the public in southwest Alberta. The study utilized the quantitative research approach and questionnaires were distributed to individuals across various location in southwest Alberta. Data analysis involved the use of descriptive and inferential statistics.

Findings from this study indicated that while some of the respondents had good antibiotic knowledge and attitude, there were still some misconceptions. The results of this study have identified some areas of misconceptions and specific groups to be targeted for intervention. There is a critical need for actions that effectively builds the understanding of how and when to take antibiotics and what they should be used for, especially targeting groups among whom these misconceptions seem to be most prevalent. Public education campaigns have been shown to be effective in changing attitudes and knowledge about antibiotic use and resistance (Finch et al., 2004; Madle, Kostkova, Mani-Saada, Weinberg & Williams, 2004). In this study, it was found that respondents who had previous exposure to antibiotic resistance education were more likely to have an adequate antibiotic knowledge and good antibiotic attitude. This further shows the importance of public health education in addressing antibiotic misuse. It is therefore suggested that a well-planned,

organized and structured educational program be undertaken to improve the appropriate use of antibiotics and this will require the concerted action of the medical world in collaboration with patient organization and policymakers.

Beyond public health education intervention, further research should be funded to investigate alternative non-antibiotic treatments for common primary problems, e.g., non-antibiotic urinary bacterial inhibitors and symptomatic relief of upper respiratory tract symptoms. In addition, research can also focus on ways to structurally modify older narrow-spectrum antibiotics for new problems such as methicillin-resistant Staphylococcus aureus (MRSA) infection.

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Appendix A

Recruitment Poster

Are you 18 years old and above who resides in any part of southwest Alberta?

Your participation is requested:

I am a graduate student interested in understanding the meanings of antibiotic to the public in south west Alberta. I will like to invite you to contribute by participating in this study.

For more information about this study, or to volunteer contact:

Oyindamola Jaja

Phone no: 403-929-4463 or email: oyindamola.olumuyide@uleth.ca

Appendix B

Participant Consent form

You are invited to participate in the study entitled "Public Attitude and Knowledge Regarding Antibiotic Use and Antibiotic Resistance in Southwest Alberta". The purpose of this study is to evaluate the level of information the public have about antibiotics and antibiotics resistance. Your participation will involve completing an anonymous questionnaire that will take about 10 to 15 minutes.

Potential Risks: There are no anticipated risks to participating in this project.

Potential Benefit: You will not benefit directly from participating in this study however you will be providing information on antibiotics, antibiotic resistance and the results of this project will provide valuable information regarding antibiotic use in southwest Alberta.

Storage of completed questionnaire: For the sake of confidentiality, the completed questionnaire sheets will be stored in a locked filing cabinet for which only the student researcher and the supervisor will have access. After the completion of this project, all the data will be stored in a secured cabinet for a period of five years.

Anonymity: The information you provide will be used as part of the researcher's written master's thesis. However, to ensure that participants are anonymous, your name is not required on any page of this document.

Rights to Withdraw: Your participation is voluntary and you can withdraw from this study at any time without any penalty. You can also choose to skip over any question you do not wish to answer. If you wish to withdraw from the study after you have started the questionnaire, you simply have to write a large "X" on the first page of the questionnaire and your questionnaire will be destroyed. If you hand in the questionnaire and then decide to withdraw from the study, it will not be possible to remove your answers because there will be no way to link any answers to a specific person.

Questions: If you have questions or concerns about this study, please free to ask at any point. You can contact the researcher Oyindamola Jaja (403-929-4463) or email Dr. Olu Awosoga (Supervisor) at olu.awosoga@uleth.ca. If you have questions regarding your rights as a participant in this research it may be addressed to the Office of Research Services, University of Lethbridge (Phone: 403-329-2747 or Email: research.services@uleth.ca).

Consent to Participate: I have had the opportunity to read this cover page, discuss the research purpose and what my participation means with the researcher. I hereby consent to participate in the research by completing this questionnaire

Appendix C

Questionnaire

1. Socio-Demographic Information

Participants have a right not to answer any question and may withdraw from the study at any time. Please tick the option that is applicable to you. Some questions will also require writing in the space provided.

1.1 Gender
□ Male
□ Female

1.2 Age
□ 18 - 29
□ 30 – 39
□ 40 – 49
□ 50 - 64
□ 65 years and above

1.3 Marital status
□ Single
□ Legally married (and not separated)
□ Separated but still legally married
□ Widowed
□ Divorced

1.4 Highest level of education achieved
□ Elementary education (grade 1-8)
□ High School (grade 9-12)
□ College / University
□ Post graduate education

1.5 Are you a healthcare professional?
□ Yes
□ No

If yes please specify **……**

1.6 Do you have previous medical care education/training?
□ Yes
□ No

If yes please specify **…….**

1.7 Occupation
□ Student

□ Self-employed
□ Employed (government)
□ Employed (non-government)
□ Unemployed

1.8 Ethnic Affiliation
□ Aboriginal
□ Arab
□ African
□ Chinese
□ European
□ Filipino
□ Japanese
□ Korean
□ Latin American
□ North American
□ South Asian (e.g. East Indian, Pakistani, Sri-lanka, etc.)
□ Southeast Asian (e.g. Vietnamese, Cambodian, Malaysian, Laotian, etc.)
□ West Asian (e.g. Iranian, Afghan, etc.)
□ Others.

If others, please specify **……..**

1.9 Do you have any chronic disease?
□ Yes
□ No
□ Don't know

1.10 Have you ever heard of antibiotics?
□ Yes
□ No
□ Don't know

1.11 Have you ever used antibiotics?
□ Yes
□ No
□ Don't know

1.12 Please provide the name of the antibiotics you have used or are familiar with

……

……

1.13 Are you currently on antibiotics?
□ Yes
□ No

□ Don't know

If answer to question 1.13 is No or Don't know please answer 1.14, if Yes move to question 1.15

1.14 When did you last use antibiotics?
□ More than 6 months ago
□ More than 12 months ago
□ More than 2 years ago
□ More than 5 years ago

1.15 Where did you get the antibiotics from?

……

1.16 Have you ever been exposed to any educational campaign on antibiotic resistance?
□ Yes
□ No
□ Don't know
If yes please state the source (e.g. pamphlet, pharmacy, television adverts)

…….....

2. Information Assessing Knowledge about Antibiotics use and Antibiotic resistance

Participants have a right not to answer any question and may withdraw from the study at any time. Please tick one of the boxes for each statement to indicate your response.

2. 1 I can differentiate between a bacterial and viral infection
□ Yes
□ No
□ Don't know

2. 2 Viruses cause most cold and cough
□ Yes
□ No
□ Don't know

2.3 Antibiotics are prescribed for most cough and cold
□ Yes
□ No
□ Don't know

2.4 Antibiotics are effective for most sore throat
□ Yes
□ No
□ Don't know

2.5 Antibiotics can kill bacteria
□ Yes
□ No
□ Don't know

2.6 Antibiotics can kill viruses
□ Yes
□ No
□ Don't know

2.7 Bacteria that live normally on the skin and in the guts are good for the health
□ Yes
□ No
□ Don't know

2.8 Antibiotics does not kill the bacteria that live normally on the skin and in the guts
□ Yes
□ No
□ Don't know

2.9 Antibiotics are the same as the medications used to relieve pain and fever such as Aspirin and Tylenol
□ Yes
□ No
□ Don't know

2.10 Antibiotic resistance means that bacteria will not be killed by antibiotics
□ Yes
□ No
□ Don't know

2.11 Infections caused by antibiotic resistant bacteria cannot be easily cured or cannot be cured
□ Yes
□ No
□ Don't know

2.12 If antibiotics are taken for a long period of time, bacteria become resistant to antibiotics
□ Yes
□ No
□ Don't know

2.13 If antibiotics are taken less than the prescribed dose, bacteria become less resistant to antibiotics
□ Yes

□ No
□ Don't know

2.14 If twice the prescribed dose of antibiotics is taken, the effects of antibiotics are more rapid
□ Yes
□ No
□ Don't know

2.15 The prescribed dose and duration of antibiotics can be terminated if the symptoms improve
□ Yes
□ No
□ Don't know

2.16 Antibiotic resistance can spread between bacteria
□ Yes
□ No
□ Don't know

2.17 Antibiotics have no side effect
□ Yes
□ No
□ Don't know

3. Information Assessing Attitude to Antibiotic Use

Participants have a right not to answer any question and may withdraw from the study at any time. Please tick one of the boxes for each statement to indicate your response.

3.1 I expect antibiotics to be prescribed by my doctor if I suffer from common cold symptoms.
□ Strongly agree
□ Agree
□ Neutral
□ Disagree
□ Strongly disagree

3.2 If I catch a cold, I ask for an antibiotic prescription to prevent my symptoms from getting worse
□ Strongly agree
□ Agree
□ Neutral
□ Disagree
□ Strongly disagree

3.3 I believe that antibiotics cure my cold faster

☐ Strongly agree
☐ Agree
☐ Neutral
☐ Disagree
☐ Strongly disagree

3.4 I take left-over antibiotics when I have flu or other symptoms
☐ Strongly agree
☐ Agree
☐ Neutral
☐ Disagree
☐ Strongly disagree

3.5 I stop taking the prescribed antibiotics once I get better
☐ Strongly agree
☐ Agree
☐ Neutral
☐ Disagree
☐ Strongly disagree

3.6 I prefer a shot (Injection) to an oral medication if antibiotics are needed
☐ Strongly agree
☐ Agree
☐ Neutral
☐ Disagree
☐ Strongly disagree

3.7 I check to see if antibiotics are included within the prescribed cold medicine
☐ Strongly agree
☐ Agree
☐ Neutral
☐ Disagree
☐ Strongly disagree

3.8 I know which medication is an antibiotic when I take cold medicines
☐ Strongly agree
☐ Agree
☐ Neutral
☐ Disagree
☐ Strongly disagree

3.9 If my family member is sick I usually give my prescribed antibiotic to them.
☐ Strongly agree
☐ Agree
☐ Neutral
☐ Disagree
☐ Strongly disagree

3.10 I normally keep antibiotic stock at home in case of emergency.

□ Strongly agree
□ Agree
□ Neutral
□ Disagree
□ Strongly disagree

3.11 I take antibiotics according to the instructions on the label.
□ Strongly agree
□ Agree
□ Neutral
□ Disagree
□ Strongly disagree

This is the end of the questionnaire, thank you for your time.

Appendix D

CERTIFICATE OF HUMAN PARTICIPANT RESEARCH
University of Lethbridge
Human Subject Research Committee

PRINCIPAL INVESTIGATOR:	Oyindamola Jaja
ADDRESS:	Faculty of Health Sciences University of Lethbridge 4401 University Drive Lethbridge, AB T1K 3M4
PROJECT TITLE:	Public Knowledge and Attitude regarding Antibiotic Use and Antibiotic Resistance in Southwest Alberta
INTERNAL FILE:	2016-005
INFORMED CONSENT:	Yes
LENGTH OF APPROVAL:	January 18, 2016 – December 31, 2016

The Human Subject Research Committee, having reviewed the above-named proposal on matters relating to the ethics of human research, approves the procedures proposed and certifies that the treatment of human participants will be in accordance with the Tri-Council Policy Statement and University policy.

Susan Entz, Ethics Officer
Human Subject Research Committee

January 18, 2016
Date