Aspects of the usage of gastro-intestinal medication in South Africa: A geographical approach

Volume 1

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“For I know the plans I have for you,” says the Lord. “They are plans for good and not for disaster, to give you a future and a hope.”

Jeremiah 29:11

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- *"A teacher affects eternity; he can never tell where his influence stops"* (Henry Adams).

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ABSTRACT

Title: Aspects of the usage of gastro-intestinal medication in South Africa: A geographical approach

Keywords: Gastro-intestinal disease, gastro-intestinal medication, South Africa, province, district, municipality, water quality, sanitation, epidemiology, prevalence, pharmacological group, active ingredient.

One of the aims included in the United Nations Millennium Development Goals is to decrease the number of the world's population without access to sanitation and water that is safe, by half by the year 2015. The use of water that is not safe for consumption leads to water-related diseases. For the purpose of this study gastro-intestinal disease was redefined as diseases of the gastro-intestinal tract caused by pathogens that spread via contaminated drinking water, poor sanitation and inadequate hygiene. Information obtained regarding the use of gastro-intestinal disease medication, may provide information about the prevalence of gastro-intestinal disease in South Africa.

The general objective of this study was to determine the prescribing patterns of gastro-intestinal medication in different geographical areas in the private health care sector of South Africa.
A retrospective drug utilisation review was conducted on data obtained from a medicine claims database of a pharmacy benefit management company for 2007 and 2008. A pharmacoepidemiological approach was followed in order to determine the prevalence of gastro-intestinal disease as well as the use of gastro-intestinal medication in South Africa as well as the different provinces of South Africa. The impact of water quality and sanitation on the prevalence of gastro-intestinal disease was also investigated.

Gastro-intestinal medication (used in the treatment of gastro-intestinal disease) included the following pharmacological groups according to the MIMS®-classification: antivertigo and anti-emetic agents (group 1.8), antispasmodics (group 12.3), antidiarrhoeals (group 12.7), minerals and electrolytes (group 20.4, selected according to specified NAPPI-codes) and antimicrobials (group 18). Antimicrobials had to be prescribed in combination with one of the specified gastro-intestinal medication groups in order to be classified as a gastro-intestinal medication.

In 2007 and 2008 respectively, 428864 and 340921 gastro-intestinal medication items were prescribed. The most frequently prescribed gastro-intestinal medication pharmacological groups

in 2007 and 2008 were beta-lactam antimicrobials (with proportion percentages of 22.77% and 20.85% in 2007 and 2008 respectively), antivertigo and anti-emetic agents, antispasmodics, antidiarrhoeals and quinolone antimicrobials. Minerals and electrolytes represented only a small proportion (2.99% and 2.56% in 2007 and 2008 respectively) of the prescribed gastro-intestinal medication in South Africa. In the Free State and Western Cape antivertigo and anti-emetic agents were the most frequently prescribed gastro-intestinal medication items, while in other provinces beta-lactam antimicrobials ranked the highest. In all provinces except the Western Cape and the Northern Cape, amoxicillin/clavulanic acid was the most frequently prescribed gastro-intestinal medication active ingredient. In the Western Cape loperamide was the most frequently prescribed active ingredient, while ciprofloxacin ranked highest as active ingredient in the Northern Cape in 2008.

Based on the prescribing patterns of gastro-intestinal disease medications the treatment of gastro-intestinal disease in this section of the private health care sector of South Africa, does not fully comply with the Standard Treatment Guidelines with regard to the use of antimicrobials and electrolyte replacement therapy.

OPSOMMING

Titel: Aspekte van die gebruik van gastro-intestinale medikasie in Suid-Afrika: ‘n Geografiese benadering

Sleutelwoorde: Gastro-intestinale siekte, gastro-intestinale medikasie, Suid-Afrika, provinsie, streek, munisapileit, waterkwaliteit, sanitasie, epidemiologie, voorkoms, farmakologiese groep, aktiewe bestanddeel.

Een van die oogmerke wat uiteengesit is in die Verenigde Nasies se Millennium Ontwikkelingsdoelwitte is dat die persentasie van die wereld se bevolking wat nie toegang het tot sanitasie en veilige water nie, met die helfde sal verminder teen 2015. Die verbruik van onveilige water lei tot waterverwante siektes. Vir die doel van hierdie studie word gastro-intestinale siektes gedefinieer as siektes van die gastro-intestinale kanaal wat veroorsaak word deur patogene wat versprei word deur gekontamineerde drinkwater, swak sanitasie en onvoldoende higiëne. Versamelde inligting oor die gebruik van gastro-intestinale medikasie mag inligting verskaf oor die voorkoms van gastro-intestinale siekte in Suid-Afrika.

Hierdie studie is daarop gefokus om die voorskryfpatrone van gastro-intestinale medikasie in die verskillende geografiese gebiede in die private gesondheidsektor van Suid-Afrika vas te stel. ‘n Retrospektiewe oorsig oor medikasiegebruik is van stapel gestuur deur gebruik te maak van data wat ingewin is oor eise wat in 2007 en 2008 op die databasis van ‘n farmaseutiese bestuursmaatskappy gestoor is. ‘n Farmako-epidemiologiese benadering is gevolg om vas te stel wat die voorkoms van gastro-intestinale siektes en die gebruik van gastro-intestinale medikasie in Suid-Afrika en die onderskeie provinsies van die land is. Die impak van waterkwaliteit en sanitasie op die voorkoms van gastro-intestinale siekte is ook ondersoek.

Gastro-intestinale medikasie (gebruik in die behandeling van gastro-intestinale siekte) het, volgens die MIMS®-klassifikasie, die volgende farmakologiese groepe ingesluit: Anitvertigo en anti-emetiese agente (groep 1.8), antispasmodiums (groep 12.3), antidiarreemiddels (groep 12.7), minerale en elektroliete (groep 20.4, verkies volgens gespesifiseerde NAPPI-kodes) en antimikrobiese middels (groep 18). Antimikrobiese middels moes voorgeskryf word in kombinasie met een van die gespesifiseerde gastro-intestinale medikasiegroepe om as ‘n gastro-intestinale medikasie geklassifiseer te word.

In 2007 en 2008 onderskeidelik is 428,864 en 340,921 gastro-intestinale medikasie-items voorgeskryf. Die gastro-intestinale medikasie farmakologiese groepe wat die algemeenste voorgeskryf is in 2007 en 2008 is beta-laktam antimikrobiese middels (met proporsionele persentasies van 22.77% en 20.85% onderskeidelik in 2007 en 2008), antivertigo en anti-emetiese agente, antispasmodiese middels, antidiarree medikasie en kinoloon-antimikrobiale middels. Minerale en elektroliete het slegs ‘n klein persentasie (2.99% en 2.56% onderskeidelik in 2007 en 2008) van die voorgeskrewe gastro-intestinale medikasie in Suid-Afrika verteenwoordig. In die Vrystaat en Wes-Kaap is antivertigo en anti-emetiese agente die mees algemene voorgeskrewe gastro-intestinale medikasie items, terwyl beta-laktam antimikrobiale middels die meeste in die ander provinsies voorgeskryf is. In al die provinsies buiten die Wes-Kaap en Noord-Kaap is amoksillien/klavulaan suur die mees algemene voorgeskrewe gastro-intestinale medikasie aktiewe bestanddeel. In die Wes-Kaap was loperamied die mees algemene voorgeskrewe gastro-intestinale medikasie aktiewe bestanddeel, terwyl siprofloksasien die mees algemene aktiewe bestanddeel in die Noord-Kaap was in 2008.

Gebaseer op die voorskrifpatrone van gastro-intestinale siekte medikasie kom die behandeling van gastro-intestinale siektes in hierdie afdeling van die private gesondheidsorgsektor van Suid-Afrika nie die Standaard Behandelingsriglyne ten volle na met betrekking tot die gebruik van antimikrobiale middels en elektrolietvervangingsterapie nie.

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LIST OF ABBREVIATIONS

ADP:	Adenosine diphosphate
ATP:	Adenosine triphosphate
cAMP:	Cyclic adenosine monophosphate
CETZ:	Chemo-effector trigger zone
DA:	Democratic Alliance
DNA:	Deoxyribonucleic acid
DOH:	Department of Health
Ds:	Descriptor Source
DUR:	Drug utilisation review
DWA:	Department of Water and Environmental Affairs
DWAF:	Department of Water Affairs and Forestry
EAggEC:	Enteroaggregative *E. coli*
EHEC:	Enterohemorrhagic *E. coli*
EIEC:	Enteroinvasive *E. coli*
EPEC:	Enteropathogenic *E. coli*
ETEC:	Enterotoxigenic *E. coli*
FIFA:	Fédération Internationale de Football Assosiation
GA:	Geographical Area
gAds:	Geographical Additional Medicine Source
gPds:	Geographical Prevalence Descriptor Source
gR:	Geographical Household Ratio
gUds:	Source Medicine Usage Unit for GA
ICD-10:	International Statistics Classification of Diseases and Related Health Problems, Tenth Edition
Ids:	Impact Descriptor Factor
IV:	Intravenous
LIMS:	Low Income Medical Scheme
MIMS:	Monthly Index of Medical Specialities
NAD:	Nicotinamide adenine dinucleotide
NAPPI:	National Pharmaceutical Product Interface

List of abbreviations (continued)

ORS:	Oral rehydration solution
ORT:	Oral rehydration therapy
PABA:	*p*-aminibenzoic acid
PBM:	Pharmacy benefit management
RNA:	Ribonucleic acid
SAS:	Statistical Analysis System
SSS:	Sugar and salt solution
STATS SA:	Statistics South Africa
TMP/SMX:	Trimethoprim-sulfamethoxazole/co-trimoxazole
UN:	United Nations
UN/ECE:	United Nations Economic Commission for Europe
UNICEF:	United Nations Children's Fund
UV:	Ultraviolet
WHO:	World Health Organisation

CHAPTER 1

Research proposal

In this chapter a short introduction and problem statement regarding gastro-intestinal diseases and poor water quality, sanitation and hygiene, will be provided together with the research methodology and chapter division.

1.1 Introduction and problem statement

According to Bosch *et al.* (2008:295) human health is continually being threatened by poor water quality. It was determined that diarrhoea claims 1.8 million lives worldwide every year (Bosch *et al*., 2008:295; World Health Organization (WHO), 2004). Although access to safe drinking water is a human right, only 83% (WHO, 2004) of the world population benefit from this. Technological failure and the inappropriate management of freshwater resources cause the spread of water-borne pathogens in developed countries, while economic burdens in developing countries cause the unavailability of safe drinking water (Brettar & Höfle, 2008:274).

One of the aims included in of the United Nations Millennium Development Goals is to decrease the number of the world's population without access to sanitation and water that is safe, by half by the year 2015 (Dungumaro, 2007:1141). When safe water is not available to the public, the use of contaminated water is forced onto the population with water-related diseases as a result. It is important to note that when an outbreak of water-borne diseases occurs, the government is forced to capitalise on diseases that can be prevented (Dungumaro, 2007:1142). In South Africa, with its population of 49 320 500 as a mid-year estimate for 2009 (Stats SA: 2009) and gross domestic product of four times that of other southern African countries, it is difficult to understand that water supply as well as sanitation problems still occur. In 2006 the Department of Water Affairs and Forestry (DWAF) in South Africa determined that 15,7 million South African citizens did not have basic water supply (Dungumaro, 2007:1142).

In this study gastro-intestinal diseases will be defined by the researcher as those gastro-intestinal diseases that are caused by pathogens that spread via contaminated drinking water, poor sanitation and inadequate hygiene practices. The main symptoms of the gastro-intestinal diseases are diarrhoea, nausea and vomiting and abdominal pain.

This study will focus mainly on medicines (redefined as gastro-intestinal medication prescribed in order to treat gastro-intestinal diseases caused by poor water quality, insufficient sanitation and inadequate hygiene practices) prescribed in order to treat diseases related to water supply, especially water-borne diseases such as gastroenteritis, giardiasis, bacillary dysentery, cholera and typhoid. These diseases as well as other examples will be discussed further in chapter two. Water-borne diseases entail diseases that are spread via water that also acts as a passive carrier for pathogens. It is important to take note that sanitation also has an impact on these disease conditions (Ashbolt, 2004:232).

Gerba *et al*. (1996:2936) stated that gastroenteritis, as a water-borne disease, has an impact on medical costs, quality of life, work loss and mortality. When medical cost is compared to the cost of water and sanitation services, water and sanitation services are more cost-effective in reducing the impact of water-borne diseases (Rietveld *et al.*, 2009:43). Payment *et al.* (1991:707) determined that the consumption of drinking water that met quality guidelines, led to 35% of gastrointestinal illnesses. South Africa has areas where safe water and sanitation are provided, but on the other hand the provision of water and sanitation to the poor is limited. This limitation in service provision can cause the spread of water-borne diseases (Dungumaro, 2007:1142).

Pharmacoepidemiological- as well as drug utilisation review (DUR) studies were performed. The main focus of pharmacoepidemiology is the identification of potential drug use problems in a particular population. In order to achieve this outcome, one must determine the extent of the use and effects of drugs in a population (Waning & Montagne, 2001:4-5). In this study a retrospective drug utilisation review was performed. According to Soumerai and Lipton (1995:1641) a drug utilisation review is a continuous and structured programme that interprets drug utilisation compared with predetermined guidelines and therefore can be utilised in the prevention of inappropriate prescribing. A retrospective drug utilisation review is performed after medicine has been dispensed (Soumerai & Lipton, 1995:1641).

The following research questions can be formulated:

- What is gastro-intestinal disease?
- What gastro-intestinal diseases occur due to substandard water quality and sanitation?
- What medications are used in the treatment of gastro-intestinal diseases due to substandard water quality and poor sanitation systems?

- What geographical parameters will be used?
- What will the geographical distribution of gastro-intestinal medicine usage be?
- Can the use of gastro-intestinal medications be attributed to specific socio-economic factors and water quality?

1.2 Research objectives

The research objectives for this study can be divided into the general objective and specific objectives.

1.2.1 General objective

The general objective of this study was to determine the prescribing patterns of gastro-intestinal medication in different geographical areas in the private health care sector of South Africa. A retrospective drug utilisation review was conducted and a pharmacoepidemiological approach followed. Special emphasis was on the epidemiology of gastro-intestinal diseases.

1.2.2 Specific objectives

The specific objectives were divided into a literature review and an empirical investigation.

1.2.2.1 Literature review

The literature review included the following specific research objectives:

- To determine from the literature what gastro-intestinal diseases can be caused by poor quality of drinking water and of sanitation in South Africa, compared to the international environment.
- To determine which gastro-intestinal medications are prescribed in South Africa for water-borne infections.

1.2.2.2 Empirical investigation

The empirical investigation included the following specific research objectives and was performed within the private health care sector of South Africa:

- To determine the geographical distribution of gastro-intestinal diseases based on prescribing patterns of gastro-intestinal medication in specific geographical areas of South Africa such as provinces, districts and municipalities.

- To determine the influence of age and gender on gastro-intestinal medication prescribing patterns in the different geographical areas of South Africa.

- To determine whether seasonal gastro-intestinal medication prescribing patterns can be identified from the database.

- To investigate whether water quality is an indicator of gastro-intestinal disease by making use of a medicine claims database, the Blue Drop Report (DWA, 2010), the Green Drop Report (DWA, 2009) and the proposed model by Serfontein (2009).

- To investigate whether there is a correlation between water quality, geographical area and the prevalence of gastro-intestinal disease and gastro-intestinal medication usage in the private health care sector of South Africa.

- To determine the value of the impact factors (model of Serfontein, 2009) to be allocated to the different water sources and toilet facilities (refer to section 3.6.4 Impact of water quality and sanitation on medicine usage in South Africa).

1.3 Research methodology

The research methodology that was followed, will be listed and discussed briefly.

- A literature study was performed to determine the extent of gastro-intestinal illness (redefined by the researcher as those diseases of the gastro-intestinal tract that are caused by poor quality of drinking water, insufficient sanitation and inadequate hygiene practices) and geographical distribution. The literature study included the significance of safe drinking water and sanitation on the prevalence of gastro-intestinal disease. Adequate treatment guidelines were determined from the literature.

- Adequate data were obtained from a medicine claims database of a Pharmacy Benefit Management (PBM) company by making use of medicine claims information regarding the use of gastro-intestinal medication. The database processes pharmaceutical claims electronically and act as a link between the pharmacies or physicians and the medical schemes. The PBM provides medicine management services to 38 medical schemes and four capitation provider clients in South Africa. The database also contains medicine

claims data for more than 1.5 million medical scheme beneficiaries (Reference in possession of the author, 2009). The geographical distribution of the prevalence of gastro-intestinal disease was based on the geographical distribution of the postal codes of prescribers.

- Medicine claims information regarding the use of gastro-intestinal medication and the postal code of the prescriber (for example a general practitioner, specialist and pharmacist) for 2007 to 2008 was retrieved from the database. All information was retrieved on an annual as well as a monthly basis in order to determine a seasonal trend in the prevalence of gastro-intestinal disease, the gender usage of gastro-intestinal medication, the age groups and National Pharmaceutical Product Interface (NAPPI)-codes of the medication provided.

- The data were processed by making use of the Statistical Analysis System® (SAS 9.1©).

- The Community Survey data of 2007 (Statistics South Africa) were used to determine the different sources of water supply and sanitation provided as well as the number of households that have access to these different sources. The Community Survey data of 2007 were provided by Statistics South Africa and contained estimates of population data made from the data obtained in the 2001 Census (STATS SA, 2008:1). The numbers retrieved were then in turn used to determine the Source Medicine Usage Unit for a specific geographical area (Serfontein, 2009). In order to determine the Source Medicine Usage Unit for a specific geographical area, an impact factor was allocated to each of the different water supply sources and sanitation services. The impact factor is a value of impact that a specific source or service provided has on the health and in turn, on the medicine usage of a household in a specific geographical area.

1.4 Study limitations

The following study limitations were observed:

- Only medicine claims data from one Pharmacy Benefit Management (PBM) company representing the private health care sector of South Africa were used. The public heath care sector was therefore excluded and the study was therefore not representative of the South African public as a whole.

1.5 Ethical considerations of this study

The medicine claims database company as well as the North-West University did provide ethical consent for this study (Ethical application number: NWU-0046-08-S 5).

1.6 Division of chapters

Chapter 1: Research proposal

Chapter 2: Literature review (water quality, disease and treatment)

Chapter 3: Literature review (research methodology)

Chapter 4: Results and discussion

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1.7 Chapter summary

In this chapter the problem statement, research objectives, with the different investigations to be performed as well as the research methodology to be followed, have been stated shortly. In the second chapter the literature review will be discussed. Water quality and sanitation in South Africa, gastro-intestinal diseases and treatment mechanisms will be investigated.

CHAPTER 2

Literature review

"Obviously, there are two principal ways and only two, in which a poison cast out upon the ground can find its way back again into the living organism. Either through the drinking water, or by emanations borne upon the air" (Budd, 1918:611).

2.1 Introduction

In this literature chapter the relevance of water quality, adequate sanitation and hygiene will be discussed. It is important to note that water quality cannot be discussed separately from sanitation and hygiene, as all these practices are interlinked in the spread of gastro-intestinal disease in a population. Therefore these factors will be discussed as a single entity. Payment *et al*. (1991:704) defined gastro-intestinal disease as a disease characterised by the following symptoms: diarrhoea or vomiting, or either diarrhoea or nausea in combination with abdominal cramps. These symptoms must be caused by or be due to the consumption of tap water prepared from surface water that is contaminated with sewage , but comply with all the criteria set for water quality to be optimal.

Gastro-intestinal disease will be redefined for the purpose of this study, as those diseases caused by pathogens that spread due to improper water quality, inadequate sanitation and lack of hygiene. Key symptoms will also be nausea, vomiting, diarrhoea and abdominal cramps. These symptoms may occur separately or in combination with each other. Gastro-intestinal diseases will be discussed by referring to the disease, the symptoms, causative agent, pathogenesis, epidemiology and the treatment and prevention. The pharmacology of the different treatment regimes will be discussed at the end of this chapter.

2.2 Water quality, sanitation and hygiene

In this section the impact of water quality, sanitation and hygiene will be discussed by first referring to the historical and current relevance thereof. The water quality of South Africa will also be discussed.

2.2.1 Historical relevance of water quality, sanitation and hygiene

In current times, it is expected that all humans have access to safe drinking water, a sewerage disposal system, soap, a clean and healthy environment that is safe and would promote health (Aiello *et al*., 2008:129). It is expected that the dead will be treated with

respect and buried in at an allocated space determined by government, that such a place will be selected with safety in mind and that the living will be protected. All of these matters are expected as a normal human right. These rights need to be acknowledged and attended to, especially now when technology is available to achieve optimal health. It is hard to believe that events depicted in reports from the 1800s by health pioneers such as Edwin Chadwick, John Snow and William Budd existed at all during some point in history, yet, it is harder still to accept that these situations still occur in the 21st century due to natural disasters, war and as expected in the past, poverty (Aiello *et al.,* 2008:129). In fact, Aiello *et al.* (2008:129) reported that in the 1840s in England, it was believed that poverty caused disease and in order to control disease among the poor, poverty would have to be alleviated.

Aiello *et al*. (2008:129) reported that the mid 1800s played a very important role in the development of sanitation as we understand it today. It was believed that disease was caused by "miasmas", that is the foul smelling emissions from decaying organic material. Although this idea was wrong in the essence, it did benefit the sanitarians in preventing disease. They drained the swamps, which led to limited breeding areas for mosquitoes, sewage disposal systems were installed, preventing the spread of cholera and lastly garbage disposal controlled insects and rodents that act as carriers and reservoirs of disease.

John Snow reported in 1854 that communicable diseases spread in many different ways. An interesting observation indicated that a deficiency of light inside the home or dwelling, influence the level of hygiene maintained and filth can therefore not be seen. Contamination of food with rice-water stool occurs easily and the prevalence of cholera among the poor increased. Poverty was seen to have an important impact on the spread of cholera. In the vagrant class where multiple people or even families occupied a single room where they slept, lived, cooked, ate and washed, cholera was most fatal. However, the spread of cholera from one family member to another in the higher income group where more than one room were occupied and washing of hands occurred, rarely took place. The mining population also suffered gravely from cholera as long working hours required the men to take food down into the coal-pits where no toilet facilities were available and contamination of the food with rice-water stool commonly occurred (Snow, 1854:11-13).

Snow's report *On the Mode of Communication of Cholera* (1854) had one of the most important infuences on water-related diseases known thus far. The scene for these grisly events took place in Broad Street, Golden Square, where more than 500 fatal attacks of cholera occurred within ten days. Snow reported that " *The mortality in this limited area probably equals any that was ever caused in this country, even by the plaque and it was*

much more sudden, as the greater number of cases terminated in a few hours" (Snow,1854:23). Snow enquired about cases of death due to cholera and came to realise that most occurred in the proximity of the Broad Street pump, thus cholera spread via water from this particular source of water. Due to enquiries made by Snow to the Board of Guardians of St. James's Parish, the handle of the pump was removed, where after the number of deaths due to cholera decreased dramatically (Snow,1854:30).

One may think that these occurrences only happened in the distant past, more than 150 years ago, but these events are not commemorated as tourist pictures of the Broad Street pump without a handle, or as Charles Dickens novels depicting 19th century England (Aiello *et al.,* 2008:130). History is unfortunately repeating itself in a very disturbing manner. As reported by Chambers (2009:993), political tension in Zimbabwe had devastating effects on the infrastructure of Harare. Sewer bursts occurred on a regular basis, defecating outside the dwelling became a regular occurrence, power failures were common. The provision of piped water was poorly neglected as one township had had no access to piped water for two years and those places with infrastructure were not maintained. Shallow wells were dug as a source of water, but were easily contaminated. The Ministry of Health and Child Welfare of Zimbabwe reported 98 424 cholera cases and 4 276 deaths with a case fatality rate of 4.3% since August 2008 to 9 June 2009 (World Health Organization, 2009). This was the largest number of infection recorded in a single outbreak on the African continent. Even more disturbing was the fact that families could not afford salt and sugar to make oral rehydration solutions and the ability to boil water was also a task of great difficulty as firewood was expensive and some townships may have had only twenty hours of electricity per week as inflation was 231 million per cent (Chambers, 2009:993). Disease due to poor quality of drinking water, sanitation and hygiene is clearly not something of the past.

2.2.2 The current relevance of water quality, sanitation and hygiene

According to the World Health Report (2002:68) 88% of diarrhoeal diseases occurring in the world, are caused by water that is not safe. Diseases caused by unsafe water can mainly be divided into water-borne diseases, water-washed diseases, water-based diseases and water-related diseases (Ashbolt, 2004:232; Mintz *et al.,* 2001:1565; White *et al.,* 2002:64-66).

- Water-borne diseases: diseases that spread via polluted water that is a passive carrier for pathogens. Sanitation also affects water quality and therefore also has an impact on water-borne diseases. Examples are: cholera, bacillary dysentery, typhoid, giardiasis and gastroenteritis.

- Water-washed diseases: diseases caused by the lack of water for hygienic and sanitary purposes. Sanitation therefore also has an impact on water-washed diseases. Examples are: salmonellosis, amoebic dysentery, trachoma, scabies and ascariasis.

- Water-based diseases: diseases that are caused by the ingestion of, or contact with water that is important in the life cycle of the infecting pathogen. An example is schistosomiasis.

- Water-related diseases: diseases that spread via insects or vectors that breed in water. Examples are: malaria, yellow fever, dengue fever and encephalitis.

These diseases will not all be discussed further as only water-borne diseases and water-washed diseases that affect the gastro-intestinal system by causing symptoms such as diarrhoea, nausea, vomiting and abdominal cramps, will be discussed further. The importance of sanitation in the spread of water-borne diseases act as further motivation of discussing water quality together with sanitation and not as separate entities, in the spread and occurrence of water-borne diseases in this study.

In 2000 the United Nations (UN) declared a set of goals that would improve the condition that humans would be living in by the year 2015 (UN, 2000:5; WHO, 2010b). This set of goals is known as the Millennium Development Goals and includes the following:

- *To eradicate extreme poverty and hunger.*

- *To achieve universal primary education.*

- *To promote gender equality and empower women.*

- *To reduce child mortality.*

- *To improve maternal health.*

- *To combat HIV/AIDS, malaria and other diseases.*

- ***To ensure environmental sustainability**.*

- *To develop a global partnership for development.*

The goal “to ensure environmental sustainability”, is of particular importance, as the United Nations are aiming to reduce the proportion of people without access to safe drinking water,

by half by the year 2015. According to the World Water Assessment Programme (2009), one billion people do not have access to safe drinking water and 2.4 million people lack appropriate sanitation worldwide. The number of people requiring safe drinking water is increasing by about 274 000 persons per day and is expected to continue at this rate till the year 2015 (World Water Assessment Programme, 2009).

One may ask why water quality has such a profound impact as one of the main targets of the Millennium Development Goals. The answer is that water is needed for life to exist and, more on a specific level, quality drinking water is considered a basic right. According to the Water Supply and Sanitation Policy White Paper of South Africa (Department of Water Affairs and Forestry (DWAF), 1994:14-15) basic water supply is defined as a minimum of 25 litres of safe water per person per day within 200m of the dwelling. Such water must also be available on a daily basis, with the assurance of a domestic water supply 98% of the time and the maintenance and operation of the water supply system must be on such a level that no longer than one week's supply per year may be interrupted.

Water may be an indicator of the developmental level of a community by taking the amount of water consumed into account. The higher the developmental level of a community, the more water is consumed. It was found that a child born in a developed country consumes 30 to 50 times more water than a child in a developing country (Enabor *et al.,* 1998:512; Obi *et al.,* 2006:331).

Factors that influence the impact of water on the consumer include the following: water treatment systems that change water composition, exposure to the elements and the materials used to transport water and exposure to contaminants as well as the consumption patterns of the individuals (Bates, 2000:30). Age is of importance when taking into account the exposure to water-borne pathogens. Bates (2000:34) identified that an infant that is fed bottled milk, consumes a high volume of drinking water. The highest consumption of bottled water is among children and the sick and elderly for the purpose of taking their medication. It is important to note that these age groups that consume the most water (children and the elderly) also have the weakest immune systems and by consuming more drinking water, they are exposed to more water-borne pathogens (Bates, 2000:34).

Water is supplied to developing communities in various ways such as taps inside the dwelling, taps outside the dwelling and communal taps (Genthe *et al.,* 1997:35). Genthe *et al*. (1997:36) performed a study on the effects of the type of water supply (source) on the water quality and in turn its effect on health by making use of diarrhoea as an indicator of

health. It was found that communal taps shared between different families have a greater risk of causing diarrhoea than water provision via a tap outside the dwelling accessed by only one family. The importance of hygiene and health-related knowledge was also emphasised among the contributory factors, together with improving water quality, in order to improve the health of a developing community (Genthe *et al.,* 1997:39). In a study performed by Taulo *et al.* (2008:136), it was identified in a population of Lungwena in Malawi, that stored water had higher microbiological counts than the source water, be it either from a pit or a borehole. The higher microbiological counts can be attributed to poor hygiene practices inside the homes, such as the covering of the water containers with objects used for purposes such as cutting of meat. It is therefore again emphasised that educating people about hygienic practices is of extreme importance (Taulo *et al.,* 2008:135-136). Trevett *et al*. (2004:273) reported that source water may be safe to drink, but deterioration in the microbiological quality of water may occur solely due to the fact that water can be recontaminated during collection and storage.

Trevett *et al.* (2005:262) defined environment as the sanitary quality of the environment and the household that a person is living in. Socio-economic factors are specified as those factors that involve the level of education and knowledge about hygiene.

The quality of drinking water must be optimal in order to ensure the optimal health of all people. This is even more relevant in people suffering from HIV/AIDS in South Africa as these people often come from the sector of the population without access to safe drinking water (Obi *et al.,* 2006:336). People suffering from HIV/AIDS are more prone to diseases that occur commonly throughout society, such as diarrhoea, than people without compromised immune systems. Therefore people with HIV/AIDS must have access to safe potable water, especially among the poor (Obi *et al.,* 2006:336). An estimate of 90% of HIV/AIDS patients in Africa suffer from chronic diarrhoea (Janoff & Smith, 1998:451; Obi *et al.,* 2006:336). It is also important to note that sources of water and latrines must be located near people making use of these systems, as it will reduce the time spent in order to collect water, referring to both sick and healthy individuals, but it will also reduce the occurrence of HIV/AIDS among women, as it reduces the chances of the women and girls fetching water, to be raped (Obi *et al.,* 2006:336).

When considering the environmental effects that have an influence on gastro-intestinal disease, water quality, sanitation and hygiene will be considered. Each of these three aspects is influenced by socio-economic factors, psychological factors, gender and religion (Avvannavar & Mani, 2008:2).

Sanitation broadly refers to the provision of an environment that is safe and healthy to live in, by safely disposing of human excrements, waste disposal, the control of animal vectors and water drainage. The human requirement of adequate sanitation is mainly governed by the need to defecate or urinate in a place that is considered safe and private. The concept of safety and privacy is influenced by religion, gender and age and most of all, it is influenced by the individual's current environment (Avvannavar & Mani, 2008:3).

Avvannavar and Mani (2008:2) defined sanitation as the safe handling and disposal of human excrement in order to prevent the fecal-oral transmission and spread of water-borne diseases. Four sub-systems influence the approach to sanitation by an individual, namely the human settlement, the natural environment, religion and culture and lastly the society. The human settlement refers to the built-environment that is created in order to adapt to the lifestyle of that particular environment and it is dependent on the settlement density, the natural environment and the rural or urban nature of the settlement. The natural environment refers to the natural elements of the environment, such as the terrain, the availability of water and the climate. The natural environment has an influence on the human settlement and therefore on the approach to sanitation (Avvannavar & Mani, 2008:3-5).

2.3 Water quality in South Africa

In this section water quality in South Africa will be discussed by referring to the history of water in South Africa and the findings of the Blue Drop Report.

2.3.1 South African historical impact

"Our science is embedded in this legacy, whether we choose it or not" (Turton, 2008:4).

It appears to be reasonable to look at and study the international environment, especially other third world countries, with regard to the history of water quality, sanitation and hygiene. In the beginning of this study, inspiration was drawn from John Snow's report on the spread of cholera in London in 1854 and the work of William Budd on typhoid fever in 1873. One must start investigating these matters in South Africa, a third world country rigged with more historical relevance that had an impact on the whole concept of the importance of safe drinking water and hygiene on health.

Turton (2008:1-4) identified three drivers that influence the economic and social well-being of South Africa. The first is dilution capacity, the second is spatial development pattern and the final driver is historic legacy.

When considering what impact the history of South Africa may have had on water quality and sanitation, the answer is astounding. Turton (2008:4) started his discussion of historical legacy with the Second Anglo-Boer War. The impact that British concentration camps had on the nation, not only on a psychological level, but also on health care, was severe. Emily Hobhouse visited some of the concentration camps established during the war in order to "house" women, children, the elderly and men that had surrendered. Her report, *Report of a visit to the camps of women and children in the Cape and Orange River colonies* (1901), was aimed to inform British government of the state of the camps, to investigate the needs of those held "captive" and to indicate how the South African Distress Fund was allocated (Hobhouse,1901:1).

This report by Hobhouse established the importance of water quality, hygiene and sanitation in preventing disease and promoting human dignity. Even more important is the fact that this was a South African case that influenced how South Africans perceived the importance of water and soap. A list was made of the most important needs in the camps that would directly influence the health of those held "captive", as the camps were thought of as "refuge camps" by the British public.

- In no camp soap was provided as part of the rations, only after much persuasion by Hobhouse, very little soap was provided. It still did not cover the amount needed to obtain personal hygiene or wash clothes (Hobhouse,1901:13).

- Drinking water was of poor quality and in insufficient amounts, especially in Bloemfontein. Typhoid was one of the most prominent diseases, mostly due to the poor quality of drinking water. Hobhouse suggested that water be boiled before consumption, but soon realised that these efforts were in vain. It was not possible for each household to boil water, as fuel was not available and there were no extra utensils or containers to act as water storage places. The suggestion was made that all water should be boiled before serving and tanks were bought (Hobhouse,1901:5).

- Washhouses were needed in some camps.

- Sanitation facilities were inadequate. Although facilities for men and women were separate, there was no privacy and it was exposed to the elements. In Bloemfontein the conditions were so deteriorated and the stench so foul that tonsillitis and other throat conditions commonly occurred in tents close to sanitation facilities (Hobhouse,1901:14).

- Overcrowding was a great problem. The tents usually had a capacity of 500 cubic feet, which were occupied by ten to 12 persons. The death rate in most camps was high, but Bloemfontein accounted for the highest death rate of 25 per cent (June 1901) (Hobhouse, 1901:14).

In order to capture these conditions in a few words, the words of Emily Hobhouse (1901:8) are quoted and very descriptive: "It is strange to think that every tent contains a family and every family is in trouble – loss behind, poverty in front, sickness, privation and death in the present. But they are very good and say they have agreed to be cheerful and make the best of it all".

The Anglo-Boer War, together with the plight of the amaXhosa and Great Cattle Killing in 1857, the ethnic cleansing of non-Zulu tribes during the *Mefecane* in the 1820's and 1830's and the destruction of the amaZulu, created a legacy in which human rights were not respected and a coherent sense of unity did not exist (Turton, 2008:5).

After World War II (1939-1945), South Africa was driven to become more economic sustainable, but together with this positive influence, one of the most disastrous historical and sociological events took place (Tempelhoff, 2009:165). With the National Party coming into power in 1948, the Apartheid-regime was born. The South African economy was growing until the 1980's, but with Apartheid still existing, together with the belief till the 1970's that coloured urban people would develop separately from whites and they would therefore later return to their homelands, townships were developed without adequate sanitation and water supply being a priority (Tempelhoff, 2009:165). Another problem occurred regarding the assurance of water quality and sanitation. Prior to 1994 each local municipality and homeland government had to take responsibility for their own water and sanitation needs (DWAF, 2004:4). A single responsible government entity that could take responsibility for these matters for the whole country, such as the Department of Water Affairs and Forestry (DWAF) now known as the Department of Water and Environmental Affairs (DWA), did not exist. Homelands had to rely on the South African Government for funding (DWAF, 2004:4).

In 1994, DWAF was established as the government entity that would ensure that all South Africans had access to water. Government also released the White Paper on Water and Sanitation in 1994, one of the first sector policy papers of the new democratic government (DWAF, 2004:5).

From 1998 to 2000 institutional changes took place. Re-demarcation took place where boundaries would include rural as well as urban settlements in order to strengthen rural Local Governments. Functions of District Municipalities and Local Municipalities were clearly indicated by the Municipal Structures Act. A process by which municipalities can make clear arrangements for service delivery was put into place by the Municipal Systems Act (Act 32 of 2000) (DWAF, 2004:16).

In 2003, the 1994 White Paper for Water Services was updated with the Strategic Framework that set goals regarding water supply and sanitation services, some of which were the following (DWAF, 2004:18):

- 2006: A cessation of the bucket system.
- 2008: A cessation of the water supply backlog.
- 2008: All assets of water services schemes must be transferred to municipalities.
- 2010: A cessation of the sanitation backlog.

The role of DWAF was also reformed by the Strategic Framework, wherein it was established that DWAF would not provide funding for new infrastructure and would not be directly involved in the operation of water services infrastructure. DWAF would, however, establish policy frameworks and would regulate activities of institutions providing water services (DWAF, 2004:18).

These historical events and the legacy it created have great consequences. Mass violence erupts when government is not able to deliver expectations; citizens are trapped in poverty if government does not intervene. Investor confidence is decreased by cases of extreme violence such as the xenophobic attacks that occurred in 2008 (Turton, 2008:4-5). The question raised by Turton (2008:5) was clear: Will anger and violence similar to that experienced during the xenophobic attacks in 2008, be caused due to perceptions of poor water quality causing deteriorating public health?

One may ask who is to blame for the current state of the quality of South African water in general. In answering this question, the term “ingenuity” comes into play. Homer-Dixon (1995:601) defines ingenuity as ideas that are applied to solve problems of technical, practical and social matters. In order to deal with resource scarcities, one usually applies technical ingenuity and social ingenuity that address problems in the physical and social

settings respectively. Resource scarcity, such as water scarcity, may often be considered as a matter that can solely be solved by technical ingenuity, as it requires the technical input of science and engineering. This is, however, not always the case, as technical ingenuity is built on the cornerstone of social ingenuity that is essential in the creation, reform and maintenance of public- and semi-public goods. Social ingenuity therefore provides incentives for innovation, provides clear channels of communication and provides resources where needed (Homer-Dixon, 1995:592).

Turton (2008:9) identified that a decrease in technical ingenuity started about ten years before the start of South African democracy. The current government therefore inherited a healthy infrastructure, but failing technical ingenuity. The current South African government therefore has to deal with an ingenuity gap caused by their historical legacy (Turton, 2008:9). One must also take into account that the history of South Africa and the establishment of a constitution had a severe impact on the demand for water and sanitation. Before 1994, the water infrastructure of South Africa only had to provide services to about six million citizens (whites), some people of colour and industrial and agricultural sectors (Tempelhoff, 2009:165). After 1994, the same infrastructure had to provide these services to about 42 million citizens, most of them living in informal settlements (Tempelhoff, 2009:165).

Homer-Dixon (1995:596) identified four factors that limit social and technical ingenuity: constraints on science, market failure, capital availability and social friction. The history and legacy of South Africa is plagued by all four of these factors. Turton (2008:14) identified three challenges within the Council for Scientific and Industrial Research (CSIR) that will aim in relieving this ingenuity gap, namely: communicating science, public funding and building trust. This ingenuity gap needs to be erased in order to deal with three strategic water quality challenges namely: the national pursuit for sustainability, the national pursuit for human health and the national pursuit for climate change adaptation (Turton, 2008:15-19). The pursuit of human health will be discussed briefly in the following section.

2.3.2 The national pursuit of human health

Some of the health challenges faced by South Africa are the levels of endocrine disrupting chemicals, partially metabolised medical agents and radio nucleotide and heavy metal contamination in water systems (Turton, 2008:11). Tempelhoff stated on 5 February (2010) that high levels, but within limits, of uranium were found in the water of Potchefstroom due to mining activities in the area, increasing the risk for cancer.

Turton (2008:11-17) has indicated that there are not enough civil engineers in local authority positions. These areas where there are no engineers present to provide technical ingenuity, are most often rural areas that have deteriorating water quality, as water treatment processes are not adapted in order to remove these endocrine disrupting chemicals and partially metabolised anti-retroviral medications. One problem that is of importance is the presence of partially metabolised medication, especially antiretroviral agents, as South Africa has a high antiretroviral load in drinking water and water used for irrigation.

These problems are only some of those identified to have health risks, but as this study will only focus on gastro-intestinal disease caused by poor water quality, lack of sanitation and poor hygiene practices, these problems will not be discussed further. These problems, however, will need to be considered in future studies.

2.3.3 Standards of water quality and sanitation according to the South African Media

The public of South Africa rely on media sources such as *Beeld, Die Burger* and *News 24. com* to confer information to them. In this particular case the situation regarding water supply in South Africa as portrayed by the media (electronic and printed newspaper articles) will be discussed shortly.

On 29 January Van Manen (2009a) reported that untreated sewage had been spilled into the Hartbeespoort dam for two months. The Madibeng municipality stated that the drinking water was safe on 5 February (Van Manen, 2009b). Five persons contracted cholera after using water from a borehole in the Brits district (Madibeng Municipality) (Pienaar, 2009).

The Mpumalanga provincial government stated on 18 February (Viljoen, 2009) that water purification systems of some municipalities were not functioning optimally. Municipalities that needed attention were Nkomazi, Albert Luthuli, Lekwa, Emalahleni and Emakhazeni.

On 23 February (SAPA, 2009) it was stated that the tap water in some small towns may not be suiTable for human consumption, especially small towns in the Free State, Eastern Cape, Limpopo, Mpumalanga and North West. There were uncertainties with regard to the quality of drinking water.

More than 20 million litres of untreated sewage spilled into the Hartbeespoort dam (6 March 2009) after one of the sewage pumps in Ifafi had failed. Two pumping stations had to be turned off, causing the overflow of manholes on the eastern shore of the dam (Van Manen, 2009b).

Tswaing Municipality in North West experienced problems with sewage disposal and water delivery systems (April 2009). Residents stopped paying their service delivery accounts to the municipality and instead paid the funds into a separate account to sustain service delivery themselves. Money owed to the municipality for electricity and water is then paid to the municipality from within this fund. After residents had started with their dispute against the Tswaing municipality, they themselves improved some of their problems. Raw sewage was not flowing down the streets and they had access to tap water. The municipality, however, wanted money for service delivery, services that they did not provide (Cilliers, 2009).

On 23 April (2009) it was reported by Neethling that doctors from the Red Cross Children's Hospital in Cape Town wore black as a form of "silent protest" against the increased impact of diarrhoea, of 20% more patients than 2008. The prevalence of diarrhoea was higher from February to May of the same year.

In June 2009 communities from Mpumalanga, West Rand, Durban-South and Soweto pleaded with the Human Rights Commission to help them to protect their right to a clean and safe environment as they were suffering from pollution due to mining and other industries (Tempelhoff, 2009).

On 13 July (2009) it was reported that 4000 households in Modimolle in Limpopo did not have access to tap water due to broken pumps. On 14 July (2009) it was stated that the elderly from the Kokanje retirement village outside Modimolle had to take sponge baths for days as there was no tapwater due to a broken pump (Louw-Carstens, 2009).

On 22 January De Beer (2010a:8) reported that a minimum of 2,2 million litres sewage from the Madibeng municipality had been spilling into the Hartbeespoort dam for a period of one month. According to De Beer the Madibeng municipality did acknowledge that the sewage pumps at Venice-pumping station in Ifafi had been removed two months earlier for repairs, but no replacements had been made. Tests to monitor water quality were not performed according to legal requirements and power supply to the treatment facilities was interrupted.

On 23 February De Beer (2010b) reported that the public of Madibeng municipality had to boil their water before use due to the presence of pathogens in the water. On 25 February (SAPA, 2010) the police fired rubber bullets at protesting residents of Oukasi in Brits. According to Captain Adele Meyburgh (SAPA, 2010) about 1500 protesters blocked the entrance to Oukasi with stones and burning tyres, where after they moved to the municipal

offices where six were injured by the police. Protesters complained about the water quality of Madibeng municipality and wanted the mayor, Sophie Molokoane-Machika, to be dismissed due to "political interference in the administration of the municipality" (Mokwena, 2010).

On 25 February (2010c) De Beer reported that no *E. coli* and other fecal coliforms were found in water from the Madibeng municipality water service stations. These tests were performed after the public had complained about the appearance and quality of piped water after reservoirs had run empty and sediment had collected in the pipes. The Democratic Alliance (DA) representative, Leon Basson, stated that the increase in water use over the last few weeks caused the low water levels in reservoirs. Members of the public were urged to use water conservatively and to continue to boil their water before use (De Beer, 2010c).

In general it can be concluded that the South African media do not regard water quality and sanitation in South Africa as meeting the necessary requirements.

2.3.4 Blue Drop Certification

On 11 September 2008, the Department of Water Affairs and Forestry (DWAF) introduced the Blue Drop Certification Programme. Legislation requires that all water service institutions must have programmes in place in order to monitor water quality and compliance. With the Blue Drop Certification Programme, preventative measures are also taken in the monitoring of drinking water quality (DWAF, 2009:2-3). The Blue Drop Certification Programme has the following objectives:

- Introduction of an incentive-based regulation system of drinking water quality management.
- Key requirements for effective management of drinking water quality by water service institutions are introduced.
- Transparency on the drinking water quality management performance of water service institutions, are being initiated.
- Information is provided to the public with regard to the drinking water quality of every water supply system.
- Closer working relationships between water services authorities and water service providers are facilitated (DWAF, 2009:2-3).

It is, however, shocking to find that only 22 water supply systems in South Africa were rewarded with Blue Drop Status (DWAF, 2009:3-4). In order to apply for Blue Drop Status, the water supply systems must exercise exceptional drinking water quality management (100%) or manage drinking water quality with excellence (95-99%) (DWAF, 2009:6-7).

Exceptional drinking water quality management implies that there would be 100% compliance to all Blue Drop Certification Criteria. There is confidence in the ability to manage water services institutions that are responsible for the treatment, monitoring and management of drinking water. The responsible institution or municipality has a full understanding of its responsibility and therefore has the ability to act proactively in ensuring a safe drinking water supply (DWAF, 2009:6).

Managing drinking water quality with excellence (95-99%) implies that DWAF has the assurance that the responsible institution or municipality is able to sustain safe drinking water supply and is able to act responsibly when a deviation in tap water quality that may pose a health risk, is detected. Continuous monitoring of operational procedures and compliance takes place (DWAF, 2009:7).

Water supply systems that have received Blue Drop Status, are the following: Peddie, Beaufort West, Plettenberg Bay, Nature's Valley, Kurland, King Williams Town, East London (Umzonyana), City of Cape Town, City of Johannesburg, City of Tshwane, Weltevreden, Paarl, Saron, Hermon, Gouda, Ekurhuleni, Emfuleni, Ethekwini, George, Danieskuil, Karatara, Mangaung East, Mangaung West, Nelspruit, Mogale City, Greater Tzaneen, Letsitele Town, Nelson Mandela Bay, City of Polokwane, Rustenburg, Stellenbosch, Middelburg/Mhluzi, Hendrina, Arnot/Rietkuil, Komati/Blinkpan, Tlokwe, Ceres, Prins Alfred Hamlet (DWAF, 2010:7).

It is important to take note of the fact that all water services that did not present the required information to DWAF needed for Blue Drop Certification, are issued with a zero Blue Drop Score. Strict regulatory audits will be performed at these authorities and all findings will be published. DWAF will therefore not use any available information regarding those authorities to guarantee the safety and confidence in the drinking water quality and management abilities of those authorities (DWAF, 2009:9).

Table 2.1: Blue Drop Certification summary 2009 (DWAF, 2009:136)

Province	Number of water service authorities	Percentage of water service authorities assessed	Provincial average Blue Drop Score (assessed %)	Provincial average drinking water quality compliance
Eastern Cape	17	65.00%	54.33%	91.6%
Free State	17	65.00%	40.03%	95.46%
Gauteng	12	75.00%	74.40%	96.20%
Kwa-Zulu Natal	14	93.00%	73.00%	82.00%
Limpopo	11	54.40%	40.82%	<85.60%
Mpumalanga	21	38.09%	51.00%	84.58%
Northern Cape	27	70.30%	28.30%	<92.90%
North West	13	61.54%	39.97%	71.45%
Western Cape	30	90.64%	60.32%	91.00%

2.3.4.1 Blue Drop Status

In order to be awarded Blue Drop Status, Water Services Authorities are required to comply with 95% of criteria specified by DWAF. Drinking water systems of each Water Services Authority will be evaluated twice a year for three consecutive years. The criteria will become more stringent each year in order to ensure continuous drinking water quality improvement (DWAF, 2008:3).

Drinking water service systems must meet the following criteria (note that the criteria will only be listed shortly and not discussed) (DWAF, 2008:4-5):

- *Water safety and security plans*
- *Process controllers*
- *Drinking water quality monitoring*
- *Drinking water sample analysis*

- *Submission of drinking water quality results*
- *Drinking water quality compliance*
- *Management of drinking water quality failures*
- *Publication of drinking water quality performance*
- *Drinking water asset management*

2.3.4.2 Red Drop Status

Red Drop Status is awarded to Water Service Authorities that show limited intentions, despite efforts from DWAF in order to improve drinking water quality management with a negative impact on public health as a result. Drinking water treatment and distribution at these facilities are neglected and these facilities are considered to be non-competent (DWAF, 2008:6).

2.3.4.3 Green Drop Status

In order for water Services Authorities to be awarded Green Drop (wastewater) Status, there needs to be 90% compliance to criteria, with assessment being performed twice yearly for three consecutive years. Criteria will also become more stringent each year in order to ensure continuous improvement in wastewater management (DWAF, 2008:6).

The following criteria, as listed below, need to be met by those Water Services Authorities responsible for the collection, treatment and discharge of wastewater (DWAF, 2008:6-7):

- *Process controllers*
- *Wastewater quality monitoring*
- *Wastewater sample analysis*
- *Submission of water quality results*
- *Wastewater quality compliance*
- *Management of wastewater quality failures*
- *Storm water management*

- *Bylaws*
- *Wastewater treatment works capacity*
- *Publication of wastewater quality performance*
- *Wastewater asset management*

2.3.4.4 Purple Drop Status

Purple Drop Status is awarded to those Water Services Authorities that did not rectify any failure regarding wastewater after 21 days after Phase B of the *DWAF Enforcement Protocol for the Organs of State* had entered. Purple Drop Status will indicate that the involved Water Services Authority showed limited intention to improve the quality of wastewater treatment and discharge, despite efforts made by DWAF (DWAF, 2008:9).

2.4 Diseases of the gastro-intestinal tract

Diseases of the gastro-intestinal tract that are caused by poor water quality, sanitation and hygiene, will be discussed. Gastroenteritis is caused by bacterial and protozoal pathogens, as well as some viruses. These pathogenic agents usually spread via fecal-oral transfer, but can also be transmitted through water contaminated with sewage (Theron & Cloete, 2002:1).

2.4.1 Definition of gastro-intestinal disease

For the purpose of this study, gastro-intestinal disease will be defined as those diseases of the gastro-intestinal tract that are caused by pathogens that spread via contaminated water, the lack of, or improper sanitation and insufficient hygiene. Symptoms of these diseases most often include abdominal cramping, diarrhoea, nausea and vomiting.

Table 2.2, adapted from the Department of Health (DOH) of South Africa (2008:10-34) stipulated standard treatment guidelines for some gastro-intestinal diseases. The standard treatment guidelines of Lesotho for some of the conditions were included for comparison (Ministry of Health and Social Welfare, 2005:68-69). These, as well as other known gastro-intestinal diseases will be discussed in sections to follow. New waterborne pathogens are emerging (Theron & Cloete, 2002:1) and although these pathogens may pose a risk, not all pathogens that cause gastro-intestinal disease will be discussed. Some of the newly recognised pathogens are *E. coli* O157, *Campylobacter*, *Helicobacter* and *Cyclospora* (Theron & Cloete, 2002:4-7). According to Peters *et al.* (1995:43) atypical mycobacteria are

present in tapwater in Berlin, but tapwater play a minor role in the transmission of mycobacteria. Future studies are required to investigate the role of emerging pathogens on medicine usage.

Table 2.2: Standard treatment guidelines for gastro-intestinal diseases (Adapted from DOH, 2008:10-34)

Acute diarrhoea without blood	
Description	**Treatment**
• Diarrhoea is usually self-limited, with only fluid replacement therapy as a requirement. • Causes: Viruses and enterotoxigenic *E. coli* (DOH, 2006:16).	• Oral rehydration solution (ORS). • Homemade sugar and salt solution (SSS) - ½ medicine measure (2,5 ml) Table salt. - 8 medicine measures (40 ml) sugar. - Dissolve in 1 ℓ boiled and cooled water. • Loperamide - 4 mg immediately, then 2 mg after each loose stool. Maximum 12 mg daily. ❖ Lesotho: ORS
Chronic diarrhoea	
Description	**Treatment**
• Diarrhoea is lasting longer than 14 days. • HIV infection is a probability, therefore the patient must be encouraged to be tested. • Stool samples are usually requested to identify the pathogen involved. • Giardiasis is a very common cause of chronic diarrhoea and may be difficult to diagnose. Empirical treatment for giardiasis is recommended.	• Giardiasis: metronidazole 2 g daily for three days.

Table 2.2 (continued): Standard treatment guidelines for gastro-intestinal diseases (Adapted from DOH, 2008:10-34)

<table>
<tr><th colspan="2">Dysentery</th></tr>
<tr><td colspan="2">- Diarrhoea with blood and mucus.
- Usually bacteriological in origin (bacillary dysentery).
- Common bacterial pathogens: Salmonella, Shigella, Campylobacter, E. coli.</td></tr>
<tr><th colspan="2">Bacillary dysentery</th></tr>
<tr><th>Description</th><th>Treatment</th></tr>
<tr><td>• Pathogens: Salmonella, Shigella, Campylobacter.
• Acute diarrhoea with blood or mucus in stools.
• Convulsions in children, fever and tenesmus.
• Prevention of the spread of the pathogen:
- Prevent the contamination of water and food through proper sanitation.
- Wash hands before handling of food.
- Wash soiled clothes and bed-linens.</td><td>• Rehydration: ORS, SSS, IV sodium chloride 0,9 %.
• Antibiotic therapy:
- Ciprofloxacin 15 mg/kg/dose 12 hourly for three days.
- Ciprofloxacin 500 mg 12 hourly for three to seven days (DOH, 2006:16).
➢ Children older than 12 months.
➢ Adults with blood in stools.
➢ HIV infected persons.
- Ceftriaxone, IM, 50-80 mg/kg/dose immediately as a single dose.
➢ Chlidren younger than 12 months.
• Loperamide is contraindicated (DOH, 2006:16).
❖ Lesotho:
- E. Coli:
➢ Cotrimoxazole 80/400 mg two Tablets twice daily, or
➢ Doxycycline 100 mg twice daily for seven days.
- Shigellosis:
➢ Nalidixic acid 1 g four times per day, or
➢ Ampicillin 500 mg every six hours IV, or
➢ Amoxycillin 500 mg every eight hours, or
➢ Cotrimoxazole two Tablets twice daily for seven days,</td></tr>
</table>

Table 2.2 (continued): Standard treatment guidelines for gastro-intestinal diseases (Adapted from DOH, 2008:10-34)

Amoebic dysentery	
Description	**Treatment**
• Loose stools or diarrhoea with blood and mucus. • Constipation may occur. • Causative agent: *Entamoeba histolytica*	• Rehydration: ORS, SSS, IV sodium chloride 0,9 %. • Metronidazole every eight hours for five days. • Children less than 12 months of age: ceftriaxone IM, 50-80 mg/kg/dose immediately as a single dose. • **Loperamide is contraindicated (DOH, 2006:17).** ❖ Lesotho: Metronidazole 400 mg every eight hours for 7 days.
Typhoid fever	
Description	**Treatment**
• Septicaemic illness with fever caused by *Salmonella typhi.* • Other symptoms: acute abdomen, prolonged or high fever, headache, convulsions, constipation during the first week, later diarrhoea with or without bleeding. • Confirmation by stool culture or blood tests. • **Notifiable condition.**	• Rehydration: ORS, SSS. • Ciprofoxacin 500 mg 12 hourly for ten days, or • Ceftriaxone IV 2 g/day. • Chronic carriers: - Ciprofoxacin 750 mg 12 hourly for six weeks (DOH, 2006:165). ❖ Lesotho: Chloramphenicol 500 mg four times per day, or Ciprofloxacin 500 mg twice daily for seven days.
Cholera	
Description	**Treatment**
• Acute, severe, watery diarrhoea. • Caused by *Vibrio cholerae.* • Stools have a rice-water appearance without blood, pus and an odor. • Possible vomiting. • Dehydration is rapid and severe.	• Rehydration: ORS, SSS, IV sodium chloride 0,9 %. • Doxycycline in adults and children (older than eight years) in confirmed cases. • Ciprofloxacin 1 g immediately as a single dose (DOH, 2006:15).

2.4.2 Diarrhoea

Diarrhoea as a symptom of gastro-intestinal disease will be discussed.

2.4.2.1 Definition of diarrhoea

According to DiPiro and Schwinghammer (2009a:256) diarrhoea refers to abnormal frequency and liquidity of the fecal discharge when compared to normal stools. Diarrhoea also refers to the frequent and abnormal discharge of fluid or semisolid matter from the bowel (Pugh *et al.,* 2000:494). The World Health Organization (2010a) defines diarrhoea as having three or more loose stools per day, or the more frequent passing of stools than usual for a particular individual. Usually diarrhoea is a symptom of gastro-intestinal infection caused by viral, bacterial or parasitic pathogens that are spread via contaminated water, food, or from one individual to another due to inadequate hygiene practices.

2.4.2.2 Pathophysiology of diarrhoea

Diarrhoea is the result of an imbalance in the absorption and secretion of electrolytes and water. There are four mechanisms in which the absorption and secretion mechanisms can cause diarrhoea and that are used in diagnosis and treatment. Firstly there is the change in active ion transport in which there is an increased chloride secretion or decreased sodium absorption. Secondly there is a change in the motility of the intestines. A change in luminal osmolarity is the third, while the fourth is an increase in tissue hydrostatic pressure (DiPiro & Schwinghammer, 2009a:256).

The Merck Manual describes the four mechanisms by which diarrhoea are caused as follows (Beers *et al.,* 2006:77):

- An increase in osmotic load
- Increased secretion
- Decreased absorption time
- Inflammation.

There are four clinical groups of diarrhoea namely secretory, osmotic, altered motility and exudative diarrhoea (DiPiro & Schwinghammer, 2009a:256).

- Secretory diarrhoea occurs when a substance with a similar structure, such as bacterial toxins and enteropathogenic viruses, increases or decreases secretion or absorption of water and electrolytes. The intestines therefore secrete more water and electrolytes than what they absorb (Beers *et al*., 2006:77). Secretory diarrhoea is of importance to this study.

- Osmotic diarrhoea is caused by water-soluble solutes that are poorly absorbed and thus retain intestinal fluids. Examples of these solutes are polyethylene glycol, magnesium salts and sodium phosphate that act as laxatives. Due to the etiology of osmotic diarrhoea (ingestion of hexitols, lactulose and lactose intolerance (Beers *et al.,* 2006:77)), osmotic diarrhoea is not of importance to this study and will not be discussed further.

- Diarrhoea due to altered motility means that intestinal tract motility can be changed by reduced contact time in the small intestine, premature emptying of the colon and overgrowth of bacteria (DiPiro & Schwinghammer, 2009a:256).

- Exudative diarrhoea is caused by inflammatory diseases of the intestines where proteins, mucus or blood is discharged into the intestines (DiPiro & Schwinghammer, 2009a:256).

2.4.2.3 Clinical presentation

Diarrhoea can be divided into either acute or chronic diarrhoea, where acute diarrhoea usually clears up within 72 hours. In cases of acute diarrhoea, there is a sudden onset of frequent watery stools, flatulence, abdominal pain and malaise. Chronic diarrhoea can be identified by weight loss, anorexia and chronic weakness (DiPiro & Schwinghammer, 2009a:257).

Diarrhoea can also be caused by certain drugs, listed in Table 2.3 (adapted from DiPiro & Schwinghammer, 2009a:257; Beers *et al.,* 2006:138-139). Drug induced diarrhoea or diarrhoea caused by the use of certain medications, will not be considered further in this study.

Table 2.3: Drugs known to cause diarrhoea

Antacids with magnesium	Digitalis	Neostigmine
Antineoplastic agents	Digoxin	Nonsteroidal anti-inflammatory agents
Auranofin (gold salts)	Guanabenz*	Prostaglandins
Bethanechol	Guanadrel*	Proton pump inhibitors
Broad-spectrum antibiotics	Guanethidine	Quinidine
Cholinergics	H_2-receptor blockers	Reserpine

Table 2.3 (continued): Drugs known to cause diarrhoea

Clindamycin	Laxatives	Sulfonamides
Colchicine	Methyldopa	Tetracyclines

* Not available in South Africa

2.4.3 Nausea and vomiting

The definition, pathophysiology and clinical presentation of nausea and vomiting will be discussed.

2.4.3.1 Definitions of nausea and vomiting

Nausea is the urge to vomit. It is known as a sensation in the epigastric region that makes one alert that vomiting may take place (DiPiro & Schwinghammer, 2009a:294; Pugh *et al.,* 2000:1183).

Vomiting is the forceful expulsion or ejection of the gastric contents through the mouth (DiPiro & Schwinghammer, 2009a:294), while Pugh *et al.* (2000:1979) define vomiting as the clearance of the stomach content through the esophagus and mouth in a retrograde manner.

2.4.3.2 Pathophysiology of nausea and vomiting

Acute gastroenteritis, as well as viral and bacterial diseases of the gastro-intestinal tract may cause nausea and vomiting, while other gastro-intestinal mechanisms, metabolic disorders, therapy-induced causes, neurological processes, cardiovascular diseases, psychiatric causes, drug withdrawal and miscellaneous causes such as pregnancy and certain odours are also known ethiologies (DiPiro & Schwinghammer, 2009a:294-295), but will not be discussed further in this study.

Afferent impulses to the vomiting centre trigger the vomiting response. The afferent impulses are received from sensory centres, such as the gastro-intestinal tract, visceral afferents from the pharynx, the cerebral cortex and the chemoreceptor trigger zone. Efferent impulses are generated and sent to the salivation centre, respiratory centre, muscles of the pharynx, gastro-intestinal tract and abdomen that lead to the vomiting action. Neurotransmittors located in the chemoreceptor trigger zone and gastro-intestinal tract are cholinergic, histaminic, serotonin, dopaminergic, opiate, neurokinin and benzodiazepine agents (DiPiro & Schwinghammer, 2009a:294; Rossiter, 2010:47).

2.4.3.3 Clinical presentation

Nausea with vomiting can be classified as simple or complex. Simple nausea with vomiting is usually self-limiting and only requires symptomatic therapy. The patient usually complains of discomfort. Complex nausea together with vomiting does not resolve after treatment with antiemetic agents and the patient deteriorates due to fluid and electrolyte imbalances. Complex nausea with vomiting is usually associated with psychogenic events and noxious agents. The patient usually complains about fever, abdominal pain and weight loss (DiPiro & Schwinghammer, 2009a:297).

2.5 Bacterial diseases of the gastro-intestinal tract

Gastro-intestinal diseases caused by bacterial pathogens will be discussed further in this section by referring to the disease, the pathogen, symptoms, pathogenesis, epidemiology, prevention and treatment.

2.5.1 Cholera

Cholera as a disease that spreads via contaminated water has become one of the cornerstones of the history of water quality and sanitation. It was of such importance that it became the first notifiable disease (Sack *et al.*, 2004:223). Cases must be reported if they comply with the World Health Organization's (2004:15) definition that cholera must be suspected if a patient older than five years develops severe dehydration or dies of acute watery diarrhoea, or if there is an increase in the daily number of acute watery diarrhoea, or if there is an increase in the daily number of acute watery diarrhoea or rice-water stools. John Snow became the first person to identify the spread of cholera via drinking water in 1854, well before the microbial era (Snow, 1936; Sack et al., 2004:223). Cholera again became very prominent in Zimbabwe in 2009 when 89 018 Zimbabweans (9 March 2009) contracted the disease, making it the largest single outbreak of this disease on the African continent. South Africa could not escape this disease as "cholera refugees" poured into the Limpopo province (Chambers, 2009:993-994).

2.5.1.1 Symptoms

Cholera is characterised by severe diarrhoea and vomiting. The stools resemble rice-water and sometimes have a fish-like odour. The diarrhoea causes severe dehydration with the rate sometimes being 500-1000 ml/hour. The vomitus is clear, alkaline and watery. Dehydration is of extreme importance with the signs of severe dehydration being low-volume peripheral pulse, low blood pressure, poor skin turgor, sunken eyes and wrinkled hands and

feet. Patients appear agitated and restless with extreme thirst at first, but if there is no treatment, the patient becomes apathetic and loses consciousness. With no rehydration measures being taken, the disease can be fatal within a few hours. If rehydration is being provided in insufficient quantities, the patient can still pass away after a few days (Sack *et al.*, 2004:224).

2.5.1.2 Pathogen

Cholera is caused by a Gram negative rod, *Vibrio cholerae.* This organism is divided into serogroups based on the somatic O antigen with serogroups O1 and O139 being the only serogroups to cause epidemic disease (Sack *et al.*, 2004:227). *V. cholera* is able to tolerate high salt concentrations and alkaline conditions (Nester *et al*., 2001:599).

2.5.1.3 Pathogenesis

As *Vibrio cholerae* is killed by the acid in the stomach, large quantities of the organism must be ingested in order to survive. The organisms adhere to the small intestinal epithelium by making use of pili and surface proteins, enabling the multiplication of the organism without visible damage to epithelial cells. *V. cholerae* produce an exotoxin known as cholera toxin, which is heat-labile and has an A and B fragment. The B fragment only serves as a binding agent for the toxin to the microvilli of epithelial cells. The A fragment activates adenylate cyclase, which is responsible for converting adenosine triphosphate (ATP) to cyclic adenosine monophosphate (cAMP). Adenosine diphosphate (ADP) ribosylation occurs as the toxin causes the ADP ribose section of nicotinamide adenine dinucleotide (NAD) to react with a G protein that regulates adenylate cyclase activity and as a result, fluid secretion. This ADP ribosylation permanently activates the G protein and therefore maximal cAMP production occurs in the cell. The cAMP act as pumps to pump water and electrolytes (K^+, Na^+, HCO_3^-) from the blood into the intestine. The volume of water in the intestines renders the large bowel unable to absorb water, with diarrhoea as a result (Nester *et al*., 2001:599-600).

2.5.1.4 Epidemiology

Fecally contaminated water is the most common source of cholera infection (Nester *et al.,* 2001:600), but it is also transmitted via food, where water is mixed with food. In developed countries undercooked seafood is the most common cause of the disease (Sack *et al.,* 2004:224). Seasons play a very important role in the transmission of cholera. Warm seasons show a peak in cholera incidence as the organisms proliferate in warm environmental temperatures. Severity of infection depends in local intestinal immunity, the

size if the ingested inoculums, the adequacy of the gastric-acid barrier and more interestingly the blood group of the patient, as the O blood group are more at risk for infection from the El Tor vibrios (Clemins *et al.,* 1989:772).

It was found that 10^8 bacteria is needed to cause severe cholera in health individuals, while 10^5 bacteria combined with the ingestion of antacids can also cause illness (Hornick *et al*., 1971:1183-1190). It was found that cholera can spread via the municipal water system with very high infection rates in urban populations (Ries *et al.*, 1992:1429), while spread via river-water or well-water only caused disease in communities living close to and making use of contaminated water (Sack *et al.,* 2004:363).

2.5.1.5 Prevention and treatment

The case fatality of cholera without any treatment is 50% (Sack *et al*., 2004:225). Treatment is simple and effective and relies on the concept of fluid and electrolyte replacement depending on the volume of fluid lost from the body (Sack *et al.,* 2004:225). This statement may sound simple and should be simple to be implemented, but as seen from the 2009 cholera epidemic in Zimbabwe, is easier said than done. In Zimbabwe it was observed that salt and sugar was too expensive to purchase due to the very high inflation. Fire-wood was also very expensive and not easily obtained, electricity delivery was limited and, very important, safe water was not available (Chambers, 2009:993-994). Therefore basic treatment could not be given and the result was with very high death tolls.

Sack *et al.* (2004:225) provided a simple regime to follow in order to manage a patient with suspected cholera:

- Assess the patient for dehydration.
- Rehydrate the patient rapidly with intravenous Ringer's solution if severe dehydration occurs. When dehydration is less severe, oral rehydration solution can be given.
- Ten per cent of the bodyweight of severely dehydrated patients must be replaced within 2-4 hours.
- The stool output, status of hydration and severity of purging must be monitored on a frequent basis.
- Hydration must be maintained by continuous fluid replacement until diarrhoea stops.

- An oral antibiotic may be given to the patient as soon as the vomiting has ceased.
- Food must be provided as soon as the patient is able to eat.

As seen in the management guidelines, assessment of dehydration stages is very important and must be performed first in order to determine the correct treatment guidelines. The World Health Organization (WHO) (2004:28) provided guidelines (Table 2.4) to assess the different stages of dehydration and the corresponding treatment guidelines.

Table 2.4: Hydration assessment (WHO, 2004:28)

Dehydration stage	Signs	Treatment
Severe	Lethargic, unconscious, floppy, very sunken eyes, unable to drink, very dry mouth, skin pinch goes back very slowly (more than two seconds) and children have no tears.	IV (intravenous) therapy + antibiotics + ORS (oral rehydration solution).
Mild	Restless and irriTable, sunken eyes, dry mouth, thirsty and drinks eagerly, skin pinch goes back slowly (less than 2 seconds), children have no tears.	ORS + very close surveillance.
No dehydration	None of the above.	ORS at home.

The intravenous (IV) fluid of choice is Ringer's lactate, but normal saline (0.9%) or half normal saline combined with 5% glucose can also be used. Oral rehydration solution (ORS) must be given together with the IV solution in order to replace lost electrolytes. The oral rehydration solution can be given by nasogastric tube when IV rehydration is not possible and ORS cannot be given orally, it should be noted that nasogastric tubes should not be used in unconscious patients (WHO, 2004:29).

Antibiotics, such as doxcycline, erythromycin, ciprofloxacin, azithromycin and co-trimoxazole should only be given in severe cases in order to shorten the duration of the disease (Sack *et al.,* 2004:226). Resistance to antibiotics is increasing at an alarming rate and resistance

patterns should be considered when antibiotics are to be given. It is known that resistance against co-trimoxazole and tetracycline does exist in some instances. Mass chemoprophylaxis is not beneficial in controlling a cholera outbreak. Selective chemoprophylaxis (one dose of doxycycline) may be given to close contacts of cholera patients and is of use when a cholera outbreak occurs in an enclosed environment or population, for example in a prison (WHO, 2004:29).

Hygiene and health education are of extreme importance in the prevention of further spread of cholera. The community must be educated in the preparation and provision of oral rehydration solutions. The provision of safe drinking water that has been boiled is of extreme importance. The family members of cholera patients should be educated in washing their hands after the patient has been taken care of, that is after touching them, removing their stools, vomitus and clothes. Further the community should be educated that the clothes of a cholera patient should not be washed in the same water as their source of drinking water to prevent contamination of their water source (Sack *et al.,* 2004:230; WHO, 2004:30).

2.5.2 Shigellosis

This disease, also known as bacillary, dysentery is easily transmitted between people and is both water-borne and food-borne (DiPiro & Schwinghammer, 2009b:430; Engelkirk & Burton, 2007:316). Although shigellosis is not common in developed countries, it does pose an important health care risk in developing countries (Gomez & Cleary, 1996:215), as inadequate sanitation, poor hygiene, inadequate water supply and a high population density increase the risk for the disease to develop, in developed and developing countries (DiPiro & Schwinghammer, 2009b:431).

2.5.2.1 Symptoms

Shigellosis has a short incubation period of three to four days (Nester *et al*., 2001:603) whereafter severe abdominal pain, nausea and vomiting occur. Thereafter fever develops and diarrhoea sets in. As many as 20 stools per day can be passed. The stools have a green appearance and contain leucocytes (DiPiro & Schwinghammer, 2009b:431; Engelkirk & Burton, 2007:316). Many patients develop dysentery, which is characterised by painful defecation, small-volume, frequent, mucoid, bloody stools (Gomez & Cleary, 1996:215). Duration of the disease is seven to ten days, while duration of the disease without treatment range from one to thirty days (DiPiro & Schwinghammer, 2009b:431), but complications such as dehydration, seizures, toxic encephalopathy, lethargy, hallucinations and death, do occur (Gomez & Cleary, 1996:215).

2.5.2.2 Pathogen

Shigella, the causative agent of shigellosis, is a Gram-negative, nonencapsulated, nonmotile bacillus that ferments lactose slowly. Four serogroups exist namely Group A (*S. dysenteriae*), Group B (*S. flexneri*), Group C (*S. bovdii*) and Group D (*S. sonnei*) (Gomez & Cleary, 1996:215). Virulent strains of *Shigella* contain a large plasmid, enabling the pathogen to attach and enter the host cells (Gomez & Cleary, 1996:215; Nester *et al.,* 2001:602).

2.5.2.3 Pathogenesis

Phagocytosis is the first step in the infection process as the pathogens are phagocytosed by M cells associated with the gastro-intestinal associated lymphoid tissue in the large intestine. The M cells transport the pathogen beneath the epithelium where they are discharged by exocytosis and in turn taken up by macrophages that do not destroy the pathogens, but release them after their own death. The pathogens then attach to receptors near the basis of epithelial cells, which trigger endocytosis of the pathogen into the epithelial cells where they are enclosed in a phagosome. Inside the cell, the pathogens break out of the phagosome, whereafter replication takes place and the cells are killed. *Shigella* are able to move from one cell to another even though they are nonmotile. It however, occurs via a specific method by which a chromosomal gene of the pathogen codes for a protein that causes the actin filaments of the host cell to form a tail attached to one end of the bacterium. The actin tails are used to push the pathogen from one cell to another. Sloughed areas of epithelium that surround the lymphoid tissues are inflamed, covered by pus and bleeding. This is the origin of the blood and pus in the stool. Some strains of *Shigella dysenteriae* produce Shiga toxin, a chromosomally coded A-B toxin. The A subunit causes the process of protein synthesis to stop, by reacting with the host cell ribosome. This toxin has a strong association with hemolytic uremic syndrome that can follow *Shigella dysenteriae* dysentery. This syndrome causes the lysis of erythrocytes in capillary vessels, resulting in anemia, kidney failure and sometimes paralysis or other forms of nervous system injury (Nester *et al.,* 2001:602).

2.5.2.4 Epidemiology

Shigella species are very easily transmitted in overcrowded populations with poor sanitation. Fecally contaminated food and water also cause outbreaks (Nester *et al.,* 2001:602). Day care centres and custodial institutions are especially high risk public areas (Gomez & Cleary, 1996:215). Only ten to 100 ingested organisms are needed to cause disease in a normal individual (Engelkirk & Burton, 2007:316). In developed countries, *S. sonneii* is the most

common, followed by *S. flexneri.* In developing countries, occasional outbreaks of *S. dysenteriae* serotype 1 do occur. Infection is very uncommon in early infancy, but peaks between one and four years of age (Gomez & Cleary, 1996:215).

2.5.2.5 Prevention and treatment

Sanitary measures and surveillance of food handlers and water supplies are important in controlling the spread of *Shigella* species (Nester *et al.,* 2001:603). Treatment usually includes fluid and electrolyte therapy and antimicrobial therapy where indicated, such as immunocompromised patients, the elderly, children in daycare centres and health care professionals. Antimicrobial therapy may decrease the duration of the disease by decreasing fecal shedding (DiPiro & Schwinghammer, 2009b:431). According to Gomez and Cleary (1996:216) children with confirmed shigellosis should be treated with antimicrobial agents with taking antimicrobial resistance into account. Ampicillin should only be used if the pathogen is still susceptible, the same with co-trimoxazole. It is suggested that an oral or parenteral cephalosporin be given for five days. The dosage for cefixime is 8 mg/kg/day divided into two oral doses. Ceftriaxone is given 50 mg/kg/day as a single parenteral dose each day, with a maximum of 1,5 g. Nalidixic acid can be given as an alternative as there is a low frequency of resistance. The recommended dose is 55 mg/kg/day in four divided doses for five days. In cases where co-trimoxazole can be given, the dosage is 10 mg/kg/day of the trimetoprim component and 50 mg/kg/day of the sulfamethoxazole component. When ampicillin is appropriate, the dose is 100 mg/kg/day in four divided doses given parenterally or orally. Antibiotic resistance has caused that quinolones, although contraindicated in children younger than 18 years due to cartilage damage, have to be prescribed. It should be noted that an antimotility agent must not be given in cases of shigellosis or any other infectious colitis (DiPiro & Schwinghammer, 2009b:431; Gomez & Cleary, 1996:216).

2.5.3 *Escherichia coli* gastroenteritis

Escherichia coli is a part of the normal intestinal flora of humans and other animals and had for a long period of time not been considered as a possible cause of gastro-intestinal disease. Later it was known that *E. coli* strains do cause gastroenteritis. Some *E. coli* strains are associated with dysentery, cholera-like illnesses and diarrhoea associated with hemolytic uremic syndrome (Nester *et al.,* 2001:603). Enterotoxigenic *E. coli* (ETEC) is currently the most common cause of traveller's diarrhoea and a common cause of diarrhoea in children in developing countries (DiPiro & Schwinghammer , 2009b:428; Engelkirk & Burton, 2007:317).

2.5.3.1 Symptoms

The symptoms of the disease depend on the type of *E. coli* strain virulence causing illness. ETEC characteristically causes nausea, watery diarrhoea and occasional abdominal cramps. Diarrhoea caused by ETEC usually lasts from 24 to 48 hours (DiPiro & Schwinghammer, 2009b:428). Symptoms from other *E. coli* strains vary from loose bowel movements, profuse watery diarrhoea, severe abdominal cramps and bloody diarrhoea. Fever is not prominent. Recovery usually occurs within ten days, but hemolytic uremic syndrome develops after some cases of bloody diarrhoea (Nester *et al*., 2001:603).

2.5.3.2 Pathogen

Diarrhoea-causing *E. coli* can mainly be divided into five groups, namely enterotoxigenic (ETEC), enteroinvasive (EIEC), enteropathogenic (EPEC), enterohemorrhagic (EHEC) and enteroaggregative *E. coli* (EAggEC) (DiPiro & Schwinghammer, 2009b:428; Gomez & Cleary, 1996:216). These groups, compared to other strains of *E. coli*, have virulence factors that enable them to be pathogenic (Nester *et al.,* 2001:603).

2.5.3.3 Pathogenesis

Gastro-intestinal disease is caused only by those *E. coli* strains that have certain virulence factors, encoded by plasmids. These virulence factors are important in the production of enterotoxins and the ability to adhere to the small intestine (Nester *et al.,* 2001:604).

Adhesins enable the ETEC strains to adhere to the intestinal epithelium where toxins, similar to the cholera toxin in action, are secreted. Enteroinvasive *E. coli* (EIEC) causes disease similar to shigellosis. Enteropathogenic *E. coli* (EPEC) is a common cause of diarrhoea in hospital nurseries, bottle-fed infants in developing countries and chronic diarrhoea in infants. The plasmid-dependent adhesins of EPEC cause loss of microvilli and thickening of the cell surface at the attachment site. Enterohemorrhagic *E. coli* (EHEC), discovered in 1982, mostly belongs to the O157:H7 serological type. EHEC produces potent toxins that cause the death of intestinal epithelium by interfering with protein synthesis and are closely related to the toxins of *Shigella dysenteriae*, apart from the fact that these toxins do not penetrate the intestinal epithelial cells. Many of those infected with EHEC develop hemolytic uremic syndrome in which lysis of erythrocytes and kidney failure occurs. Fatalities usually occur among the elderly and in infants. Epidemics are usually cases where food and water are contaminated with cattle feces (Nester *et al.,* 2001:603).

2.5.3.4 Epidemiology

The disease can spread in a variety of ways that vary from person-to-person, e.g. spread via the fecal-oral route, consumption of contaminated food, unpasteurised milk and juice and fecally contaminated water (Engelkirk & Burton, 2007:317; Nester *et al.,* 2001:604).

2.5.3.5 Prevention and treatment

Prevention of *E. coli* gastroenteritis usually entails sanitary precautions such as the washing of hands after defecation, the pasteurisation of drinks and consumption of thoroughly cooked meat. Travellers should be informed to boil their water before consumption, avoid using ice in drinks, wash their fruit and vegetables before consumption or eat only fruit that can be peeled. Fluid replacement (oral rehydration therapy (ORT)) is the first line treatment of *E. coli* gastroenteritis, in order to replace fluid and electrolytes lost from diarrhoea and vomiting. Rehydration therapy should be initiated as soon as symptoms appear (DiPiro, 2009:430). The use of antibiotics may be required, but as the widespread use of antibiotics in prevention of diarrhoea promotes antibacterial resistance, antibiotics should only be used when necessary (Nester *et al.*, 2001:604). The antibiotics that may be used in the treatment of *E. coli* infection are trimethoprim-sulfamethoxazole (TMP/SMX), ciprofloxacin and norfloxacin (DiPiro, 2009:429). Bismuth preparations can also be used in the prevention of traveller's diarrhoea (Nester *et al.,* 2001:604), but it is important to take note that loperamide is not indicated in patients that present with fever or dysentery (DiPiro & Schwinghammer, 2009b:430).

2.5.4 Salmonellosis

Salmonella-caused diseases in humans are usually classified into different categories. The first is acute gastroenteritis, also known as enterocolitis, bacteremia is the second, extaintestinal localised injection is the third and lastly, enteric fever such as typhoid and paratyphoid fever, a chronic carrier state also occurs (DiPiro & Schwinghammer, 2009b:431).

2.5.4.1 Symptoms

Nontyphoid *Salmonella* usually causes symptoms such as watery or bloody diarrhoea, while asymptomatic intestinal colonisation or extraintestinal spread with metastatic focal infections can also occur. *Salmonella typhi* usually cause enteric fever. Acute gastroenteritis due to nontyphoidal *Salmonella* has a short incubation period of six to 72 hours (Nester *et al.,* 2001:606), whereafter symptoms such as nausea, vomiting, abdominal pain and diarrhoea, either watery or bloody, occur. Fever is also common. The disease is usually self-limiting

and antibiotic treatment is usually not required (DiPiro & Schwinghammer, 2009b:431; Gomez & Cleary, 1996:214).

If obtained early in the disease (acute gastroenteritis), stool cultures do not contain the causative agent, but this decreases over time so that after three to four weeks, only 5% to 15% of adults suffering from the disease, would pass *Salmonella* in their stools. Chronic carriers of *S. typhi*. may continue to pass *Salmonella* in their stools for more than 12 months. Other *Salmonella* serotypes rarely cause chronic passing or shedding of the organism (DiPiro & Schwinghammer, 2009b:432).

Bacteremic nontyphoidal *Salmonella* infection usually occurs in immunocompromised patients such as infants younger than three months and children with inherited or drug-induced immunodeficiencies. The symptoms of bacteremia usually include fever and toxicity. The most common serotype associated with bacteremia is *S. typhimurium*, while *S. paratyphi A* and *S. choleraesus* occur mostly with bacteremia rather than with diarrhoea (Gomez & Cleary, 1996:214).

S. typhi is the causative agent of enteric fever, characterised by a stepwise increase in temperature associated with headache, lethargy, malaise, myalgia and abdominal pain. Stupor, bradycardia, hepatosplenomegaly and rose spots occur in the second week of disease. After three to four weeks, intestinal hemorrhage and perforation may occur, with myocarditis, shock, meningitis and pneumonia as a possibility. Diarrhoea is less prominent than in nontyphoidal *Salmonella* infections. In young children the symptoms caused by *S. typhi* may not be easily observed and can be misinterpreted as a nonspecific viral syndrome (Gomez & Cleary, 1996:214).

2.5.4.2 Pathogen

Salmonella are nonspore-forming, nonencapsulated, nonlactose-fermenting, motile, Gram-negative bacilli (Gomez & Cleary, 1996:212). The taxonomy of *Salmonella* is very complex, but it is considered that only two species of *Salmonella*, namely *S. enterica* and *S. bongori* exist. *Salmonella* can further be subdivided into more than 2400 serotypes based on their different antigens, with *Salmonella* Typhimurium and *Salmonella* Enteritidis as the most commonly isolated serotypes in the United Sates (Nester *et al.,* 2001:604).

2.5.4.3 Pathogenesis

Salmonella is killed in acid environments, therefore a large number of organisms have to be ingested in order to cause the disease. When the lower small intestine is reached, the

bacteria are attached to specific receptors on the surface of epithelial cells by making use of an adhesion on the bacterial surface. The transfer of bacterial substances into the epithelial cell triggers the uptake of the bacterium by the method of endocytosis. Multiplication takes place inside the phagosome and bacteria are exocytosed from the base of the cell. Macrophages usually destroy the bacteria, but the inflammatory response increases fluid secretion and in turn diarrhoea. *Salmonella typhi* are not killed by macrophages, but in turn multiply within them and are carried throughout the body via the bloodstream. The bacteria released by the macrophages' death, invade tissues and cause fever, abscesses, septicemia and shock. Peyer's patches are sometimes destroyed, leading to intestinal rupture and hemorrhage (Nester *et al.,* 2001:605).

2.5.4.4 Epidemiology

Salmonella is found in a wide range of animal reservoirs, therefore contact with animals or animal products can be the source of human infection, with *S. typhi* as an exception as it only occurs in humans. It has been determined that 10^6 to 10^8 nontyphoidal *Salmonella* have to be ingested in order to cause disease, but the ingested inoculum can be smaller during the first few months of the disease as nontyphoidal *Salmonella* is most common at this age. 105 *S. typhi* organisms need to be ingested in order to cause enteric fever in adults. *S. typhi* are primarily found where water treatment is inadequate or where a chronic carrier is handling the food, while nontyphoidal *Salmonella* is found in every environment (Gomez & Cleary, 1996:213).

2.5.4.5 Prevention and treatment

Salmonella infections need to be reported and managed by tracing sources, sanitary handling of animal carcasses, pasteurisation and irradiation of animal products, testing of animal products for contamination and adequate cooking (Nester *et al.,* 2001:606).

In cases of enterocolitis, antimicrobial therapy is often not required. The first line of treatment is fluid and electrolyte replacement (DiPiro & Schwinghammer, 2009b:432).

Asymptomatic, chronic infection is usually treated, except in cases where *S. typhi* is associated with gall bladder disease. Antimicrobial therapy is reserved for high-risk hosts and cases where possible bacteremia is suspected. For high-risk hosts with sensitive nontyphoidal *Salmonella* the following antimicrobial treatment may be considered: ampicillin (200mg/kg/day in four divided doses), co-trimoxazole (10-50 mg/kg/day in two divided doses), cefotaxime (150-200 mg/kg/day in three to four divided doses), ceftriaxone (100

mg/kg/day in one to two doses) and chloramphenicol (75 mg/kg /day in four divided doses). A third generation cephalosporin is the drug of choice in cases where the extra intestinal focus is meningeal. Chronic *S. typhi* carriers can be treated with a high-dose parenteral ampicillin, high-dose oral amoxicillin, or ciprofloxacin in adults (Gomez & Cleary, 1996:214).

DiPiro & Schwinghammer (2009b:429,432) recommended that the following antibiotics be used. (The doses indicated refer to adult doses): Ciprofloxacin 500 mg or norfloxacin 400 mg may be taken orally twice daily for three to seven days. Azithromycin is another option in which 1 g must be taken for one day, where after 500 mg must be taken once daily for six days (DiPiro & Schwinghammer, 2009b:429). Third generation cephalosporins such as ceftriaxone and cefotaxime are also indicated. In cases of bacteremia or localised infections, chloramphenicol or ampicillin is indicated. In cases of resistance against chloramphenicol or ampicillin, co-trimoxazole (TMP/SMX) may be used. Enteric fever and cases where drug resistance occurs, can be treated with ciprofloxacin 500 mg given twice daily for 10 days. Norfloxacin 400 mg orally twice daily for 28 days is recommended for chronic carriers of *Salmonella* (DiPiro & Schwinghammer, 2009b:432).

2.5.5 Campylobacteriosis

Campylobacter is considered one of the main causes of diarrhoea when compared to *Salmonella* or *Shigella* (DiPiro & Schwinghammer, 2009b:433).

2.5.5.1 Symptoms

The incubation period for Campylobacter is two to four days. The symptoms caused by *Campylobacter jejuni* are similar to those caused by *Shigella* spp. and include diarrhoea, abdominal cramps, nausea, vomiting, bloody stools and fever. Dysentery occurs in about 50% of cases. The disease is usually self-limiting with symptoms lasting for about seven days. In 10% to 20% of individuals, symptoms may last for longer than one week (DiPiro & Schwinghammer, 2009b:433; Nester *et al.,* 2001:606).

2.5.5.2 Pathogen

Campylobacter jejuni is a Gram-negative rod that can be cultured in microaerophilic conditions (Nester *et al.,* 2001:606; Engelkirk & Burton, 2007:315).

2.5.5.3 Pathogenesis

It requires only 500 (or fewer) organisms in order to cause the disease. The ingested pathogens penetrate the epithelial cells of the small and large intestine, where they then

multiply beneath or inside the cells and cause an inflammatory reaction. Penetration into the bloodstream does not usually occur. Campylobacteriosis is of importance as about 40% of Guillian-Barré syndrome cases are preceded by *C. jejuni* infections. This syndrome begins in about ten days of the onset of diarrhoea, with tingling of the feet and progressive paralysis of the rest of the body (Nester *et al.,* 2001:606-607).

2.5.5.4 Epidemiology

C. jejuni outbreaks are usually foodborne and waterborne with poultry being the common source. Epidemics can result after ingesting unpasteurised milk and nonchlorinated surface water. Person-to-person transfer does not usually occur (Nester *et al.,* 2001:607). Transmission of infection usually occurs via the ingestion of contaminated water or food (DiPiro & Schwinghammer, 2009b:433).

2.5.5.5 Prevention and treatment

The chlorination of water and pasteurisation of milk are extremely important in the prevention of *C. jejuni* outbreaks. Raw poultry must be properly handled and contamination of surfaces must be prevented. Poultry must also be properly cooked. Patients usually recover within ten days without any antimicrobial treatment (Nester *et al.,* 2001:607). It is important to note that fluid and electrolyte replacement therapy is the first line of treatment. Antimicrobial therapy is only effective if it is started within four days of the start of the disease. Antimicrobial therapy will not decrease the severity or duration of diarrhoea. Antimicrobial therapy is considered in children, the elderly, immunocompromised patients and in patients with bloody diarrhoea. The anitimicrobial agent of choice is erythromycin, while clarithromycin and azithromycin are also effective. It is important to note that antimotility agents are contraindicated in campylobacteriosis (DiPiro & Schwinghammer, 2009b:433).

2.6 Viral diseases of the gastro-intestinal tract

Gastroenteritis can occur due to viral agents (Adams & Moss, 2004:305). Only some of the viruses known to cause gastro-intestinal disease will be discussed in this section.

2.6.1 Rotaviral gastroenteritis

Gerba *et al.* (1996:2930) reported that the rotavirus possesses several unique characteristics that makes it an important pathogen of the gastro-intestinal tract. Firstly, the rotavirus is the most common cause of viral gastroenteritis in the world, it has the highest infectivity rate of any known waterborne virus and it has the highest known case fatality for viral

gastroenteritis. The rotavirus causes 100-fold greater case fatality rates in the elderly and in immune-compromised individuals there can be a 50% greater case fatality compared to the 0,01% of the general population. Of all the enteric RNA (ribonucleic acid) viruses, the rotavirus shows the greatest resistance to UV (ultraviolet) light disinfection.

2.6.1.1 Symptoms

The incubation period is one to three days with infection usually occurring in children younger than five years. Common symptoms presented by rotaviral infection include the following: nausea, vomiting, abdominal cramping, diarrhoea (lasting one to nine days) and dehydration (Gerba *et al.,* 1996:2931 ; DiPiro & Schwinghammer, 2009b:434). The disease may also be asymptomatic, as is usually the case in adults that are infected. Other symptoms are fever, respiratory symptoms, lethargy, irritability, rhinitis, pharyngeal erytema, red tympanic membranes and palpable cervical lymph nodes (DiPiro & Schwinghammer, 2009b:434). The case of death is most often an electrolyte imbalance due to dehydration (Gerba *et al.,* 1996:2931).

2.6.1.2 Pathogen

Rotaviruses form part of the Reoviridae family, where the names of different genera are determined by taking their morphology into account. The morphology of rotaviruses resemble that of a wheel (*rota:* wheel) (Levy *et al.,* 1994:111). Rotaviruses are double-stranded RNA viruses, with a double-walled capsid that is formed by 32 capsomeres that radiate from the centre. The RNA genome consists of 11 segments. This 70 nm diameter virus is resistant to inactivation at a low and high pH (Gerba *et al.,* 1996:2930; Levy *et al.,* 1994:111; Nester *et al.,* 2001:607).

2.6.1.3 Pathogenesis

Rotaviruses infect the epithelial cells that line the upper section of the small intestine. The infection causes cell death and a decrease in digestive enzyme production takes place (Nester *et al.,* 2001:608).

2.6.1.4 Epidemiology

Rotaviruses are mainly spread via the fecal-oral route (Nester *et al.,* 2001:608), but waterborne transmission is also possible, as rotaviruses are also detected in drinking water and recreational water contaminated by fecal matter. In order to cause waterborne disease, the viral count in drinking water must be higher than $2{,}2 \times 10^{-7}/\ell$ (Gerba *et al.,* 1996:2937). Rotavirus infections occur most commonly in children younger than two years, but are not

common after five years of age. Infected children were in the majority of cases younger than three years old (O'Ryan *et al.,* 2005:127). Nester *et al.* (2001:608) reported that most epidemics occur during the winter when children are mostly confined indoors in groups, providing circumstances for the easy spread of the disease. Rotavirus infection in adults usually occurs in the following circumstances: waterborne outbreaks, contact with infected children, traveller's diarrhoea, occurrence of endemic rotavirus infections and the epidemic spread of rotavirus infection, with or without contact with infected children (Hrdy, 1987:462).

2.6.1.5 Prevention and treatment

As dehydration occurs commonly in children, treatment must be given to correct electrolyte and fluid loss. Antimicrobial treatment is not effective and antimotility agents are not recommended (DiPiro & Schwinghammer, 2009b:434). Proper sanitation and hygiene are the most important components in the prevention of the spread of the disease as the fecal-oral transfer of the virus would be limited (Nester *et al.,* 2001:608).

2.6.2 Norwalk virus gastroenteritis

In 1968 the Norwalk virus caused a gastroenteritis outbreak in children in Norwalk, Ohio. Although this virus is a known cause of food-borne gastroenteritis, it will also be discussed in this section as transmission does occur via the fecal-oral route and may be an indicator of inadequate sanitation and/or hygiene (Adams & Moss, 2004:305).

2.6.2.1 Symptoms

The symptoms caused by the Norwalk virus, are nausea and vomiting that relate to the symptoms caused by rotavirus infections (Nester *et al.,* 2001:608). The gastroenteritis is characterised by abdominal cramps, nausea and vomiting with a sudden onset. Adults usually show symptoms of non-bloody diarrhoea, while children experience vomiting. Other symptoms include myalgia, malaise, headache and fever in about 50% of all cases. The infection usually has a duration of 12 hours to two days (DiPiro & Schwinghammer, 2009b:434; Nester *et al.,* 2001:608).

2.6.2.2 Pathogen

The Norwalk virus is a non-enveloped virus with a positive-sense RNA genome that is about 35 to 40 nm in diameter and has an icosahedral shape. This virus is part of the Caliciviridae family and has four described Norwalk virus serotypes namely Norwalk, Snow Mountain, Hawaii and Taunton, based on the geographical areas where these viruses were first found (Levy *et al.,* 1994:38; Nester *et al.,* 2001;608).

2.6.2.3 Pathogenesis

The upper section of the small intestine's epithelium is infected by this virus and changes are similar to those caused by rotavirus infection. It takes about two weeks for the epithelium to recover (Nester *et al.,* 2001:608).

2.6.2.4 Epidemiology

Transmission usually occurs via the fecal-oral route. Both children and adults get infected. The infection is sometimes also contracted by eating shellfish as calciviruses are widespread among marine animals. The virus usually gets eliminated in the feces of infected individuals for a few days (Nester *et al.,* 2001;608).

2.6.2.5 Prevention and treatment

The most important preventative tool in this infection is the maintenance of proper hygiene, such as the washing of hands after defecation, the use of disinfectants, as well as proper sanitation (Nester *et al.,* 2001:608). The disease is self-limiting and any other therapy other than oral rehydration is rarely required (DiPiro & Schwinghammer, 2009b:434).

2.7 Protozoan diseases of the gastro-intestinal tract

Some of the protozoan diseases of the gastro-intestinal tract will be discussed.

2.7.1 Giardiasis

Giardia is known as one of the most common causative agents of waterborne disease in the United States and it causes many cases of traveller's diarrhoea (Nester *et al.,* 2001:613).

2.7.1.1 Symptoms

The incubation period for giardiasis is six to twenty days. Symptoms usually vary from mild nausea and indigestion to more severe vomiting, diarrhoea, abdominal cramps, fatigue and weight loss. The symptoms usually disappear after a period of one to four weeks, while some cases are chronic (Nester *et al.,* 2001:613).

2.7.1.2 Pathogen

Giardia lamblia, the causative agent, is a protozoan with two nuclei that is located next to each other with the resemblance of eyes. It is pear shaped, with flagella and a disc on the undersurface. *Giardia lamblia* has the ability to exist in two different forms namely a trophozoite or a cyst. The trophzoite is the actively feeding form that colonises the upper

section of the small intestine. When the patient has diarrhoea, the trophozoites can be found in the feces. Cysts develop when the trophozoites are carried slowly to the large intestine. These *Giardia* cysts have thick chitin walls that protect the cyst from environmental conditions (Nester *et al.,* 2001:613).

2.7.1.3 Pathogenesis

The cyst form of *Giardia lamblia* is responsible for infection as the outer chitin wall of the cyst protects it against damage from the gastric acid when it is ingested. After ingestion, the trophozoites emerge from the cysts, thereafter the trophozoites adhere to the epithelial surface by making use of their adhesive disks while others move in the intestinal mucus by using their flagella. Trophozoites that migrate toward the gallbladder may cause jaundice or abdominal cramps. The epithelium covered by the trophozoites, is not destroyed, but may sometimes be completely covered. The ability of the epithelium to absorb nutrients or secrete enzymes is altered, with malnutrition, fat-containing feces and intestinal gas due to the microbial digestion of unabsorbed food material, as result (Nester *et al.,* 2001:614).

2.7.1.4 Epidemiology

Giardia lamblia is usually transmitted via the fecal-oral route, with special emphasis on the consumption of fecal contaminated water (Nester *et al.,* 2001:614). In communities where the prevalence rates of infection are high and where personal hygiene is not maintained, the risk of acquiring giardiasis by drinking post-treatment contaminated water and eating fresh vegeTables with contaminated hands, is quite high (Mohammed Mahdy *et al.*, 2008:469). Water filtration is extremely important as the cysts are not destroyed by the chlorination levels of municipal water. The disease can also be transmitted by person-to-person contact as in day care centres where hands get contaminated when diapers are changed, or via anal intercourse (Nester *et al.,* 2001:614).

2.7.1.5 Prevention and treatment

Water purification before ingesting the possibly contaminated water, is of extreme importance. Drinking water must be boiled for at least one minute, or must be disinfected. Community water supplies must be filtrated. Good personal hygiene practices such as hand washing is also important in preventing the transfer of the pathogen. Quinacrine hydrochloride and metronidazole can be used in the treatment of giardiasis (Nester *et al.,* 2001:614).

2.7.2 Cryptosporidiosis

In April 1993, the Milwaukee Department of Health (United States of America) received reports of cases of gastrointestinal disease occurring in the area, causing teachers, students and hospital workers to be absent from their daily activities. Laboratory tests performed on stool samples of the patients identified the presence of *Cryptosporidium* oocysts (MacKenzie *et al.,* 1994:162). In this outbreak, it was estimated that more than 400 000 people were suspected to be infected, as they have shown signs of watery diarrhoea. More than 600 cases were confirmed to have been caused by *Cryptosporidium*. In this outbreak in Milwaukee, is was found that *Cryptosporidium* oocysts, found in the untreated water from Lake Michigan, entered the southern water treatment plant and were not removed by coagulation and filtration processes. Possible sources for the oocysts may include the following: cattle farms along the rivers that flow into the Milwaukee harbour, human sewerage and slaughterhouses. Oocysts may have been transported to and from Lake Michigan to the Milwaukee Water Works' southern plant, via river swells caused by spring rain and snow runoff (MacKenzie *et al*., 1994:167).

2.7.2.1 Symptoms

After an incubation period of four to 12 days, fever, nausea, abdominal cramps and diarrhoea appear. The duration of the disease is usually ten to 14 days, but it may last longer in immunocompromised patients (Engelkirk & Burton, 2007:340; Nester *et al*., 2001:614).

2.7.2.2 Pathogen

Cryptosporidium sp. form coccidian member of the phylum Apicocomplexa (Nester *et al.,* 2001:615; Xiao *et al.,* 2004:73).

2.7.2.3 Pathogenesis

After ingestion of oocysts via water or food, the oocysts give rise to sporozoites that enter beneath the brush border of the epithelium of the intestines. The sporozoites develop into trophozoites and later schizonts cause blunting of the villi, mild inflammation, diarrhoea and malnutrition (Dillingham *et al.,* 2002:1062).

2.7.2.4 Epidemiology

Cryptosporidium transmission usually depends on the characteristics that will be mentioned shortly. *Cryptosporiduim* have acid- and chlorine-resistant oocysts that can easily spread via water and food. The infective dose is as few as 1-10 oocysts. Cryptosporidial oocysts are 4-

6 µm in size, which is difficult to filter because of the small size. The oocysts are infectious when shed and will therefore ease transfer among individuals. *Cryptosporidium* has zoonotic potential, implicating that transfer between animals and humans is possible (Dillingham *et al.*, 2002:1060; Steiner *et al.,* 1997:331).

2.7.2.5 Prevention and treatment

Municipal water supplies must be monitored. Drinking water must also be boiled to avoid contracting the disease. Beverages must be pasteurized. Human and animal waste must be disposed of in a sanitary and hygienic manner. The combination of paromomycin (not available in South Africa according to Snyman, *ed.*, 2008) and azithromycin has been successful in controlling the disease in AIDS patients, but no effective treatment is known (Nester *et al.,* 2001:615).

2.7.3 Cyclosporiasis

Cyclosporiasis was noted in the late 1980s when epidemics of severe diarrhoea occurred (Nester *et al.,* 2001:615).

2.7.3.1 Symptoms

The incubation period for this disease is about one week, whereafter symptoms such as fatigue, loss of appetite, fever, nausea, vomiting and diarrhoea with weight loss occur. The duration of diarrhoea is between nine and 43 days in patients that are not immunocompromised, but it may last months in immunocompromised patients (Engelkirk & Burton, 2007:340; Nester *et al.,* 2001:616).

2.7.3.2 Pathogen

The causative agent in this disease is a coccidian member of the Apicomplexa, namely *Cyclospora cayetanensis*. The oocysts of *C. cayetanensis* are eight to ten µm in diameter and do not contain sporozoites when they are passed through the feces. Only after being in favourable conditions outside the body, two sporocysts that contain two infectious sporozoites each develop within each oocyst (Engelkirk & Burton, 2007:340; Nester *et al.,* 2001:616).

2.7.3.3 Pathogenesis

The pathogenesis of this organism is not well-known as laboratory animals are not susceptible to the disease. Small intestinal biopsies from patients infected with *C.*

cayetanensis proved that the sexual and asexual forms of this protozoan are present in the epithelium of the small intestine (Nester *et al.,* 2001:616).

2.7.3.4 Epidemiology

Transmission usually takes place via fecally contaminated water and food rinsed with contaminated water, therefore this disease is usually waterborne, but food-borne infections also occur (Engelkirk & Burton, 2007:340). Person-to-person transfer of *Cyclospora cayetanensis* does not occur as the oocysts eliminated in the feces of the patient, are non-infectious. Infections usually occur during warmer months of the year as the warm and moist conditions favour the maturation of the oocysts; this also indicates why travellers to tropical areas usually contract this disease (Nester *et al.,* 2001:616). Chacín-Bonilla *et al.* (2007:1023) indicated that exposure to soil contaminated with human fecal matter, may be an important mode of transmission for the infection in endemic areas. It was also found that cyclosporiasis usually affect families living in substandard environments (Chacín-Bonilla *et al.,* 2007:1023).

2.7.3.5 Prevention and treatment

Water must be boiled and filtered before consumption, while berries and other leafy vegetables must also be washed with uncontaminated water before consumption. Cyclosporiasis can be treated with co-trimoxazole (Nester *et al.,* 2001:616).

2.7.4 Amoebiasis

This disease, also known as ameobic dysentery, is a protozoal infection that occurs worldwide (Engelkirk & Burton, 2007:340).

2.7.4.1 Symptoms

Amoebiasis is usually asymptomatic, but in some cases mild chronic diarrhoea or even acute dysentery and death can occur (Nester *et al.,* 2001;616). Known symptoms are fever, diarrhoea with blood and mucus and sometimes constipation may occur (Engelkirk & Burton, 2007:340).

2.7.4.2 Pathogen

The causative agent of this disease is *Entamoeba histolytica*, which is a member of the Apicomplexa. This organism is about 20 to 40 µm in diameter and has a cyst form that is covered by a chitin cyst wall. Immature cysts contain only one nucleus, while the mature cyst contains four nuclei. The mature cyst is the infectious form (Nester *et al.,* 2001:616).

The trophozoite stage represents the motile amoebae that is metabolically active and is able to reproduce (Engelkirk & Burton, 2007:340).

2.7.4.3 Pathogenesis

The mature cysts are able to survive passage through the stomach. In the small intestine, the organisms are released from their cysts. Thereafter the cytoplasm and nuclei divide, yielding eight trophozoites. When the lower intestine is reached, the trophozoites begin to feed on mucus and other intestinal bacteria. Some strains produce a cytotoxic enzyme that kills the intestinal epithelium on contact. This allows the organisms to penetrate the lining cells and deeper tissue layers of the intestinal wall. In some instances the blood vessels are penetrated and the organisms are then transported via the blood to other organs of the body. Ameobic abscesses occur when the organisms multiply in the intestine and other body tissues and tissue destruction occurs. Amebas on the cells lining the intestine have irritating effects that cause intestinal cramps and diarrhoea. Intestinal ulceration causes the diarrhoea to be bloody and is commonly known as ameobic dysentery (Nester *et al.,* 2001:616).

2.7.4.4 Epidemiology

Amoebiasis commonly occurs in tropical areas where the sanitation is poor, but is distributed worldwide. Amoebiasis is commonly associated with poverty, male homosexuality and migrant workers (Nester *et al.,* 2001:617). It was found that the population mostly infected is under 15 years of age (Ximénez *et al.,* 2009:1026). Humans are the only important reservoir. Transmission of the disease occurs via the fecal-oral route (Nester *et al.,* 2001:617), as well as the ingestion of fecally contaminated water and food, flies that transport cysts from feces to food and oral-anal sexual contact (Engelkirk & Burton, 2007:340).

2.7.4.5 Prevention and treatment

Good sanitation and hygiene are of extreme importance in the prevention of amoebiasis. Another preventative measure is the avoidance of the contamination of drinking water sources with fecal matter. Metronidazole can be used in the treatment of this disease (Nester *et al.,* 2001:617).

2.8 Pharmacological therapy

In simple acute diarrhoea, also known as gastroenteritis, adults usually do not need medication during the first 24 hours, but oral fluid and electrolyte therapy are suggested. Acute gastroenteritis in children is of a more serious nature and electrolyte replacement is of

extreme importance. Antidiarrhoeal agents are of secondary importance and may even be undesirable as the treatment delays viral clearance and is not indicated in young children. These agents may be useful when diarrhoea persists for longer than 24 hours, but a diagnosis should be made. Antimicrobial agents are usually unnecessary and should preferably not be used in simple gastroenteritis, as bacterial gastroenteritis usually clears up within three to four days without the use of antimicrobials. Antimicrobials are, however, indicated in the treatment of acute dysentery. In instances where a bacterial pathogen is identified after the diarrhoea has ceased, antimicrobial agents must still not be used, except in cases of cholera, *Shigella*, *Campylobacter and Salmonella* infections (Gibbon *et al.,* 2005:53).

2.8.1 Rehydration therapy

Oral rehydration therapy forms the first line of treatment in gastro-intestinal infections. Parenteral fluid and electrolyte replacement is indicated in cases where the patient is in shock, not able to tolerate oral fluids, in a comatose state and in patients where there is vomiting or a continuous stool output of more than 10 ml/kg per hour. In most cases, however, oral rehydration therapy is sufficient in replacing fluids and electrolytes lost. Glucose, sodium, chloride, potassium and water form essential components of oral rehydration therapy. During the first phase of treatment, known as the rehydration phase, fluids must be replaced in four to six hours. During the second phase, the maintenance phase, fluid replacement must not exceed 150 ml/kg per day. Fluid replacement is usually adjusted to equal the stool output and other fluids lost (DiPiro & Schwinghammer, 2009b:426).

2.8.2 Antidiarrhoeal agents

Antidiarrhoeal agents may be used in the treatment of diarrhoea conditions that are not severe, but should not be used in cases where the patient has a high fever, bloody diarrhoea or systemic toxicity. Antidiarrhoeals can be used in the treatment of chronic diarrhoea caused by conditions such as irritable bowel syndrome or inflammatory bowel disease (McQuaid, 2004:1041), but these conditions are not included in the scope of this study.

2.8.2.1 Opioid agonists

Opioid agonists have constipating effects as they increase colonic phasic segmenting activity by inhibition of the presynaptic cholinergic nerves in the myenteric and submucosal plexuses. The effects are prolonged colonic transit time together with fecal water absorption. Mass colonic movements and gastrocolic movements and gastrocolic reflexes are decreased. A

negative effect of opioids is their potential to cause addiction. Opioids are also contraindicated in certain cases of infectious diarrhoea. A nonprescription opioid agonist that has no analgesic properties or addiction potential due to the fact that it does not cross the blood-brain barrier is loperamide (DiPiro & Schwinghammer, 2009a:258; McQuid, 2004:1047).

Loperamide is usually prescribed in the management of acute and chronic diarrhoea (DiPiro, 2009:258). Loperamide inhibits contractions in the longitudinal and circular muscle and thereby decreases gastro-intestinal motility. Loperamide is usually prescribed as 4 mg immediately and thereafter 2 mg after each loose stool until the diarrhoea ceases, not exceeding the maximum dose of 16 mg per day (Rossiter *et al.,* 2010:61).

Diphenoxylate has opioid-like constipating effects and may be used in addition with rehydration therapy, but not as a replacement for rehydration therapy in the treatment of diarrhoea. Atropine, an anticholinergic agent, blocks the vagal tone and increases the gut transit time, but use is limited due to side-effects. Atropine is usually included in preparations with diphenoxylate (diphenoxylate hydrochloride 2,5 mg together with 0.025 mg atropine sulphate) in order to discourage abuse (DiPiro & Schwinghammer, 2009a:261; McQuaid, 2004:1047; Rossiter *et al.,* 2010:61).

2.8.2.2 Kaolin and pectin

Kaolin, a naturally occurring hydrated magnesium aluminum silicate and pectin, an ingestible carbohydrate, decrease stool frequency by absorbing fluid, bacteria and toxins and are usually used in symptomatic treatment. These formulations, known as adsorbents, are not absorbed and do not have other important side-effects apart from constipation (DiPiro & Schwinghammer, 2009a:258; McQuaid, 2004:1047; Pasricha, 2009).

2.8.3 Antispasmodic agents

The antimuscarinic antispasmodic agents can be divided into two main groups namely the synthetic antimuscarinics (tertiary and quaternary ammonium compounds) and atropine and related belladonna compounds. These agents relieve muscle spasms. Examples of these agents are dicyclomine that may act directly as a non-selective smooth muscle relaxant and mebeverine, that has papaverine-like properties and may be selectively spasmolytic on the smooth muscle of the gastro-intestinal tract (Rossiter *et al*., 2010:43).

Propantheline is an example of a synthetic anticholinergic drug. It is a quaternary ammonium compound that is often used in gastro-intestinal disorders that involve spasm of the smooth muscle (Rossiter *et al.,* 2010:44).

Belladonna alkaloids are tertiary amines, such as atropine and belladonna alkaloids and semi-synthetic quaternary ammonium compounds such as hyoscine butylbromide. Atropine competitively antagonises acetylcholine activity at muscarinic receptors. Hyoscine butylbromide has similar activity as that of atropine and is mainly used as an anti-spasmodic agent of the gastro-intestinal, biliary and genitourinary tracts (Rossiter *et al.,* 2010:44).

2.8.4 Anti-emetic agents

The lateral medullary reticular formation contains the brainstem vomiting centre, where the vomiting is coordinated via interactions with the cranial nerves VIII and X and neural networks located in the nucleus tractus solitarius that control vasomotor, respiratory and salivatory centres. The vomiting centre contains high concentrations of serotonin 5-HT_3, muscarinic and histamine H_1 receptors (McQuaid, 2009:1084).

Four sources of afferent input to the vomiting centre have been identified and will be discussed shortly (McQuaid, 2009:1084-1085).

- 5-HT_3 receptors are located in the vagal and enteric afferents in the gastro-intestinal mucosa. Mucosal serotonin release and activation of the 5-HT_3 receptors are triggered by irritation of the gastro-intestinal mucosa by acute infectious gastroenteritis, chemotherapy and radiation therapy. This stimulates vagal afferent input to the vomiting centre and the chemoreceptor trigger zone.

- The chemoreceptor trigger zone, located in the fourth ventricle in the area postrema, is outside the blood-brain barrier and can therefore be accessible to emetogenic stimuli in the blood or cerebrospinal fluid. Dopamine D_2 receptors, serotonin 5-HT_3 receptors and opioid receptors are located in the chemoreceptor trigger zone.

- In motion sickness the vestibularsystem plays an important role via the cranial nerve VIII. This nerve is rich in histamine H_1 receptors and muscarinic receptors.

- Vomiting due to psychiatric disorders, stress and anticipatory vomiting before chemotherapy emphasises the role of the central nervous system in emesis.

Cyclizine is a piperazine-type antihistamine that is mainly indicated in the prevention and treatment of motion sickness as well as nausea and vomiting caused by labyrinthine disorders and other conditions with nausea and vomiting as symptoms. Promethazine is a phenothiazine derivative antihistamine and is also used in the prevention and treatment of motion sickness, vertigo, nausea and vomiting. Other medications of importance are metoclopramide and prochlorperazine. Metoclopramide is a substituted benzamide that increases lower esophageal sphincter tone, gastric emptying is increased and via the release of asetylcholine, transit through the small bowel is increased. Metoclopramide is used in the treatment of nausea and vomiting caused by infections, toxins, drugs, uraemia, in radiation sickness and in cases of post-operative nausea and vomiting. It is, however, not effective in the treatment of nausea and vomiting caused by labyrinthine disorders. Prochlorperazine is a phenothiazine derivative that is a neuroleptic and has antiemetic activity by blocking dopamine at the CETZ. It also has weak anticholinergic activity. Ondansetron, granisetron, dolasetron and tropisetron are 5-HT_3 antagonists that are indicated in the treatment of chemotherapy- and radiotherapy-induced nausea and vomiting (DiPiro & Schwinghammer, 2009a:300; Pasricha, 2009; Rossiter *et al.,* 2010:47-52).

Other agents are motility stimulants namely dopamine antagonists. Examples of these agents are domperidone and metoclopramide. Dopamine antagonists enhance gastric emptying, increase gastro-esophageal sphincter tone and decrease the small bowel transit time (Rossiter *et al.,* 2010:43).

Metoclopramide is mainly used in the treatment of nausea and vomiting, but is not effective in cases where nausea and vomiting are caused by labyrinthine disturbances. The antiemetic activity is achieved by the antagonism of dopamine at the CETZ (chemo-effector trigger zone). There is an increase in the intestinal motility and gastro-esophageal sphincter tone that may be due to the stimulatory action of acetylcholine on the smooth muscle of the gastro-intestinal tract. Domperidone relieves nausea and vomiting of central or peripheral origin by acting as a peripheral dopamine blocking agent (Rossiter *et al.,* 2010:45).

It is clear from the discussions of antispasmodic and antiemetic agents, that these medications are used in a wide variety of disorders. As diagnosis information in the form of ICD-10 (International Statistics Classification of Diseases and Related Health Problems, Tenth Revision) codes are incomplete on the data received, it is assumed that medicines prescribed, are indicated in the treatment of gastro-intestinal disorders caused by inadequate water supply and sanitation. The fact that no diagnosis is available is one of the primary limitations of this study.

2.8.5 Antimicrobial agents

In the following section some of the antimicrobial agents used in the treatment of gastro-intestinal disease will be discussed. Table 2.5 (Nester *et al.,* 2001:598-618; O'Ryan *et al.,* 2005:131) indicates the antimicrobial treatment indicated for different enteric pathogens.

Table 2.5: Antibacterial treatment for enteric pathogens (Nester *et al.,* 2001:598-618; O'Ryan *et al.,* 2005:131)

Pathogen	Antimicrobial Treatment
Bacterial pathogens	
Diarrhoeagenic *Escherichia coli*	Ampicillin, Co-trimoxazole, Ciprofloxacin, Chloramphenicol,Tetracycline, Aminoglycosides,Cephalosporins, Fluoroquinolone
Shigella spp.	Fluoroquinolone, Azithromycin, Co-trimoxazole, Ceftriaxone, Ampicillin.
Salmonella spp.	Cefotaxime, Ceftriaxone, Fluoroquinolone, Ampicillin, Co-trimoxazole, Chloramphenicol
Campylobacter spp.	Azithromycin, Erythromycin, Fluoroquinolone, Tetracycline, Gentamycin
Vibrio cholerae	Doxycycline,Co-trimoxazole, Fluoroquinolone, Chloramphenicol
Clostridium difficile	Metronidazole, oral Vancomycin

Table 2.5 (continued): Antibacterial treatment for enteric pathogens (Nester *et al.,* 2001:598-618; O'Ryan *et al.,* 2005:131)

Pathogen	Antimicrobial treatment
Protozoal pathogens	
Giardia lamblia	Metronidazole, Tinidazole
Entamoeba histolitica	Metronidazole
Cryptosporidium parvum	Azithromycin
Cyclospora cayetanensis	Co-trimoxazole

Rossiter *et al.* (2010:275) also provide essential information on the treatment of gastro-intestinal infections caused by microbes. In cases of acute non-inflammatory diarrhoea by enterotoxogenic *Escherihcia coli*, antibiotics are not indicated and only rehydration therapy is essential. In acute inflammatory diarrhoea caused by *Shigella*, *Salmonella* (non-typhoid) and *Campylobacter*, quinolones are indicated only in severe cases. Rehydration therapy is also of extreme importance. In cholera, caused by *Vibrio cholera*, quinolones are indicated. The most important component of cholera treatment is rehydration therapy. In typhoid fever, caused by *S. typhi*, quinolones are indicated with third generation cephalosporins as an alternative.

In this study, all antimicrobials prescribed together with an antidiarrhoeal agent, antispasmodic, antiemetic and/or oral rehydration therapy will be included as the diagnosis is not always indicated as ICD-10 codes on the data system. In this discussion, however, only the antimicrobials classified by Gibbon *et al.*(2005:253) and the next edition by Rossiter *et al.* (2010:275) for the treatment of gastro-intestinal infections caused by enterotoxigenic *E. coli*, *Shigella* spp., non-typhoid *Salmonella*, *Campylobacter*, *V. cholera* and *Salmonella typhi* will be discussed.

2.8.5.1 DNA gyrase inhibitors

Fluoroquinolones as DNA (deoxyribonucleic acid) gyrase inhibitors will be discussed briefly.

2.8.5.1.1 Fluoroquinolones

Fluoroquinolones inhibit DNA gyrase and in turn bacterial DNA cannot be replicated, with a bactericidal effect (Rossiter *et al.,* 2010:298).

These synthetic fluorinated analogs of nalidixic acid are active against gram-positive as well as gram-negative bacteria. Bacterial DNA synthesis is blocked by inhibiting bacterial topoisomerase II, also known as DNA gyrase and topoisomerase IV. When DNA gyrase is inhibited, the positively supercoiled DNA cannot be relaxed (uncoiled), with the result that transcription and replication are prevented. During cell division, topoisomerase IV plays an important role as it is required in the separation of replicated chromosomal DNA into the resulting daughter cells. When topoisomerase IV is inhibited, this process cannot take place (Chambers & Deck, 2009b:819).

Fluoroquinolones originally had limited activity against gram-positive organisms and are highly effective against gram-negative organisms. More recent generations of fluoroquinolones, however, have better activity against gram-positive cocci. Fluoroquinolones are effective in the treatment of diarrhoea caused by *Salmonella, Shigella, Campylobacter and* toxigenic *E. coli* (Chambers & Deck, 2009b:819-820).

Examples of fluoroquinolones used in practice are norfloxacin, ciprofloxacin and ofloxacin (Chambers & Deck, 2009b:820; Rossiter *et al.,* 2010:298).

2.8.5.2 Antifolate drugs

Trimethoprim-sulfamethoxazole (co-trimoxazole/TMP-SMX) will be discussed briefly.

2.8.5.2.1 Trimethoprim-sulfamethoxazole

When trimethoprim-sulfamethoxazole (co-trimoxazole) mixtures are considered, the actions of sulfonamides and trimethoprim must be considered separately as combination as synergism of drug activity takes place. In order for microorganisms to produce purines and ultimately nucleic acids, dihydrofolic acid must be formed as an essential step. Extracellular PABA (*p*-aminobenzoic acid) is required in the formation of dihydrofolic acid. Sulfonamides competitively inhibit dihydropteroate synthase, as it is a structural analog of PABA. Growth of gram-negative and gram-positive organisms is reversibly inhibited by blocking folic acid synthesis. *Salmonella, Shigella, E. coli and* some protozoa are inhibited. Trimethoprim inhibits bacterial dihydrofolic acid reductase. Dihydrofolic acid conversion to tetrahydrofolic acid by dihydrofolic acid reductases is inhibited, also in turn inhibiting the synthesis of

purines and DNA. The combination of trimethoprim-sulfamethoxazole enhances the activity of both these drugs by sequential blocking that occurs in the production of DNA from PABA (Chambers & Deck, 2009b:815-818). This metabolic sequence, adapted from Chambers and Deck (2009b:816), is depicted in Figure 2.1.

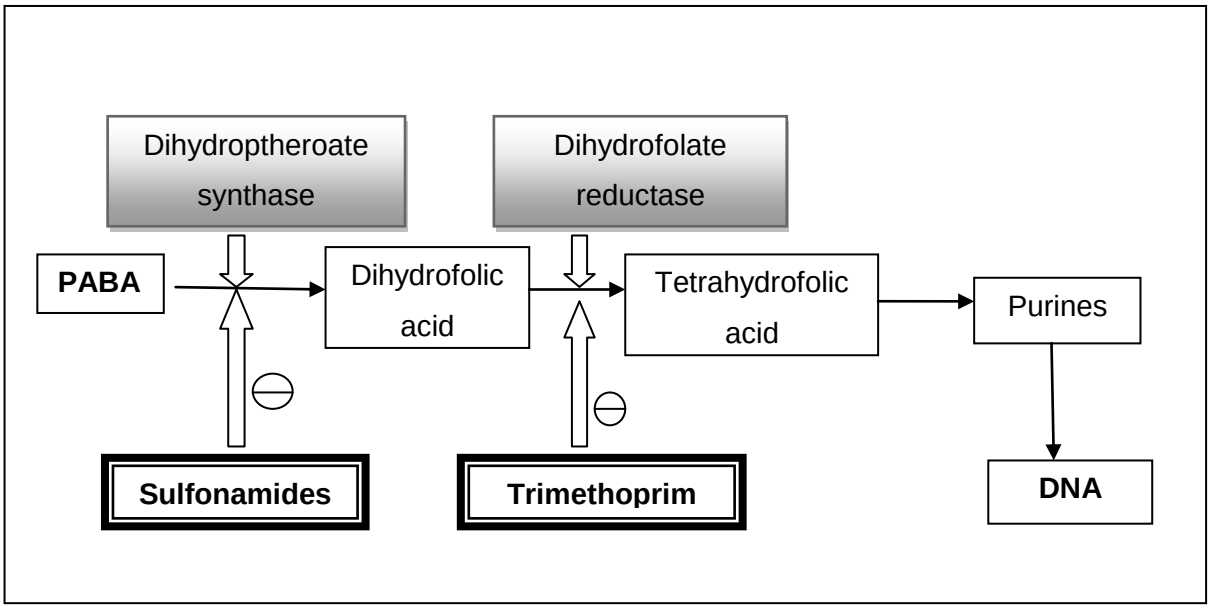

Figure 2.1: The actions of sulfonamides and trimethoprim on the synthesis of DNA

2.8.5.3 Protein synthesis inhibitors

Tetracycline as an inhibitor of protein synthesis will be discussed briefly.

2.8.5.3.1 Tetracycline

Tetracylines are broad spectrum bacteriostatic antimicrobials that are active against gram-positive and gram-negative bacteria and act by inhibiting protein synthesis. Tetracyclines bind reversibly to the 30S subunit of the bacterial ribosome. There it blocks the binding of aminoacyl-tRNA to the receptor on the mRNA-ribosome complex. The addition of amino acids to the growing peptide chain is prevented (Chambers & Deck, 2009a:796; Rossiter *et al.,* 2010:292).

According to Chambers and Deck (2009a:797-780) tetracyclines are used against *Vibrio cholera* infections where it ends the shedding of vibrios during cholera, however, resistance against the drug is occurring. *Entamoeba histolytica* infections, bacterial gastroenteritis and, in combination therapy in gastric and duodenal ulcer disease caused by *Helicobacter pylori* , a newly recognised water-borne pathogen (Theron & Cloete, 2002:4).

2.8.5.4 Miscellaneous antimicrobial agents

Metronidazole will be discussed briefly.

2.8.5.4.1 Metronidazole

Metronidazole, a nitroimidazole antiprotozoal drug, also has activity against anaerobes (Chambers & Deck, 2009c:877). Metronidazole acts by inhibiting nucleic acid synthesis and interaction with intracellular macromolecules, making this agent both bactericidal as well as antiprotozoal. This drug is mainly indicated in the treatment of amoebic dysentery caused by *Entamoeba histolytica*, anaerobic infections such as giardiasis caused by *Giardia lamblia and* in combination therapy in peptic ulcer disease caused by *Helicobacter pylori* (Rosenthal, 2009:912-913; Rossiter *et al.,* 2010:510).

2.9 Chapter summary

In this chapter the history as well as the current relevance of water quality, sanitation and hygiene was discussed. An introduction of the Blue Drop Report of 2009 was given. The Blue Drop Report will be referred to again in later chapters. The view of the media regarding water quality and sanitation in South Africa was shortly summarised. Gastro-intestinal diseases related to water quality, sanitation and hygiene, were defined and discussed. The pharmacological therapy of gastro-intestinal diseases was discussed.

In the next chapter, the research methodology will be discussed by referring to the general and specific objectives, the research design, the data sources to be used, the study population, categorisation of the data, the measurements used and data analysis. Pharmacoepidemiology will be discussed as part of the research design.

CHAPTER 3

Research methodology

In the following chapter the research methodology will be discussed with special emphasis on pharmacoepidemiology in order to assess the prevalence of gastro-intestinal diseases in the private health care sector of South Africa.

3.1 Research objectives

The research objectives for this study were divided into the general objective and the specific objectives.

3.1.1 General objective

The general objective for this study was to determine the prescribing patterns of gastro-intestinal medication in different geographical areas in the private health care sector of South Africa. A retrospective drug utilisation review was conducted and a pharmacoepidemiological approach followed. Special emphasis was on the epidemiology of gastro-intestinal diseases.

3.1.2 Specific objectives

The specific objectives of the performed study were divided into a literature review and an empirical investigation.

3.1.2.1 Literature review

The literature review included the following specific research objectives:

- To determine from the literature what gastro-intestinal diseases can be caused by poor quality of drinking water and of sanitation in South Africa, compared to the international environment.
- To determine which gastro-intestinal medications are prescribed in South Africa for water-borne infections.

3.1.2.2 Empirical investigation

The empirical investigation included the following specific research objectives and was performed within the private health care sector of South Africa:

- To determine the geographical distribution of gastro-intestinal diseases based on prescribing patterns of gastro-intestinal medication in specific geographical areas of South Africa such as provinces, districts and municipalities.
- To determine the influence of age and gender on gastro-intestinal medication prescribing patterns in the different geographical areas of South Africa.
- To determine whether seasonal gastro-intestinal medication prescribing patterns can be identified from the database.
- To investigate whether water quality is an indicator of gastro-intestinal disease by making use of a medicine claims database, the Blue Drop Report (DWA, 2010), the Green Drop Report (DWA, 2009) and the proposed model by Serfontein (2009).
- To investigate whether there is a correlation between water quality, geographical area and the prevalence of gastro-intestinal disease and gastro-intestinal medication usage in the private health care sector of South Africa.
- To determine the value of the impact factors (model of Serfontein, 2009) to be allocated to the different water sources and toilet facilities (refer to section 3.6.4 Impact of water quality and sanitation on medicine usage in South Africa).

3.2 Research methodology

The study was performed in two phases, the first being the literature review and the second the empirical investigation.

3.2.1 Phase 1: Literature review

A literature study was performed in order to determine the extent of gastro-intestinal illness and geographical distribution. The literature study included the significance of safe drinking water, sanitation and hygiene on the prevalence of gastro-intestinal disease. The pathogens involved, the different gastro-intestinal diseases and adequate treatment guidelines were determined from the literature, as discussed in chapter two.

3.2.2 Phase 2: Empirical investigation

The empirical investigation included the following:

- Research design selection.
- Selection of the data sources to be used.
- Determination of the included study population.
- Categorisation of the data.
- Determination of the different statistical measurements to be used.
- Application of statistical measures to analyse the obtained data.
- Geographical application of the data.
- Comparison of the obtained data with the Blue Drop Report (DWA, 2010) results.
- Determination and application of relevant impact factors of different water sources and sanitation services on medicine usage in the unpublished model of Serfontein (2009).
- The presentation and discussion of the obtained results.
- Conclusions made based on the obtained results.
- Study limitations and recommendations for future studies to be performed.

3.3 Research design

The research design followed was a retrospective, quantitative pharmacoepidemiological study. According to Waning and Montagne (2001:46) epidemiological studies can be either retrospective or prospective. In retrospective studies, the research question and the hypothesis stated are investigated by using data that were collected before the design of the current study. Drug utilisation studies also formed part of this study. A retrospective quantitative drug utilisation review was performed. According to Sacristán and Soto (1994:299) drug utilisation studies can be defined as studies that focus on the marketing, prescription, distribution and the use of medicines or drugs in a population. In such studies the medical, social, as well as the economic consequences of drug usage are investigated.

Pharmacoepidemiology as well as drug utilisation review (DUR) studies will be discussed in the following sections.

3.3.1 Definition of pharmacoepidemiology

According to Strom (1994:3) pharmacoepidemiology can be defined as the "study of the use and effects of drugs in large numbers of people". Pharmacoepidemiology are compiled out of two distinct study fields, namely pharmacology and epidemiology. Pharmacology is a study on the effects of drugs (Strom, 1994:4). Pharmacoepidemiology is mainly used in the field of pharmacology in order to investigate adverse drug reactions in a population. Epidemiology is defined as the study of the distribution of health-related events in a specified population. This study is used to manage problems related to health that may occur in future (Pugh *et al.,* 2000:604). Epidemiology, the study of the distribution and determinants of diseases in a population, forms the other sector of pharmacoepidemiology. The methods used in order to obtain information, are mainly derived from the field of epidemiology (Strom, 1994:5).

3.3.2 Methods applied in pharmacoepidemiology

In order to study the frequency of disease, parameters such as incidence and prevalence are used (Suruki & Chan, 2008:220).

3.3.2.1 Incidence

Incidence is defined by Suruki and Chan (2008:220) as the number of new cases of a disease that occur during a specified time period in a specified population that are at risk of developing the disease. For the pupose of this study, the period of time was considered to be one month and one year (2007 and 2008). Incidence, also known as cumulative incidence (Waning & Montagne, 2001:108) can be calculated as follows (Suruki & Chan, 2008:221):

$$\text{Cumulative incidence} = \frac{\text{Number of new cases of disease during a particular period of time}}{\text{Total population at risk}}$$

3.3.2.2 Prevalence

Suruki and Chan (2008:220,224) defined prevalence as the total number of cases of a disease in a population in a specified period of time. Therefore not only new cases are taken into account, as in incidence, but prevailing cases as well. Prevalence is therefore a measure of the proportion of the population that is at risk of developing a particular disease at a specified point in time. In this study the point of time was considered to be the end of each month, as well as the end of each study year, namely 2007 and 2008.

Prevalence is calculated as follows (Waning & Montagne, 2001:108; Suruki & Chan, 2008:224):

$$\text{Prevalence} = \frac{\text{Number of existing cases in a population at a particular point in time}}{\text{Total number of people in the population}}$$

3.3.3 Drug utilisation review (DUR)

According to the WHO (2003:8) drug utilisation review or research can be defined by using the definition stated by the WHO in 1977. Drug utilisation research is "the marketing, distribution, prescription and use of drugs in a society, with special emphasis on the resulting medical, social and economic consequences". Retrospective DUR refers to the study of drug usage patterns of patients after medication has been dispensed (Radloff & Jones, 2007:34). Pharmacoepidemiology mainly focuses on the safety and efficacy of medications by applying epidemiological methods to the clinical use of medications in a population (WHO, 2003:8), but it must be stated that DUR forms an integral part of pharmacoepidemiology as it focuses on medicine usage or exposure. Epidemiology refers to the study of defined populations where medicine usage is expressed by referring to methods such as prevalence or incidence, while DUR studies make use of different information sources that focus on medicine usage. Together DUR and pharmacoepidemiology can be used to study medicine usage patterns, determinants of drug usage, quality of drug usage and drug usage outcomes (WHO, 2003:8-9). DUR can therefore be used to determine patient exposure to a specific medication, a profile of medicine usage can be determined, the usage of certain medications during a specific period of time or in a specified geographical area can be determined and patterns of medicine usage can be compared to alternative medicine usage in order to treat specified conditions (WHO, 2003:9). According to Sacristán and Soto (1994:300) the

identification of drug therapy patterns can also be used in order to provide information in order to identify illnesses.

For the purpose of this study, a retrospective DUR study was performed by making use of a medicine claims database that provided information regarding the prescribing trends in specific geographical areas up to municipality level, by making use of postal codes of prescribers. This was used to provide quantitative DUR data in order to identify areas where the prevalence of gastro-intestinal diseases were most prominent, as gastro-intestinsal medication prescribing patterns were used to indicate gastro-intestinal disease without the regular availability of ICD-10 codes.

3.3.4 Medicine claims database

In epidemiology practices, patient records and databases are primary information resources. Health care utilisation databases are administrative databases that are generated when the patient utilises the health care system, a diagnosis is generated and/or medication is prescribed. Health care utilisation companies are mainly used in foreign countries, while medicine claims databases are used in South Africa.

According to Schneeweiss and Avorn (2005:325-326) a limitation of drug utilisation databases' validity of primary data collection is the influence that the researcher has on the time at which data are collected, as well as the accuracy of the data. Another limitation in the generation of an electronic record of an insurance claim is that a third party payer must be involved. Bias can occur in each of the stages followed in order to generate a claim (Schneeweiss & Avorn, 2005:325-326). These processes and the potential biases that may occur, are summarised in Table 3.1 (adapted from Schneeweiss & Avorn, 2005:326). It is important to note that not all of the possible areas of bias are applicable to the medicine claims databases of South Africa. The areas of bias that are applicable in medicine claims databases of South Africa and that may be considered as areas of bias that may occur in this study, are indicated with (*) in Table 3.1.

It is important to emphasise that it was considered by the researcher that the medicine claims database used in this study was correct and data used were not manipulated by the researcher or the medicine claims database providing the data and that possible areas of bias did not influence the compiling of the secondary database or any possible results to be obtained and discussed in chapter four. The area of bias that was of importance in the consideration of limitations in this study were the incomplete ICD-10 codes that were not

documented correctly (incorrectly indicated on prescriptions or unavailable) and could therefore not be used for searches based on diagnoses of gastro-intestinal diseases.

Table 3.1: Potential bias situations occurring during construction of health care utilisation databases (adapted from Schneeweiss & Avorn, 2005:326)

	Record generation process	**Potential sources of bias in drug utilisation databases**
Patient seeks medical care	Patient shows symptoms and consults a health care professional	Patients without medical aid coverage or insufficient medical insurance are less likely to seek medical care*
Routine clinical care	Documentation of medical history, examination, diagnosis, medical interventions, drug prescribing, pharmacy encounter	Incomplete documentation, misdiagnosis, miscoding of drug, dose, strength, non-recording of over-the-counter (OTC) medication*
Provider notes	Electronic medical record, paper-based records.	Incomplete record keeping
Coding by staff	Coding of claims, filing of claims	Miscoding of diagnoses, miscoding of procedures, failure to file claims*
Insurance company	Filing and settlement of final claims, construction of administrative database	Transaction error, lag-time until settlement and final filing, failure to follow-up if patient has left the system
Researchers	Research database	Incomplete or false record linkage between administrative and research databases
*: Possible areas of bias in medicine claims databases that may be applicable in this study		

It was identified by Levy *et al*. (2003:67) that a drug database, such as the Ontario Drug Benefit database, can be used in order to draw reliable conclusions as pharmacists mostly dispense the prescribed medication and that those data are then transferred to the database in a reliable fashion. Medicaid pharmacy claims databases are accepted sources to obtain data for epidemiology as well as drug utilisation (McKenzie *et al.,* 2000:1255). Electronic drug utilisation databases that contain detailed clinical information, such as medicine history and the results of diagnostic tests are useful in the assessment of medicine use, but the limitations of the database must be taken into account (Schneeweiss & Avorn, 2005:334).

One major limitation of this study is the limited availability of diagnostic information in the form of ICD-10 (Intenational Statistics Classification of Diseases and Related Health Problems, Tenth Revision) (Council for Medical Schemes & Department of Health, 2009:96) codes in the medicine claims database used. ICD-10 is a diagnostic coding standard that is used by the national Department of Health as the national standard for South Africa (Council for Medical Schemes & Department of Health, 2009:5). Due to this limitation, the researcher focused on the use of medications used in the treatment of gastro-intestinal diseases or symptoms thereof in order to determine the prevalence of gastro-intestinal diseases in South Africa.

3.4 Data sources

The following data sources were used in this study:

3.4.1 Medicine claims database

Suitable data were obtained from the medicine claims database of a South African Pharmacy Benefit Management (PBM) company. The database processes pharmaceutical claims electronically and acts as a link between the pharmacies or physicians and the medical insurance companies. The PBM provides medicine management services to 38 medical schemes and four capitation provider clients in South Africa. The database also contains medicine claims data for more than 1.5 million medical scheme beneficiaries (Reference in possession of the author, 2009). Medicine claims information regarding the use of gastro-intestinal medication and the postal codes of the prescribers of gastro-intestinal medication for 2007 to 2008 were retrieved from the database. Other information that was retrieved were the different months in order to determine a seasonal trend in the prevalence of gastro-intestinal disease, the age groups, gender, active ingredient, pharmacological group according to the MIMS classification of 2009, the pharmacological sub-classification according to the MIMS classification of 2009, National Pharmaceutical Product Interface

(NAPPI)-codes of the medication provided (where applicable) and the municipality codes of the prescriber of the medication.

3.4.2 Community Survey 2007

In this study the Community Survey data of 2007 were used to determine the different sources of water supply and sanitation provided as well as the number of households that have access to these different sources. The Community Survey of 2007 is a household survey conducted by Statistics South Africa (Stats SA) to bridge the gap between censuses that previously took place at five-year intervals (1996 and 2001), but will now take place every ten years, with the next census to be performed in 2011 (Stats SA, 2007a). The objective of the 2007 Community Survey is to provide demographic as well as socio-economic data on municipal level (Stats SA, 2007b). In the Community Survey of 2007, 949 105 persons and 246 618 households were enumerated (Stats SA, 2007b). In this study the Community Survey of 2007 is of extreme importance as this survey was also intended to focus on questions raised around the Millennium Development Goals, established by the United Nations, to which South Africa committed itself during the 1990s (Stats SA, 2007c).

The Community Survey data of 2007 contain estimates of population data made from the data obtained in the 2001 Census. The numbers retrieved were then in turn used to determine the Source Medicine Usage Unit for a specific geographical area (Serfontein, 2009) (Refer to section 3.6.4 Impact of water quality and sanitation on medicine usage in South Africa). In order to determine the Source Medicine Usage Unit for a specific geographical area, an impact factor was allocated to each of the different water supply sources and sanitation services. The impact factor would indicate a value of impact that a specific source or service provided would have on the health and in turn, on the medicine usage of a household in a specific geographical area.

3.5 Study population

In this study the need was identified by the researcher and study supervisors to compile two different datasets from the medicine claims database used. Dataset B contains information that includes claims processed on a monthly basis as well as different geographical areas in which the medication had been prescribed (according to the postal code of the prescriber's practice). Dataset B provides accurate information regarding monthly medicine usage in different geographical areas, but it must be emphasised that a patient is defined as a person that claimed from his/her medical aid once or more in a month's time in one or more different geographical areas. A patient can therefore be counted more than once in a period of one year.

On the basis of the above-mentioned dataset B that provides data on a monthly basis, dataset A contains information on all medicine claims during a period of one year (2007 and 2008 respectively) and the different geographical areas in which the medication had been prescribed. This dataset (A) does not contain information regarding the monthly prescribing patterns of gastro-intestinal medication, but patient duplications may occur if claims had been made by individual patients in more than one geographical area for example in different municipalities during a one-year period. Figure 3.1 indicates the differences between the different datasets compiled from the total database.

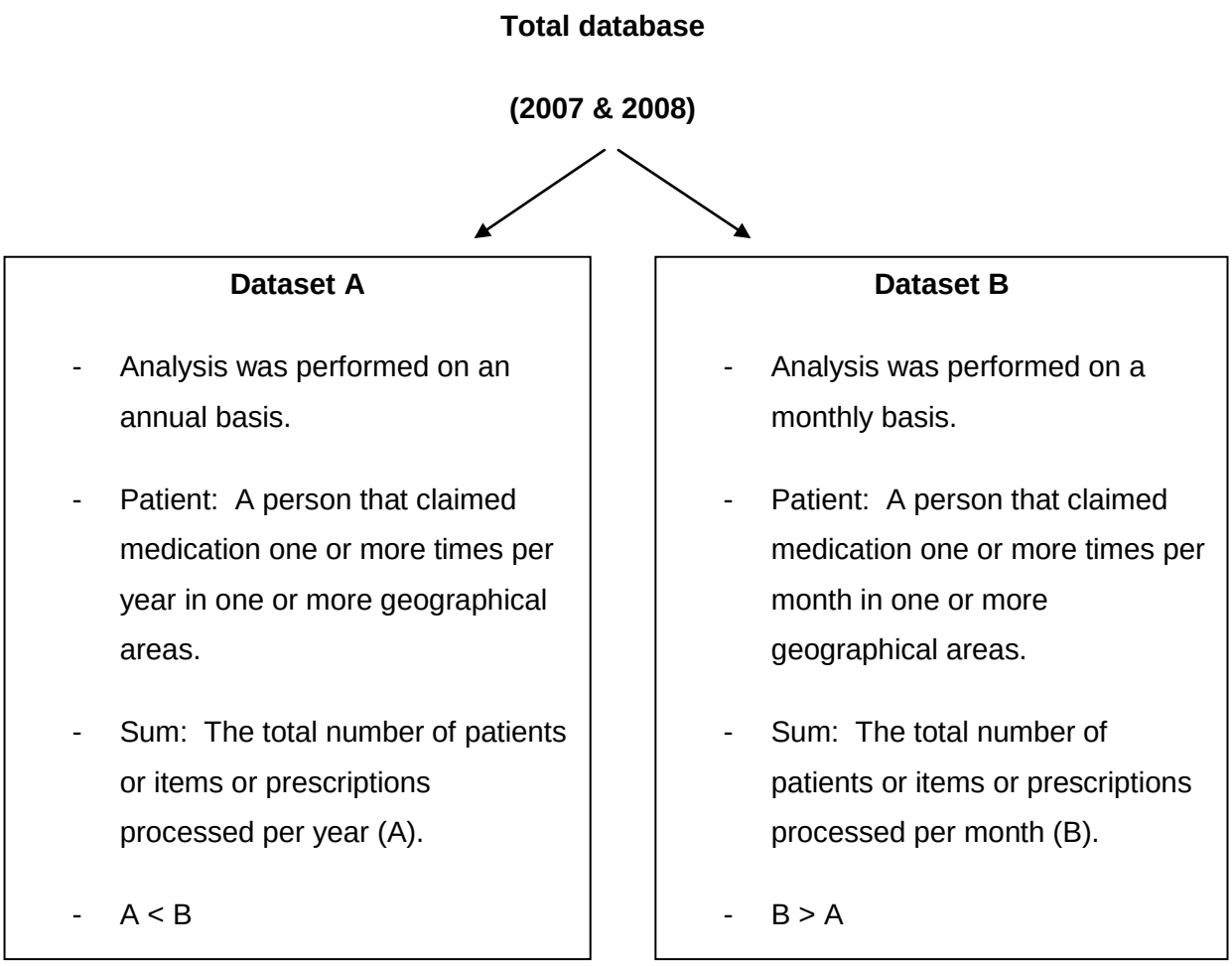

Figure 3.1: Organogram indicating the two different datasets compiled from the total database

In this study, the total dataset B of the PBM for the study period 1 January 2007 to 31 December 2008 contained 5717420 and 4871399 patients (*n*) for 2007 and 2008 respectively, where patients could be counted for each month a claim was made and therefore the total number of patients per year was regarded as the sum of all the patients that claimed in every month of the year. Dataset A contained 1546184 and 1290017 patients

(*n*) for 2007 and 2008 respectively. The years 2007 and 2008 were chosen as the study periods as 2007 correlated with the 2007 Community Survey performed by Statistics South Africa and 2007 acted as a half way mark in the achievement of the Millennium Development Goals that had to be achieved by 2015. The year 2008 was included as it was the latest year for which data were made available by the medicine claims database used. Only two years were included as there was a time limitation by which the study had to be completed. The two years used, however, provided information that enabled the researcher to determine seasonal trends in the prescribing of gastro-intestinal medication.

In order to compile the dataset A, the same PBM was used, but a specific study population was selected by taking the following criteria into account:

- All prescriptions claimed containing the specified combinations of products used in gastro-intestinal disease for the period between 1 January 2007 and 31 December 2008.

- The claimed prescriptions had to contain one or more of the following medication groups indicated for the treatment of gastro-intestinal diseases as redefined by the researcher, using the MIMS® (Monthly Index of Medical Specialities)- classification (Snyman, 2008) and NAPPI codes for group 20.4 (minerals and electrolytes):

    - Group 1.8: antivertigo and anti-emetics;

    - Group 12.3: antispasmodics;

    - Group 12.7: antidiarrhoeals;

    - Group 18: antimicrobials;

    - Group 20.4: minerals and electrolytes:

        - 781444004 Electropak®
        - 722871007 Electropak®
        - 701385001 Gastrolyte®
        - 707419002 Gastrolyte®
        - 779687019 Hydrol®
        - 815187009 Rehidrat®

- 815195001 Rehidrat®
- 815209002 Rehidrat®
- 759546010 Rehidrat®
- 762873019 Scripto-Lyte®
- 762873027 Scripto-Lyte®
- 707286001 Sorol Citrate®

- Group 18 (antimicrobials) had to be prescribed in combination with any of the above specified groups in order to be included in the study. All antimicrobials were included in the study in order to cover all possible gastro-intestinal diseases caused by microbial pathogens. In order to be more specific about the prevalence of gastro-intestinal disease and not all diseases caused by microorganisms, the antimicrobial must be prescribed together with any of the above-mentioned groups. Products from group 20.4 (minerals and electrolytes) were specified for selection by making use of their individual NAPPI (National Approved Product Pricing Index) codes. NAPPI, owned by Medikredit®, is a unique national coding system for all pharmaceutical, surgical and health care consumable products in South Africa that enabled providers, such as pharmacies, to claim products by using unique codes (Medikredit®, 2008).

- The pharmacological classification and active ingredients of the prescribed medication were provided.

- The total number of prescriptions in the total database, the total number of prescriptions that comply with the selection criteria, the total number of items prescribed on the total database and the total number of gastro-intestinal medication items prescribed, were specified.

- The specified age groups of patients were the following:

  - 0 – ≤5 years;
  - >5 – ≤15 years;
  - >15 – ≤30 years;

- >30 – ≤45 years;
- >45 – ≤60 years;
- >60 years.

- According to Farthing (2000:66) the population groups that are at risk for developing infectious diarrhoea would be children (infants and pre-school age) and the elderly. Jain *et al.* (2005:209) found that children up to five years of age may have a two-fold higher risk of developing campylobacteriosis than those individuals aged five years and older. The age groups specified in this study, were based on the age groups used in the study performed by Jain *et al.* (2005:209) with the only difference in the final group where the researcher divided the group into the age groups >45 to ≤60 years and > 60 years, instead of 45 to 76 years (Jain *et al.,* 2005:209). In this study the age group in which a patient will fall depends on the age of the patient on 1 January 2008, for the 2007 age groups and the age of the patient on 1 January 2009, for the age groups of 2008.

- The data were also specified according to gender. The month the prescription was filled (dataset B) and geographical information (province, district, metropolitan municipality and municipality).

- In the data and results containing monthly prescribing information, a patient was defined as an individual that claimed medication once or more than once in a specified geographical area during a period of one month (dataset B).

- During the annual analysis (dataset A), a patient was defined as an individual that claimed medication once or more than once in a specified geographical area during the period of one year (2007 or 2008).

- For the purpose of this study, gastro-intestinal disease was defined as those diseases of the gastro-intestinal tract that are caused by pathogens that spread via contaminated water, the lack of, or improper sanitation and insufficient hygiene. Symptoms of these diseases most often include abdominal cramping, diarrhoea, nausea and vomiting. Gastro-intestinal disease medication was therefore specified as those medications used to treat gastro-intestinal disease.

- It is important to note that due to the limited availability if diagnostic information in the database in the form of ICD-10 codes, the prescription of the medication classified as

gastro-intestinal medication and antimicrobials used to treat gastro-intestinal diseases, as redefined by the researcher, are merely a guideline in the determination of prevalence of gastro-intestinal diseases and are not absolute.

- In cases when ICD-10 codes were indicated and could be assumed as complete and correct, DSN0105 was used in cases of diarrhoea and gastroenteritis without further specification (National Task Team for the Implementation of ICD-10, 2010:48). A09 Diarrhoea and gastroenteritis of presumed infectious origin were assigned in cases of diarrhoea and gastroenteritis without further specification. In cases where the patient had diarrhoea as well as vomiting, A09 Diarrhoea and gastroenteritis without further specification as well as R11 Nausea and vomiting were allocated. In cases where both gastroenteritis and vomiting were identified, only A09 Diarrhoea and gastroenteritis without further specification were allocated. In cases where dehydration was documented, a code for dehydration had to be assigned. A code for dehydration, however, could not be assigned in cases where rehydration took place without dehydration being documented (National Task Team for the Implementation of ICD-10, 2010:48). In this study ICD-10 codes could not be used in the identification of gastro-intestinal diseases as ICD-10 codes were not always correctly entered into the system or may not have been indicated at all.

3.6 Variables investigated

The following variables were investigated in this study:

3.6.1 Pharmacoepidemiological data

The following pharmacoepidemiological parameters were investigated:

3.6.1.1 Prevalence

As discussed in section 3.3.2.2, prevalence as a method if investigation applied in pharmacoepidemiology, investigate the total number of cases of a particular disease (gastro-intestinal diseases) in a specified population at risk during a specified period of time. In this study the following were determined:

- The prevalence of gastro-intestinal diseases in South Africa.

- The prevalence of gastro-intestinal diseases in each of the nine provinces of South Africa.
- The prevalence of gastro-intestinal disease in each of the 46 districts of South Africa.
- The prevalence of gastro-intestinal diseases in each of the six metropolitan districts of South Africa.
- The prevalence of gastro-intestinal diseases in each of the 231 local municipalities and 20 district management areas.

The prevalence was determined for the total number of gastro-intestinal disease cases, each specified age group (refer to section 3.5), according to gender and according to the month of the year.

3.6.2 Geographical parameters of South Africa

In this study data were collected and presented by using a geographical approach. The geographical framework or parameters for South Africa refer to the way South Africa has been divided and sub-divided into smaller areas that were managed by local government structures and systems according to the present government's regulation.

South Africa was divided into nine provinces, which were then divided into 46 district municipalities and six metropolitan municipalities. The districts were divided into 231 local municipalities and 20 district managed areas (Stats SA, 2005). Further division up to enumeration areas was documented by Stats SA (2005), but for the purpose of this study, only division up to municipality level was taken into account.

The spatial representation of municipality boundaries of the 2007 Community Survey was used. This represents the December 2005 municipality boundaries as released by the Municipal Demarcation Board in 2006. The names of district councils and municipalities were the names used in August 2007. As of December 2005, no cross boundary municipalities existed in South Africa and this was included in the geographical parameters used in the 2007 Community Survey. The eight cross-boundary municipalities that existed in 2001 that were included in the 2001 Census (Stats SA, 2008:34), did not pose as a limitation in this study.

In this study the postal codes of the prescribers were used in order to determine the geographical distribution of the prevalence of gastro-intestinal diseases in South Africa by

referring to the prevalence of gastro-intestinal diseases in South Africa, the different provinces, the different districts, the different metropolitan municipalities and the different municipalities. By using the postal codes of the prescribers, the following study limitations could occur:

- Patients may use the services of more than one prescriber in more than one geographical area with different postal codes, for example prescribers from different municipalities, while the patient lives in one geographical area.
- The postal code of the prescriber was the postal address of the practice.
- One prescriber may use more than one practice address, for example the private practice of the prescriber and the hospital practice of the prescriber.
- One municipality may have more than one postal code.
- Geographical area division was performed up to municipality level only, as that was the smallest geographical division made available by the 2007 Community Survey. Division of geographical parameters up to main place level, as performed in the 2001 Census, was not done in this study.

3.6.3 Comparison of results with results obtained from the Blue Drop Report of 2010

One of the objectives of the empirical investigation of this study was to determine whether the results obtained from the Medicine Claims database comply with the Blue Drop Certification Programme instated by DWAF in 2008 as discussed in section 2.3.4. The importance of drinking water quality was emphasised by the Minister of Water and Environmental Affairs, Ms Buyelwa Sonjica, as South Africa was host the FIFA World Cup™ from 11 June to 11 July 2010 (FIFA, 2010a).

On 17 March 2010, the Minister of Water and Environmental Affairs released the official 2010 Host Cities Drinking Water Quality Management Audit Report in order to determine the compliance of the official 2010 FIFA (Fédération Internationale de Football Association) Host Cities with the Blue Drop Certification requirements. The Blue Drop Certification programme was introduced in 2008 in municipal drinking water quality management services in order to ensure sustainable and continuous optimal drinking water quality management. As of 17 March 2010 all of the nine 2010 FIFA Host Cities (Cape Town, Durban, Johannesburg,

Mangaung/Bloemfontein, Nelson Mandela Bay/Port Elizabeth, Nelspruit, Polokwane, Rustenburg and Tshwane/Pretoria (FIFA, 2010b)) were rewarded with Blue Drop Status (DWA, 2010). This emphasises the continuous development and quality control of water quality as well as the impact that other organisations, such as FIFA, have on the insurance of health in South Africa.

Blue and Green Drop statuses were developed by the Department of Water Affairs and Forestry (DWAF), now known as the Department of Water and Environmental Affairs (DWA), in order to provide the general public with information regarding drinking water and wastewater quality management.

3.6.4 Impact of water quality and sanitation on medicine usage in South Africa

The United Nations Economic Commission for Europe (UN/ECE, 1995) defined water quality as the "physical, chemical and biological characteristics of water necessary to sustain desired water uses" (UN Water, 2010). Water quality deteriorates when municipal as well as industrial water treatment and sanitation infrastructures become insufficient, causing waste water to contaminate groundwater sources.

According to the WHO (2010) drinking water is used for drinking, cooking, domestic purpose and hygiene. In order for water to be classified as being safe, water must comply with chemical and microbiological standards. According to the WHO (2010), an improved drinking water source is one where water is protected from contamination by the environment, especially fecal contamination. Improved water sources include the following (WHO, 2010):

- Piped water connections
- Borehole
- Public sand pipe
- Protected spring
- Protected well
- Rainwater collection

Water sources that are not considered to be improved sources are (WHO, 2010):

- Surface water (dam, stream, canal, irrigation channel)
- Unprotected well
- Unprotected spring
- Bottled water
- Water provided by a vendor (cart with a tank, drum, or tanker truck)

According to the WHO (2010) bottled water is only considered as an improved water source if another improved water source, such as piped water, is used for hygiene and cooking sources.

Improved sanitation (WHO, 2010) refers to those sanitation facilities that separate human excreta from human contact in a safe and hygienic fashion. Factors considered include the following:

- Sewer connections
- Pour-flush toilets
- Septic system connections
- Ventilated improved pit latrine
- Covered pit latrines

Shared sanitation facilities, such as public toilets, are those sanitation facilities that are used by two or more households and although they may consist of facilities that are considered to be improved sanitation facilities, the WHO (2010) does not identify these as improved facilities.

Unimproved sanitation facilities are those that do not separate human excreta from human contact in a hygienic fashion and are considered to be the following (WHO, 2010):

- Uncovered pit latrines
- Hanging latrines
- Bucket latrines

- Open defecation

- Disposal of fecal matter together with other solid waste material

In 2009 Serfontein proposed a model (Refer to section 3.4.2 Community survey 2007) that may be used to calculate and predict the impact of water quality and sanitation on medicine usage in South Africa, especially gastro-intestinal medication. This model, depicted as the Medicine Usage Standard, is outlined later in this section and was used for calculations with regard to water source and sanitation facility. In short the model is represented as follows:

$$\text{Medicine usage standard} = \text{Source prevalence} \times \text{Impact factor} \times \text{Household ratio}$$

The *Medicine Usage Standard* identifies the calculated factor by which medicine usage may increase by making use of a particular drinking water source or sanitation facility. The *Source prevalence* indicates the fraction of the households with access to a particular water source or sanitation facility. The *Household ratio* refers to the size ratio of households in the selected geographical area. The *Impact factor* is of relative importance as it refers to the value of impact that a particular water source or sanitation facility may have on medicine usage, particularly in increasing medicine usage. It is important to note that the impact factor is not absolute and may be influenced by one or more socio-economic variables such as level of education and income (Serfontein, 2009).

The impact factor in this study was not based on results of previous studies, but did compare to indications on the safety of water sources and sanitation facilities by the World Health Organization (2010). Rietveld *et al.* (2009:43,49) indicated that weighing factors used to technically assess rural water supply systems in South Africa, were not fixed an could be changed in new situations that might occur. This was applied in this study where the impact factor, ranging from one to ten, with one being the factor that will have the smalles impact on medicine usage and ten being the factor that will have the largest impact on medicine usage, was decided upon by the researcher and study coordinators. The validity of the impact factor was determined and adjustments were made if indicated. In this study it was assumed that all water sources and sanitation facilities would have a baseline impact on medicine usage. The baseline impact of water sources was one, while the baseline value for sanitation was two. The impact factors for water sources and toilet or sanitation facilities (facilities specified by STATS SA (2007d)) were indicated as follows:

Access to water:

- Piped water inside the dwelling (2)
- Piped water inside the yard (3)
- Piped water from access point outside the yard (5)
- Borehole (5)
- Spring (7)
- Dam/pool (8)
- River/stream (8)
- Water vendor (6)
- Rain water tank (6)
- Other (5)

Toilet facilities:

- Flush toilet (connected to a sewage system) (3)
- Flush toilet (with septic tank) (4)
- Dry toilet facility (5)
- Pit toilet with ventilation (6)
- Pit toilet without ventilation (7)
- Chemical toilet (4)
- Bucket toilet system (8);
- None (9).

Medicine Usage Standard:

$$\textbf{Geographical Additional Medicine Source} = \left(\begin{matrix}\text{Geographical}\\ \text{Household Ratio}\end{matrix}\right) \times \left(\frac{\text{Impact Descriptor Factor}}{10}\right) \times \left(\begin{matrix}\text{Geographical Prevalence}\\ \text{Descriptor Source}\end{matrix}\right)$$

$$\boldsymbol{gAds} = \frac{\text{g Number of persons}}{\text{g Number of households}} \times \frac{Ids}{10} \times \frac{\text{Geographical number of households ds}}{\text{Geographical number of households}}$$

$$\boldsymbol{gAds} = gR \times \frac{Ids}{10} \times gPds$$

Source Medicine Usage Unit for GA = g Household Ratio + g Additional Medicine Usage Standard

$$\boldsymbol{gUds} = \frac{\text{g Number of persons}}{\text{g Number of households}} + \left(\frac{\text{g Number of persons}}{\text{g Number of households}} \times \frac{Ids}{10} \times \frac{\text{Geographical number of households ds}}{\text{Geographical number of households}}\right)$$

$$\boldsymbol{gUds} = gR + \left(gR \times \frac{Ids}{10} \times gPds\right) = gR + gR\left(\frac{Ids}{10} \times gPds\right) = gR\left(1 + \left(\frac{Ids}{10} \times gPds\right)\right)$$

$$\boldsymbol{gUds = gR\left(1 + \left(\frac{Ids}{10} \times gPds\right)\right)}$$

3.7 Statistical analysis

The statistical methods used in this study will be discussed briefly in the following section.

3.7.1 The sample mean

The mean can be defined as the average of a sample and can be calculated by dividing the sum of the observations by the number of observations (Samuels & Witmer, 1999:32). The mean is depicted by the symbol $\bar{x}$ and can be calculated as follows:

$$\bar{x} = \frac{\sum x}{n}$$

Where:

x = observations in the sample

n = the sample size

3.7.2 The sample standard deviation

The standard deviation is the difference between an observation and the sample mean (Samuels & Witmer, 1999:104) and is calculated by means of the following equation (Brase & Brase, 1999:104):

$$s = \sqrt{\frac{\sum (x - \bar{x})^2}{n-1}}$$

Where:

s = standard deviation

x = observations in the sample or any entry in the distribution

$\bar{x}$ = mean

$\sum x - \bar{x}$ = deviation (the difference between a data point and the mean (Samuels & Witmer, 1999:49)

n = sample size or number of entries

3.7.3 Effect size

Effect size is used in order to calculate the magnitude of difference between two sample means and can be calculated by using the following equation (Samuels & Witmer, 1999:272-273):

$$d = \frac{(\bar{x}_1 - \bar{x}_2)}{s}$$

Where:

d = effect size

$\bar{x}_1$ = mean of sample 1

$\bar{x}_2$ = mean of sample 2

s = standard deviation (largest standard deviation of the two mean values used)

According to Cohen (1988:25-27), the effect size values can be interpreted as follows:

- d = 0.2: this is a small effect size that is usually observed in cases that are not under good experimental or measurement control.
- d = 0.5: this is considered to be a medium effect size that can be observed with the naked eye.
- d = 0.8: this is a large effect size and can be considered as being statistically significant.

In this study effect sizes were used to calculate whether the difference in prevalence observed between 2007 and 2008, different months, different provinces, different districts, different municipalities, gender and age groups were significant.

3.7.4 Estimated gastro-intestinal disease prevalence index

Serfontein (1989:180) used the cost-prevalence index, mainly used in the academic pharmaco-economical sector in order to interpret the cost of medication as relatively expensive or inexpensive by making use of the equation:

$$\text{Cost - prevalence index} = \frac{\text{Cost (\%)}}{\text{Prevalence (\%)}}$$

The cost-prevalence index was, however, adapted by the researcher and study supervisors in order to determine the estimated gastro-intestinal disease prevalence index in the private health care sector of South Africa by means of the following formula:

$$\text{Estimated gastro - intestinal disease prevalence index} = \frac{\text{Prevalence of gastro - intestinal medication claims (\%)}}{\text{Prevalence of medicine claims utilization in the relatively higher income sector of SA (\%)}}$$

This equation combined the following two formulae namely:

$$\text{Prevalence of gastro - intestinal medication claims (\%)} = \frac{\text{Number of patients that claimed according to the gastro - intestinal medicine claims database}}{\text{Number of patients that claimed according to the total database}} \times 100$$

As well as

$$\text{Prevalence of medicine claims utilisation in the higher income sector of SA (\%)} = \frac{\text{Number of patients that claimed according to the total database}}{\text{Estimated number of persons in households with an annual income of R76801,00 and more}} \times 100$$

The estimated gastro-intestinal disease prevalence index (%) was determined in order to estimate whether gastro-intestinal medication claims constitute a significant proportion of the medicine claims made by the higher income sector of South Africa (households earning R76801-00 per annum and more). According to CMS (Council for Medical Schemes) (2009:6), less than 50% of the population earning below R4000-00 per month, belong to a medical aid, while Grobler *et al.* (2006:1) determined that the threshold income for LIMS

(Low Income Medical Schemes) schemes is R6500-00 per month. In this study the assumption was made that those households with an income of R76801-00 per year (figures are derived from the Community Survey of 2007), belong to a medical scheme. Patients counted on the total database as well as the secondary databases compiled for gastro-intestinal medication claims, are only those patients that claimed from their medical aid. When *number of patients* is being mentioned, it must be emphasised that the numbers are estimated and based on processed medical aid claims.

In this study the estimated gastro-intestinal disease prevalence index was interpreted as follows:

- Estimated gastro-intestinal disease prevalence index < 1: the prevalence of gastro-intestinal medication claims was relatively small in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme.

- Estimated gastro-intestinal disease prevalence index = 1: the prevalence of gastro-intestinal medication claims was in equilibrium with the total medicine claims prevalence of the higher income population that may utilise a medical scheme.

- Estimated gastro-intestinal disease prevalence index > 1: the prevalence of gastro-intestinal medication claims is relatively high in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme.

3.7.5 Relative risk

Woodward (1999:107) defined relative risk as the risk of persons having a certain risk factor pertaining to developing a disease, compared to the risk of people not having a particular risk factor for developing disease.

The relative risk can be calculated by using the following formula as provided in Samuels and Witmer (199:435).

$$\text{Relative risk} = P_1 / P_2$$

If the relative risk (risk ratio) is more than 1, the risk factor that is investigated increases the risk for developing disease (Woodward, 1999:107). In this study relative risk (risk ratio) was used to identify whether gender could be identified as a risk in developing gastro-intestinal disease. Therefore the different probablilities (*P*) were calculated as follows:

P_1= Number of female patients receiving gastro-intestinal disease medication / Total number of female patients

P_2= Number of male patients receiving gastro-intestinal disease medication / Total number of male patients

3.7.6 Odds ratio

According to Samuels and Witmer (1999:436) the odds ratio, identified by θ and calculated by using the formula below, is the ratio of two odds under different conditions. P_1 and P_2 are the probabilities of two different events occurring under two different conditions.

Odds ratio = θ

$$\theta = \frac{\frac{P_1}{1-P_1}}{\frac{P_2}{1-P_2}}$$

As for the relative risk, an odds ratio larger than 1 indicates that the risk factor that is being investigated, increases the odds of contracting the investigated disease. A value of smaller than 1 indicates that the factor investigated does not increase the odds of contracting the investigated disease (Woodward, 1999:111). In this study the odds ratio was used to identify whether being male or female (investigated factor) would increase or decrease the odds of contracting gastro-intestinal disease.

3.7.7 Computer and software used

The data were processed by making use of the Statistical Analysis System® (SAS 9.1©). Microsoft® Excel 2007 and Microsoft® Word 2007 was used for data and word processing.

3.8 Results and discussion

The results obtained in this study and the detailed discussion will be included in chapter four.

3.9 Conclusion and recommendations

In chapter five the conclusions and recommendations regarding future studies will be made.

3.10 Chapter summary

In this chapter the research methodology that was followed was discussed. Firstly the research objectives were stated and the research methodology was discussed. Pharmacoepidemiology as the main research design was shortly discussed and the data sources were specified. The study population was defined by using inclusion criteria and the variables investigated. The statistical analysis methods to be used were also specified. In chapter four the results obtained and the discussion of the results will follow.

CHAPTER 4

Results and discussion

In the following chapter the results obtained from the empirical investigation were discussed in order to gather information regarding the use of gastro-intestinal medication with special emphasis on the geographical distribution of the prevalence of gastro-intestinal disease as defined by the researcher.

4.1 Introduction

In this study, the study period was identified as 1 January 2007 to 31 December 2008, in which the data obtained from 2007 were compared with those of 2008. In this study two different medicine claims datasets were compiled. In the first database, known as dataset B, detailed information was provided regarding the prescribing patterns of gastro-intestinal medication in different geographical areas of South Africa in different months of the year. In dataset B a patient was therefore defined as a person that received a prescription for any of the redefined gastro-intestinal medications once, or more times, per month in a specific geographical area. A patient can therefore be counted once a month but more than once per year, making seasonal determination of the prescribing patterns of gastro-intestinal medication very accurate. A dataset A was also compiled to eliminate the duplication of patients. In dataset A a patient was defined as a person that received and claimed for gastro-intestinal medication once, or more times, during the period of one year (2007 and 2008 respectively) in one or more of the geographical areas. Patient duplications may still occur if a patient claimed for gastro-intestinal medications in more than one geographical area within the period of one year. The two datasets can be summarised as follows:

Dataset A: patients claiming gastro-intestinal disease medication once, or more times, during the period of **one year** in a specific geographical area.

Dataset B: patients claiming gastro-intestinal disease medication once, or more times, during a period of **one month** in a specific geographical area.

Figure 4.1 contains a schematic representation of the different steps and data analysis that were followed in this study.

Medicine claims database

Dataset B (claims per month)		Dataset A (claims per year)	
Total dataset	**Gastro-intestinal medication dataset**	**Total dataset**	**Gastro-intestinal medication dataset**
South Africa **Provinces** **Districts** **Municipalities***		**South Africa** **Provinces** **Districts** **Municipalities***	
• Prevalence of gastro-intestinal disease according to the patient prevalence*		• Prevalence of gastro-intestinal disease according to the patient prevalence* • Estimated risk index according to household income and patient prevalence*	
• Prevalence of gastro-intestinal disease according to the number of prescriptions claimed		• Prevalence of gastro-intestinal disease according to the number of prescriptions claimed	
• Prevalence of gastro-intestinal disease according to the number of items claimed		• Prevalence of gastro-intestinal disease according to the number of items claimed	
South Africa **Provinces**		**South Africa** **Provinces**	
• Prevalence of gastro-intestinal disease in different age groups		• Prevalence of gastro-intestinal disease in different age groups	
South Africa **Provinces**		**South Africa** **Provinces**	
• Prevalence of gastro-intestinal disease according to gender		• Prevalence of gastro-intestinal disease according to gender	
South Africa **Provinces** **Districts**		**Not Applicable**	
• Determination of seasonal trends of gastro-intestinal disease according to the patient and prescription prevalence		Not Applicable	
South Africa **Provinces**		**South Africa** **Provinces**	
• Types of gastro-intestinal medication claims processed • Pharmacological classification of the gastro-intestinal medication claims according to the MIMS® - classification (2008) • The top twenty gastro-intestinal medication active ingredients prescribed		• Types of gastro-intestinal medication claims processed • Pharmacological classification of the gastro-intestinal medication claims according to the MIMS® - classification (2008) • The top twenty gastro-intestinal medication active ingredients prescribed	

Figure 4.1: Schematic representation of the datasets used to achieve research objectives

4.1.1 Terms and definitions

A short list of definitions will be provided in order to interpret the results obtained more efficiently. A more comprehensive glossary will be provided for further referral.

Gastro-intestinal disease: those diseases of the gastro-intestinal tract that are caused by pathogens that spread via contaminated water, the lack of, or improper sanitation and insufficient hygiene.

Gastro-intestinal disease medication: those medications used to treat gastro-intestinal disease.

Total database: this refers to all the data that can be obtained from the medicine claims database. The total number of patients in the total database therefore refers to all the patients that submitted one or more claims that were processed and paid for by the involved PBM.

Gastro-intestinal disease medication dataset: The dataset that only included the patients and claims processed and paid for by the involved PBM with regard to the selection criteria for gastro-intestinal disease medication. These medication groups were identified by the researcher from the MIMS® - classification (2008) as well as NAPPI (National Pharmaceutical Product Interface) codes for group 20.4 (minerals and electrolytes) and included the following groups:

- Group 1.8: antivertigo and anti-emetics
- Group 12.3: antispasmodics
- Group 12.7; antidiarrhoeals
- Group 18: antimicrobials
- Group 20.4: minerals and electrolytes (according to specified NAPPI-codes)

Group 18 can only be included when prescribed in combination with any of the above-mentioned gastro-intestinal disease medication groups.

Dataset A: Dataset A was compiled by defining a patient as any person that submitted a claim that was processed and paid for by the PBM once, or more times, a year in a specific geographical area. From dataset A total datasets as well as gastro-intestinal disease

medication datasets were compiled by using the patient definition in which a patient was defined as any person that claimed gastro-intestinal disease medication once, or more times, during the period of one year in one or more of the geographical areas.

Dataset B: Dataset B was compiled by defining a patient as any person that submitted a claim that was processed and paid for by the PBM once, or more times, a month in a particular geographical area. From dataset B a total dataset as well as a gastro-intestinal disease medication dataset was compiled by using the patient definition in which a patient was any person that claimed any gastro-intestinal disease medication once, or more times, within a period of one month in one or more of the geographical areas.

4.1.2 Points of interest when interpreting results

For the purpose of this study the study periods covered 1 January 2007 to 31 December 2007 as well as 1 January 2008 to 31 December 2008. The years will be clearly indicated in the Tables, Figures as well as discussion.

It will be specified whether the primary or dataset A had been used in order to avoid confusion and to interpret results correctly and efficiently. It is also important to note that only dataset B will contain any information regarding the specific months in which a claim had been processed as this distinguishes dataset B from dataset A where only years will be an indicator of the period of study.

Geographical information forms an essential part of the study and must therefore be interpreted correctly. When considering the geographical hierarchy of South Africa, one first starts to interpret information on a national level. Therefore results will first be presented by referring to South Africa as a whole. On the second level, South Africa is divided into provinces. When results are presented and discussed, the provinces will always be discussed in alphabetical order. On the third level the provinces are divided into districts and metropolitan municipalities. Each district and metropolitan municipality has a specific code that will be provided in the result Tables. When providing the results and discussion, the districts and metropolitan municipalities will be listed and discussed firstly according to the province in which the district is allocated as well as the alphabetical order of the different provinces and then the districts and metropolitan municipalities will be listed and discussed according to the alphabetical order of the districts within one province. On the fourth level the districts are divided into municipalities. When municipalities, also having specific codes that will be provided in tables, are listed and discussed, one first identifies the province in

alphabetical order, then the district in alphabetical order according to the province in which the district is allocated, then the municipality is identified alphabetically according to the district and province in which the municipality is allocated. A list of all the provinces, districts, metropolitan municipalities, municipalities and the codes allocated will be provided in the Appendix H.

As some of the geographical information in the database was not indicated, those claims could not be allocated to a specific geographical area. Those results were included in the total number of claims, but will not be indicated in the tables and discussion.

4.2 The geographical distribution of gastro-intestinal disease in South Africa

According to the data obtained from dataset A a patient was defined as one person that claimed for the defined gastro-intestinal disease medication items once, or more times, during the period of one year in one or more of the geographical areas. To determine the geographical distribution of gastro-intestinal disease in South Africa, dataset A was used. In order to determine the prevalence of gastro-intestinal disease among patients, the estimated gastro-intestinal disease prevalence index had to be calculated (section 3.7.4) and when the estimated gastro-intestinal disease prevalence index had been calculated it can be interpreted. In this study the estimated gastro-intestinal disease prevalence index can be interpreted as follows:

- Estimated gastro-intestinal disease prevalence index < 1: the prevalence of gastro-intestinal medication claims is relatively small in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme.

- Estimated gastro-intestinal disease prevalence index = 1: the prevalence of gastro-intestinal medication claims is in equilibrium with the total medicine claims prevalence of the higher income population that may utilise a medical scheme.

- Estimated gastro-intestinal disease prevalence index > 1: the prevalence of gastro-intestinal medication claims is relatively high in comparison with the total medicine claims prevalence of the higher income population that may utilise a medical scheme.

According to Grobler *et al.* (2006:1) the monthly income of persons or joined income of a household has to be R6500-00 per month in order to belong to a medical aid. For the

purpose of this study, the annual household income for persons that may probably belong to a medical aid is R76801-00 or more (Community Survey 2007). It is assumed by the researcher that persons coming from a household with an annual household income of R76801-00 would belong to a medical aid and would claim from that medical aid. When discussing the geographical distribution of gastro-intestinal disease in South Africa, the prevalence of gastro-intestinal disease in each province, district and municipality will be discussed for 2007 and 2008.

4.2.1 The prevalence of gastro-intestinal disease in the different provinces of South Africa for 2007 and 2008

According to Table 4.1 the province with the highest prevalence of gastro-intestinal disease according to the number of patients that submitted claims for gastro-intestinal disease medication prescriptions in 2007 is the Eastern Cape with 21.30%. The province with the lowest prevalence of gastro-intestinal disease according to the number of patients that submitted claims for gastro-intestinal disease medication prescriptions in 2007 is the Western Cape with 12.54%. Although the Northern Cape has the smallest number of patients on the total database (dataset A) (20540 patients), the prevalence of gastro-intestinal disease among those patients is the second highest with 19.79%. Overall the prevalence of gastro-intestinal disease in South Africa, based in the number of patients that claimed gastro-intestinal disease medication prescription in 2007, was 17.04%.

When considering the estimated gastro-intestinal disease prevalence index of the total population of South Africa, where having an annual household income of R76801 is taken into consideration, the province with the highest estimated gastro-intestinal disease prevalence index for 2007 was the Eastern Cape, with 1.72. As discussed in Section 3.7.4 an estimated gastro-intestinal disease prevalence index of larger than one, indicates that the prevalence of gastro-intestinal medication claims is relatively high in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme. Apart from the Eastern Cape (1.72), the Free State Province (1.13), Kwa-Zulu Natal (1.15) and the Northern Cape (1.63), has estimated gastro-intestinal disease prevalence index values of more than one. These four provinces are therefore considered to have a high prevalence of gastro-intestinal disease medication claims in comparison with the total medicine claims of the higher income population that may utilise a medical scheme. Both Gauteng and the North West Province had the lowest estimated gastro-intestinal disease prevalence of 0.71. This value is smaller than one and therefore the prevalence of

Table 4.1: Prevalence of gastro-intestinal disease among patients in South Africa in 2007

	Community Survey 2007 database					Total database		Gastro-intestinal medication dataset		
Province	**Number of persons (N)**	**Number of households (N_H)**	**Average size of household (N/N_H)**	**$N_{H\ Income}$**	**N_1**	**Number of patients (N_2)**	**Prevalence$_{Total\ database}$ %**	**Number of patients (N_3)**	**Prevalence$_{GI}$ %**	***Prevalence Index**
Eastern Cape	6527744	6527744	4.11	168738	693513	85971	12.40	18316	21.30	1.72
Free State	2773064	2773064	3.45	106560	367632	58525	15.92	10537	18.00	1.13
Gauteng	10451707	10451707	3.29	764384	2514823	618642	24.60	108539	17.54	0.71
Kwa-Zulu Natal	10259220	10259220	4.59	344918	1583174	240638	15.20	41945	17.43	1.15
Limpopo	5238285	5238285	4.31	123896	533992	112020	20.98	18112	16.17	0.77
Mpumalanga	3643436	3643436	3.87	131363	508375	92227	18.14	16473	17.86	0.98
Northern Cape	1058062	1058062	4.00	42352	169408	20540	12.12	4065	19.79	1.63
North West	3271955	3271955	3.59	105963	380407	97569	25.65	17876	18.32	0.71
Western Cape	5278588	5278588	3.86	371184	1432770	220052	15.36	27593	12.54	0.82
South Africa	48502061	12500607	3.88	2159358	8378309	1546184	18.45	263456	17.04	0.92

$N_{H\ Income}$: Number of households earning R76801 and more per year

N_1: Estimated number of persons in households earning above R76801 per year ($N_1 = N_{H\ Income}$ x Average size of household)

Prevalence $_{Total\ database}$ %: Number of patients (N_2) divided by the estimated number of persons in households earning above R76801 per year (N_1) multiplied by 100

Prevalence $_{GI}$%: Number of patients in the gastro-intestinal medication dataset (N_3), divided by the number of patients in the total database (N_3), multiplied by 100

*Prevalence index: Estimated gastro-intestinal disease prevalence index (Prevalence $_{GI}$ / Prevalence $_{Total\ database}$)

Table 4.2: Prevalence of gastro-intestinal disease among patients in South Africa in 2008

	Community Survey 2007 database					Total database		Gastro-intestinal medication dataset		
Province	**Number of persons (N)**	**Number of households (N_H)**	**Average size of household (N/N_H)**	**$N_{H\ Income}$**	**N_1**	**Number of persons (N_2)**	**Prevalence$_{Total\ database}$ %**	**Number of patients (N_3)**	**Prevalence$_{GI}$ %**	***Prevalence Index**
Eastern Cape	6527744	6527744	4.11	168738	693513	72605	10.47	15234	20.98	2.00
Free State	2773064	2773064	3.45	106560	367632	49896	13.57	8794	17.62	1.30
Gauteng	10451707	10451707	3.29	764384	2514823	515825	20.51	86609	16.79	0.82
Kwa-Zulu Natal	10259220	10259220	4.59	344918	1583174	202760	12.81	33389	16.47	1.29
Limpopo	5238285	5238285	4.31	123896	533992	85908	16.09	13210	15.38	0.96
Mpumalanga	3643436	3643436	3.87	131363	508375	74093	14.57	12699	17.14	1.18
Northern Cape	1058062	1058062	4.00	42352	169408	18069	10.67	3066	16.97	1.59
North West	3271955	3271955	3.59	105963	380407	77830	20.46	13791	17.72	0.87
Western Cape	5278588	5278588	3.86	371184	1432770	186237	13.00	22541	12.10	0.93
South Africa	48502061	12500607	3.88	2159358	8378309	1290017	15.40	209881	16.27	1.06

$N_{H\ Income}$: Number of households earning R76801 and more per year

N_1: Estimated number of persons in households earning above R76801 per year ($N_1 = N_{H\ Income}$ x Average size of household)

Prevalence $_{Total\ database}$ %: Number of patients (N_2) divided by the estimated number of persons in households earning above R76801 per year (N_1) multiplied by 100

Prevalence $_{GI}$%: Number of patients in the gastro-intestinal medication dataset (N_3), divided by the number of patients in the total database (N_3), multiplied by 100

*Prevalence index: Estimated gastro-intestinal disease prevalence index (Prevalence $_{GI}$ / Prevalence $_{Total\ database}$)

gastro-intestinal medication claims is considered to be relatively small in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme. Also South Africa scored an estimated gastro-intestinal disease prevalence index of 0.92 for 2007.

Table 4.2 indicates the prevalence of gastro-intestinal disease in the different provinces of South Africa in 2008. The Eastern Cape had the highest prevalence of gastro-intestinal disease among patients that claimed in the total database with 20.98%. Western Cape had the lowest prevalence of gastro-intestinal disease in 2008 with 12.10%. In 2008 the North West Province had the second highest prevalence of gastro-intestinal disease (17.72%) in South Africa.

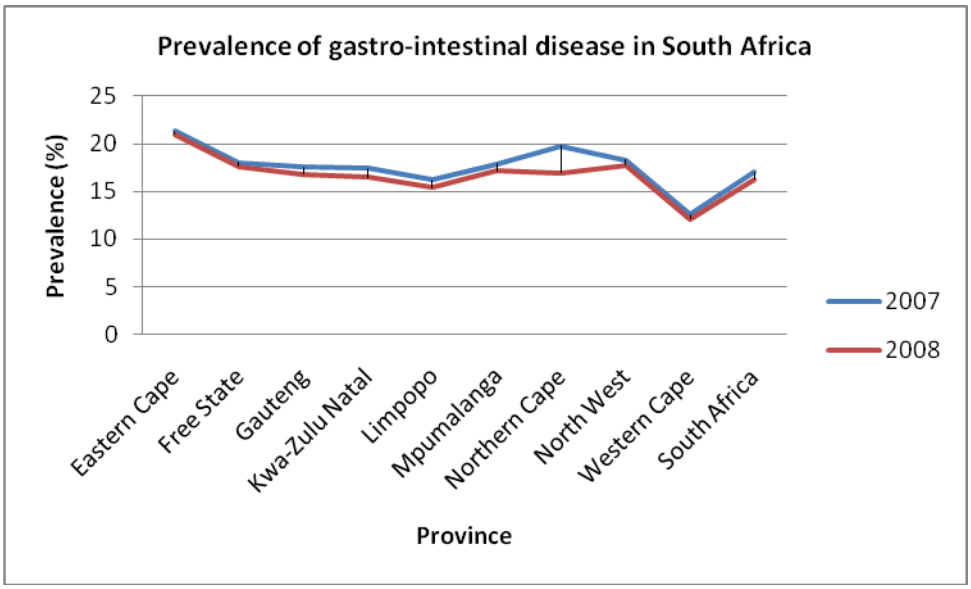

Figure 4.2: Prevalence of gastro-intestinal disease in South Africa

The overall prevalence of gastro-intestinal disease in South Africa was lower in 2008 (16.27%) than in 2007 (17.04%), with the largest difference being a decrease in the prevalence of gastro-intestinal disease in the Northern Cape in 2008 (16.97%), as can be seen in Figure 4.2. It is clear that the province with the highest prevalence in gastro-intestinal disease is the Eastern Cape, while the Western Cape has the lowest prevalence of gastro-intestinal disease in both 2007 as well as 2008.

In 2008 the estimated gastro-intestinal disease prevalence index was the highest in the Eastern Cape with 2.00 and the lowest in Gauteng with 0.82. The Free State (1.30), Kwa-Zulu Natal (1.29), Mpumalanga (1.18) and the Northern Cape (1.59) along with the Eastern Cape had estimates of gastro-intestinal disease prevalence indices larger than one, indicating that in those provinces the prevalence of gastro-intestinal disease medication

claims was large in comparison with the total medicine claims prevalence of the higher income population that may utilise a medical scheme. Overall the estimated gastro-intestinal disease prevalence index increased from 2007 (South Africa (0.92)) to 2008 (South Africa (1.06)) as can be seen in Figure 4.3.

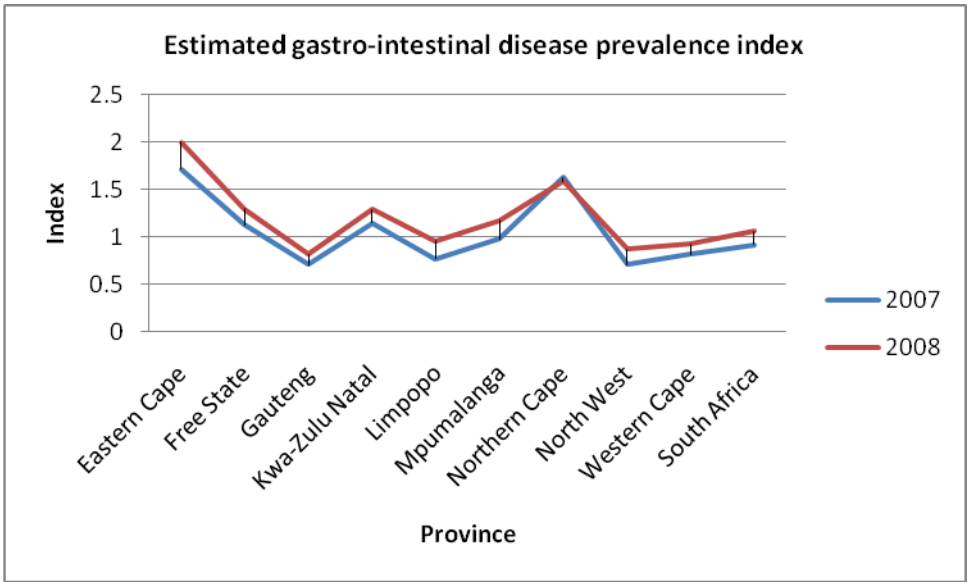

Figure 4.3: Estimated gastro-intestinal disease prevalence index

4.2.2 The prevalence of gastro-intestinal disease in the different districts of South Africa for 2007 and 2008

When considering the prevalence of gastro-intestinal disease among patients in the different districts of South Africa, the estimated Gastro-intestinal disease prevalence index was calculated in order to determine whether the prevalence of gastro-intestinal disease medication claims would be small (<1) or large (>1) in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme. The prevalence of gastro-intestinal disease among patients was first determined for 2007 and then 2008 for the different districts according to the province in which the district is localised.

Table 4.3: Prevalence of gastro-intestinal disease among patients in the different districts of South Africa in 2007

			Community Survey 2007 database					Total database		Gastro-intestinal medication dataset		
Province	**District**	**District Code**	**Number of persons (N)**	**Number of households (N_H)**	**Household ratio (N/N_H)**	**$N_{H\ Income}$**	**N_1**	**Number of patients (N_2)**	**Prevalence $_{Total\ database}$ %**	**Number of patients (N_3)**	**Prevalence $_{GI}$ %**	***Prevalence index**
Eastern Cape			**6527744**	**1586741**	**4.11**	**168738**	**693513**	**85971**	**12.40**	**18316**	**21.30**	**1.72**
	Alfred Nzo	DC44	479389	102024	4.70	5593	26287	1303	4.96	207	15.89	3.20
	Amatole	DC12	1664752	458580	3.63	47055	170810	21712	12.71	3986	18.36	1.44
	Cacadu	DC10	363497	99833	3.64	14905	54254	8606	15.86	1450	16.85	1.06
	Chris Hani	DC13	798602	203041	3.93	12844	50477	5740	11.37	1329	23.15	2.04
	Nelson Mandela Bay Metro	NMA	1050930	276881	3.80	59967	227875	36650	16.08	8839	24.12	1.50
	O.R. Tambo	DC15	1862220	356085	5.23	23458	122685	9214	7.51	2103	22.82	3.04
	Ukhahlamba	DC14	308366	90301	3.41	4918	16770	2746	16.37	402	14.64	0.89
Free State			**2773064**	**802869**	**3.45**	**106560**	**367632**	**58525**	**15.92**	**10537**	**18.00**	**1.13**
	Fezile Dabi	DC20	474088	149095	3.18	20698	65820	10441	15.86	1890	18.10	1.14
	Lejweleputswa	DC18	639649	202391	3.16	24553	77587	12813	16.51	2648	20.67	1.25
	Motheo	DC17	837376	227023	3.69	40153	148165	24722	16.69	4393	17.77	1.06
	Thabo Mofutsanyane	DC19	694316	187115	3.71	17096	63426	8935	14.09	1404	15.71	1.11
	Xhariep	DC16	127627	37245	3.43	4060	13926	1614	11.59	202	12.52	1.08
Gauteng			**10451707**	**3175580**	**3.29**	**764384**	**2514823**	**618642**	**24.60**	**108539**	**17.54**	**0.71**
	City of Johannesburg	JHB	3888170	1165014	3.34	290666	970824	176211	18.15	23140	13.13	0.72
	City of Tshwane	TSH	2345904	686640	3.42	177040	605477	270989	44.76	53544	19.76	0.44
	Ekurhuleni	EKU	2724230	849349	3.21	211632	679339	119518	17.59	22104	18.49	1.05
	Metsweding	DC46	153544	46498	3.30	6443	21262	8044	37.83	836	10.39	0.27
	Sedibeng	DC42	800820	241223	3.32	39809	132166	21735	16.45	4648	21.38	1.30

Table 4.3 (continued): Prevalence of gastro-intestinal disease among patients in the different districts of South Africa in 2007

			Community Survey 2007 database					Total database		Gastro-intestinal medication dataset		
Province	**District**	**District Code**	**Number of persons (N)**	**Number of households (N_H)**	**Household ratio (N/N_H)**	**$N_{H\ Income}$**	**N_1**	**Number of patients (N_2)**	**Prevalence $_{Total\ database}$ %**	**Number of patients (N_3)**	**Prevalence $_{GI}$ %**	***Prevalence index**
	West Rend District Municipality	DC48	539038	186850	2.88	38794	111727	22145	19.82	4267	19.27	0.97
Kwa-Zulu Natal			**10259220**	**2234128**	**4.59**	**344918**	**1583174**	**240638**	**15.20**	**41945**	**17.43**	**1.15**
	Amajuba	DC25	442270	101056	4.38	12245	53633	6897	12.86	1513	21.94	1.71
	Sisonke	DC43	500079	105654	4.73	7085	33512	3194	9.53	612	19.16	2.01
	UMgungunglovu	DC22	988836	217873	4.54	42485	189058	21326	11.28	4243	19.90	1.76
	Ugu	DC21	709915	151623	4.68	14937	69905	13004	18.60	1865	14.34	0.77
	Umkhanyakude	DC27	614046	114986	5.34	10403	55552	5478	9.86	996	18.18	1.84
	Umzinyathi	DC24	495735	104534	4.74	5838	27672	3745	13.53	867	23.15	1.71
	Uthukela	DC23	714907	139638	5.12	11147	57073	4241	7.43	886	20.89	2.81
	Uthungulu	DC28	894261	184506	4.85	29330	142251	24215	17.02	5125	21.16	1.24
	Zululand	DC26	902891	155883	5.79	15820	91598	10482	11.44	2676	25.53	2.23
	eThekwini	ETH	3468078	833859	4.16	185066	769875	142710	18.54	22383	15.68	0.85
	iLembe	DC29	528206	124525	4.24	10565	44796	5346	11.93	779	14.57	1.22
Limpopo			**5238285**	**1215935**	**4.31**	**123896**	**533992**	**112020**	**20.98**	**18112**	**16.17**	**0.77**
	Capricorn	DC35	1243165	285565	4.35	34781	151297	32311	21.36	5466	16.92	0.79
	Greater Sekhukhune	DC47	1090427	217169	5.02	16812	84396	15160	17.96	2444	16.12	0.90
	Mopani	DC33	1068570	265289	4.03	23735	95652	25659	26.83	4070	15.86	0.59
	Vhembe	DC34	1240032	287189	4.32	25699	111020	19963	17.98	2746	13.76	0.77
	Waterberg	DC36	596091	160717	3.71	22866	84833	18927	22.31	3386	17.89	0.80

Table 4.3 (continued): Prevalence of gastro-intestinal disease among patients in the different districts of South Africa in 2007

			Community Survey 2007 database					Total database		Gastro-intestinal medication dataset		
Province	**District**	**District Code**	**Number of persons (N)**	**Number of households (N_H)**	**Household ratio (N/N_H)**	**$N_{H\ Income}$**	**N_1**	**Number of patients (N_2)**	**Prevalence $_{Total\ database}$ %**	**Number of patients (N_3)**	**Prevalence $_{GI}$ %**	***Prevalence index**
Mpumalanga			**3643436**	**940405**	**3.87**	**131363**	**508375**	**92227**	**18.14**	**16473**	**17.86**	**0.98**
	Ehlanzeni	DC32	1526243	387317	3.94	46833	184522	34682	18.80	5634	16.24	0.86
	Gert Sibande	DC30	890699	247518	3.60	39877	143557	31941	22.25	5680	17.78	0.80
	Nkangala	DC31	1226503	305570	4.01	44654	179063	25604	14.30	5159	20.15	1.41
Northern Cape			**1058062**	**264651**	**4.00**	**42352**	**169408**	**20540**	**12.12**	**4065**	**19.79**	**1.63**
	Frances Baard	DC9	353209	82883	4.26	6960	29650	11536	38.91	2247	19.48	0.50
	Kgalagadi	DC45	173458	42152	4.12	4821	19863	2791	14.05	612	21.93	1.56
	Namakwa	DC6	126499	36435	3.47	6960	24151	1557	6.45	199	12.78	1.98
	Pixley ka Seme	DC7	166848	43293	3.85	5326	20505	2007	9.79	382	19.03	1.94
	Siyanda	DC8	238060	59894	3.97	7787	30914	2649	8.57	625	23.59	2.75
North West			**3271955**	**911123**	**3.59**	**105963**	**380407**	**97569**	**25.65**	**17876**	**18.32**	**0.71**
	Bojanala	DC37	1268610	357201	3.55	40838	144975	35216	24.29	7015	19.92	0.82
	Bophirima	DC39	354555	100070	3.54	8288	29340	4845	16.51	670	13.83	0.84
	Ngaka Modiri Molema District Municipality	DC38	798785	183401	4.36	19999	87196	29937	34.33	4636	15.49	0.45
	Dr Kenneth Kaunda District Municipality	DC40	849988	270445	3.14	36838	115671	27571	23.84	5555	20.15	0.85

Table 4.3 (continued): Prevalence of gastro-intestinal disease among patients in the different districts of South Africa in 2007

			Community Survey 2007 database					Total database		Gastro-intestinal medication dataset		
Province	**District**	**District Code**	**Number of persons (N)**	**Number of households (N_H)**	**Household ratio (N/N_H)**	**$N_{H\ Income}$**	**N_1**	**Number of patients (N_2)**	**Prevalence $_{Total\ database}$ %**	**Number of patients (N_3)**	**Prevalence $_{GI}$ %**	***Prevalence index**
Western Cape			**5278588**	**1369175**	**3.86**	**371184**	**1432770**	**220052**	**15.36**	**27593**	**12.54**	**0.82**
	Cape Winelands	DC2	712409	173346	4.11	36701	150841	15938	10.57	2360	14.81	1.40
	Central Karoo	DC5	56232	15701	3.58	2460	8807	711	8.07	141	19.83	2.45
	City of Cape Town	CPT	3497091	902278	3.88	271486	1053366	169952	16.13	19608	11.54	0.72
	Eden	DC4	513305	141580	3.63	29019	105339	21331	20.25	3532	16.56	0.82
	Overberg	DC3	212793	60056	3.54	11124	39379	6078	15.43	919	15.12	0.98
	West Coast	DC1	286749	76216	3.76	20393	76678	6042	7.88	1033	17.10	2.17
South Africa			**48502061**	**12500607**	**3.88**	**2159358**	**8378309**	**1546184**	**18.45**	**263456**	**17.04**	**0.92**

$N_{H\ Income}$: Number of households earning R76801 and more per year

N_1: Estimated number of persons in households earning above R76801 per year ($N_1 = N_{H\ Income}$ x Average size of household)

Prevalence $_{Total\ database}$ %: Number of patients (N_2) divided by the estimated number of persons in households earning above R76801 per year (N_1) multiplied by 100

Prevalence $_{GI}$%: Number of patients in the gastro-intestinal medication dataset (N_3), divided by the number of patients in the total database (N_3), multiplied by 100

*Prevalence index: Estimated gastro-intestinal disease prevalence index (Prevalence $_{GI}$ / Prevalence $_{Total\ database}$)

Table 4.4: Prevalence of gastro-intestinal disease among patients in the different districts of South Africa in 2008

			Community Survey 2007 database					Total database		Gastro-intestinal medication dataset		
Province	**District**	**District Code**	**Number of persons (N)**	**Number of households (N_H)**	**Household ratio (N/N_H)**	**$N_{H\ Income}$**	**N_1**	**Number of patients (N_2)**	**Prevalence $_{Total\ database}$ %**	**Number of patients (N_3)**	**Prevalence $_{GI}$ %**	***Prevalence Index**
Eastern Cape			**6527744**	**1586741**	**4.11**	**168738**	**693513**	**72605**	**10.47**	**15234**	**20.98**	**2.00**
	Alfred Nzo	DC44	479389	102024	4.70	5593	26287	1192	4.53	185	15.52	3.43
	Amatole	DC12	1664752	458580	3.63	47055	170810	18623	10.90	3469	18.63	1.71
	Cacadu	DC10	363497	99833	3.64	14905	54254	7031	12.96	1250	17.78	1.37
	Chris Hani	DC13	798602	203041	3.93	12844	50477	4758	9.43	1092	22.95	2.43
	Nelson Mandela Bay Metro	NMA	1050930	276881	3.80	59967	227875	31692	13.91	7408	23.37	1.68
	O.R. Tambo	DC15	1862220	356085	5.23	23458	122685	7160	5.84	1479	20.66	3.54
	Ukhahlamba	DC14	308366	90301	3.41	4918	16770	2149	12.81	351	16.33	1.27
Free State			**2773064**	**802869**	**3.45**	**106560**	**367632**	**49896**	**13.57**	**8794**	**17.62**	**1.30**
	Fezile Dabi	DC20	474088	149095	3.18	20698	65820	8041	12.22	1424	17.71	1.45
	Lejweleputswa	DC18	639649	202391	3.16	24553	77587	13706	17.67	2464	17.98	1.02
	Motheo	DC17	837376	227023	3.69	40153	148165	19922	13.45	3645	18.30	1.36
	Thabo Mofutsanyane	DC19	694316	187115	3.71	17096	63426	6891	10.86	1108	16.08	1.48
	Xhariep	DC16	127627	37245	3.43	4060	13926	1336	9.59	153	11.45	1.19
Gauteng			**10451707**	**3175580**	**3.29**	**764384**	**2514823**	**515825**	**20.51**	**86609**	**16.79**	**0.82**
	City of Johannesburg	JHB	3888170	1165014	3.34	290666	970824	150921	15.55	18385	12.18	0.78
	City of Tshwane	TSH	2345904	686640	3.42	177040	605477	225605	37.26	42802	18.97	0.51
	Ekurhuleni	EKU	2724230	849349	3.21	211632	679339	97930	14.41	17556	17.93	1.24
	Metsweding	DC46	153544	46498	3.30	6443	21262	5391	25.36	680	12.61	0.50
	Sedibeng	DC42	800820	241223	3.32	39809	132166	18345	13.88	3869	21.09	1.52

Table 4.4 (continued): Prevalence of gastro-intestinal disease among patients in the different districts of South Africa in 2008

			Community Survey 2007 database					Total database		Gastro-intestinal medication dataset		
Province	**District**	**District Code**	**Number of persons (N)**	**Number of households (N_H)**	**Household ratio (N/N_H)**	**N_H Income**	**N_1**	**Number of patients (N_2)**	**Prevalence$_{Total\ database}$ %**	**Number of patients (N_3)**	**Prevalence $_{GI}$ %**	***Prevalence Index**
	West Rand District Municipality	DC48	539038	186850	2.88	38794	111727	17633	15.78	3317	18.81	1.19
Kwa-Zulu Natal			**10259220**	**2234128**	**4.59**	**344918**	**1583174**	**202760**	**12.81**	**33389**	**16.47**	**1.29**
	Amajuba	DC25	442270	101056	4.38	12245	53633	5907	11.01	1334	22.58	2.05
	Sisonke	DC43	500079	105654	4.73	7085	33512	2726	8.13	397	14.56	1.79
	UMgungunglovu	DC22	988836	217873	4.54	42485	189058	19253	10.18	3474	18.04	1.77
	Ugu	DC21	709915	151623	4.68	14937	69905	12001	17.17	1714	14.28	0.83
	Umkhanyakude	DC27	614046	114986	5.34	10403	55552	4497	8.10	670	14.90	1.84
	Umzinyathi	DC24	495735	104534	4.74	5838	27672	2983	10.78	700	23.47	2.18
	Uthukela	DC23	714907	139638	5.12	11147	57073	3711	6.50	729	19.64	3.02
	Uthungulu	DC28	894261	184506	4.85	29330	142251	19069	13.41	3636	19.07	1.42
	Zululand	DC26	902891	155883	5.79	15820	91598	8267	9.03	2152	26.03	2.88
	eThekwini	ETH	3468078	833859	4.16	185066	769875	119875	15.57	17964	14.99	0.96
	iLembe	DC29	528206	124525	4.24	10565	44796	4221	9.42	562	13.31	1.41
Limpopo			**5238285**	**1215935**	**4.31**	**123896**	**533992**	**85908**	**16.09**	**13210**	**15.38**	**0.96**
	Capricorn	DC35	1243165	285565	4.35	34781	151297	24138	15.95	4038	16.73	1.05
	Greater Sekhukhune	DC47	1090427	217169	5.02	16812	84396	11581	13.72	1615	13.95	1.02
	Mopani	DC33	1068570	265289	4.03	23735	95652	20304	21.23	2948	14.52	0.68
	Vhembe	DC34	1240032	287189	4.32	25699	111020	15090	13.59	1995	13.22	0.97
	Waterberg	DC36	596091	160717	3.71	22866	84833	14666	17.29	2607	17.78	1.03

Table 4.4 (continued): Prevalence of gastro-intestinal disease among patients in the different districts of South Africa in 2008

			Community Survey 2007 database					Total database		Gastro-intestinal medication dataset		
Province	**District**	**District Code**	**Number of persons (N)**	**Number of households (N_H)**	**Household ratio (N/N_H)**	**N_H Income**	**N_1**	**Number of patients (N_2)**	**Prevalence$_{Total\ database}$ %**	**Number of patients (N_3)**	**Prevalence $_{GI}$ %**	***Prevalence Index**
Mpumalanga			**3643436**	**940405**	**3.87**	**131363**	**508375**	**74093**	**14.57**	**12699**	**17.14**	**1.18**
	Ehlanzeni	DC32	1526243	387317	3.94	46833	184522	26609	14.42	4078	15.33	1.06
	Gert Sibande	DC30	890699	247518	3.60	39877	143557	26524	18.48	4469	16.85	0.91
	Nkangala	DC31	1226503	305570	4.01	44654	179063	20960	11.71	4152	19.81	1.69
Northern Cape			**1058062**	**264651**	**4.00**	**42352**	**169408**	**18069**	**10.67**	**3066**	**16.97**	**1.59**
	Frances Baard	DC9	353209	82883	4.26	6960	29650	9344	31.51	1740	18.62	0.59
	Kgalagadi	DC45	173458	42152	4.12	4821	19863	3225	16.24	417	12.93	0.80
	Namakwa	DC6	126499	36435	3.47	6960	24151	935	3.87	133	14.22	3.67
	Pixley ka Seme	DC7	166848	43293	3.85	5326	20505	1599	7.80	301	18.82	2.41
	Siyanda	DC8	238060	59894	3.97	7787	30914	2966	9.59	475	16.01	1.67
North West			**3271955**	**911123**	**3.59**	**105963**	**380407**	**77830**	**20.46**	**13791**	**17.72**	**0.87**
	Bojanala	DC37	1268610	357201	3.55	40838	144975	30126	20.78	5669	18.82	0.91
	Bophirima	DC39	354555	100070	3.54	8288	29340	3569	12.16	444	12.44	1.02
	Dr Kenneth Kaunda District Municipality	DC40	849988	270445	3.14	36838	115671	21585	18.66	4453	20.63	1.11
	Ngaka Modiri Molema District Municipality	DC38	798785	183401	4.36	19999	87196	22550	25.86	3225	14.30	0.55

Table 4.4 (continued): Prevalence of gastro-intestinal disease among patients in the different districts of South Africa in 2008

			Community Survey 2007 database					Total database		Gastro-intestinal medication dataset		
Province	**District**	**District Code**	**Number of persons (N)**	**Number of households (N_H)**	**Household ratio (N/N_H)**	**N_H Income**	**N_1**	**Number of patients (N_2)**	**Prevalence$_{Total\ database}$ %**	**Number of patients (N_3)**	**Prevalence $_{GI}$ %**	***Prevalence Index**
Western Cape			**5278588**	**1369175**	**3.86**	**371184**	**1432770**	**186237**	**13.00**	**22541**	**12.10**	**0.93**
	Cape Winelands	DC2	712409	173346	4.11	36701	150841	13451	8.92	1966	14.62	1.64
	Central Karoo	DC5	56232	15701	3.58	2460	8807	565	6.42	107	18.94	2.95
	City of Cape Town	CPT	3497091	902278	3.88	271486	1053366	143277	13.60	15887	11.09	0.82
	Eden	DC4	513305	141580	3.63	29019	105339	18589	17.65	2980	16.03	0.91
	Overberg	DC3	212793	60056	3.54	11124	39379	5073	12.88	761	15.00	1.16
	West Coast	DC1	286749	76216	3.76	20393	76678	5282	6.89	840	15.90	2.31
South Africa			**48502061**	**12500607**	**3.88**	**2159358**	**8378309**	**1290017**	**15.40**	**209881**	**16.27**	**1.06**

$N_{H\ Income}$: Number of households earning R76801 and more per year

N_1: Estimated number of persons in households earning above R76801 per year ($N_1 = N_{H\ Income}$ x Average size of household)

Prevalence $_{Total\ database}$ %: Number of patients (N_2) divided by the estimated number of persons in households earning above R76801 per year (N_1) multiplied by 100

Prevalence $_{GI}$%: Number of patients in the gastro-intestinal medication dataset (N_3), divided by the number of patients in the total database (N_3), multiplied by 100

*Prevalence index: Estimated gastro-intestinal disease prevalence index (Prevalence $_{GI}$ / Prevalence $_{Total\ database}$)

4.2.2.1 Eastern Cape

In the Eastern Cape in 2007 (Table 4.3) the prevalence of gastro-intestinal disease among patients that claimed according to the total database was 21.30%, with the highest prevalence in the Nelson Mandela Bay Metro with 24.12%. When determining the estimated gastro-intestinal disease prevalence index, all the districts except for Ukhahlamba (0.89) had indices higher than one. This indicates that the prevalence of gastro-intestinal medication claims was large in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme. The district with the highest estimated gastro-intestinal disease prevalence index in the Eastern Cape in 2007 was Alfred Nzo, with 3.20, indicating that the prevalence of gastro-intestinal disease was problematic among the higher income population.

In 2008 the prevalence of gastro-intestinal disease (Table 4.4) in the Eastern Cape was lower than in 2007. The prevalence of gastro-intestinal disease among patients in 2008 was 20.98%. The highest prevalence was documented for the Nelson Mandela Bay Metro (23.37%), while the smallest prevalence was documented for Alfred Nzo (15.52%). The estimated gastro-intestinal disease prevalence index, however, increased from 2007 to 2008 for each district in the Eastern Cape. All the districts in the Eastern Cape had an estimated gastro-intestinal disease prevalence index larger than one, indicating that the prevalence of gastro-intestinal disease medication claims was relatively large in comparison with the total medicine claims of the higher income population that may utilise a medical scheme. In 2008 the district with the highest estimated gastro-intestinal disease prevalence index was O.R. Tambo with 3.54, while the smallest prevalence index was documented for Ukhalamba (1.27).

4.2.2.2 Free State

In 2007 the prevalence of gastro-intestinal disease among patients in the Free State was 18.00% (Table 4.3). The highest prevalence of gastro-intestinal disease was documented for Lejweleputswa (20.67%), while Xhariep had the smallest prevalence of gastro-intestinal disease (12.52%). The estimated gastro-intestinal disease prevalence index for the Free State was 1.13 in 2007. An estimated gastro-intestinal disease prevalence index larger than one indicates that the prevalence of gastro-intestinal disease medication claims is relatively small in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical aid. Lejweleputswa had the largest estimated gastro-intestinal disease prevalence index with a value of 1.25, while Motheo, with an index value of 1.06, was the smallest. All the districts in the Free State had estimated gastro-intestinal disease prevalence index values larger than one.

In 2008 (Table 4.4) the prevalence of gastro-intestinal disease among patients decreased from 2007, to 17.62%. Motheo had the highest prevalence with 18.30%, while Xhariep had the lowest prevalence with 11.45%. The estimated gastro-intestinal disease prevalence index of all the districts in the Free State was higher than one, indicating that the prevalence of gastro-intestinal medication claims was relatively high in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme. The estimated gastro-intestinal disease prevalence index increased to 1.30 in 2008, with the highest prevalence index (1.48) in Thabo Mofutsanyane and the lowest prevalence index (1.02) in Lejweleputswa.

4.2.2.3 Gauteng

In 2007 (Table 4.3), Gauteng had a prevalence of gastro-intestinal disease among patients of 17.54%. Sedibeng had the highest gastro-intestinal disease prevalence index of 21.38%, while the City of Johannesburg had the lowest prevalence with 13.13%. The estimated gastro-intestinal disease prevalence index calculated for Gauteng in 2007 was 0.71. This indicated that the prevalence of gastro-intestinal disease medication claims was relatively small in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme. Only Ekurhuleni (1.05) and Sedibeng (1.30) had prevalence index values larger than one. The smallest prevalence index value (0.27) was observed in Metsweding.

In 2008 (Table 4.4) the prevalence of gastro-intestinal disease among patients decreased to 16.79% while the estimated gastro-intestinal disease prevalence index increased to 0.82, but still remained below one, indicating that the prevalence of gastro-intestinal medication claims was relatively small in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme. Three districts and metropolitan municipalities had prevalence index values higher than one, namely Ekurhuleni (1.24), Sedibeng (1.52), as well as the West Rand District Municipality (1.19). The prevalence index values higher than one indicated that the prevalence of gastro-intestinal medication claims was relatively large in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme. Metsweding had the lowest prevalence index value of 0.50 in 2008 in Gauteng.

4.2.2.4 Kwa-Zulu Natal

The prevalence of gastro-intestinal disease among patients in Kwa-Zulu Natal in 2007 (Table 4.3) was 17.43%. Zululand had the highest prevalence of 25.53%, while Ugu had the lowest prevalence of 14.34%. The estimated gastro-intestinal disease prevalence index was 1.15. This index value being larger than one indicated that the prevalence of gastro-intestinal disease medication claims was relatively large in comparison to the total medication claims prevalence of the higher income population that may utilise a medical scheme. Uthukela had the highest index value of 2.81 in 2007, while Ugu had the lowest prevalence index value of 0.77. Ugu and also eThekwini (0.85) with prevalence index values smaller than one showed that the prevalence of gastro-intestinal medication claims was relatively small in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme.

The prevalence of gastro-intestinal disease decreased in 2008 (Table 4.4) to 16.47%, while the estimated gastro-intestinal disease prevalence index increased to 1.29 in 2008. Zululand had the highest prevalence of gastro-intestinal disease among patients (26.03%), while iLembe had the lowest prevalence of gastro-intestinal disease among patients (13.31). Uthukela had the highest estimated gastro-intestinal disease prevalence index of 3.02 in Kwa-Zulu Natal in 2008. This high prevalence index value above one indicated that the prevalence of gastro-intestinal disease medication claims was relatively large in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme.

4.2.2.5 Limpopo

In 2007 (Table 4.3) the prevalence of gastro-intestinal disease among patients in Limpopo was 16.17%, with Waterberg being the district with the highest prevalence being 17.89%, while Vhembe had the lowest prevalence with 13.76%. The estimated gastro-intestinal disease prevalence calculated was 0.77. This index value was smaller than one and therefore the prevalence of gastro-intestinal medication claims was relatively small in comparison with the total medicine claims prevalence of the higher income population that may utilise a medical scheme. All districts in Limpopo had prevalence index values lower than one in 2007. Greater Sekhukhune had the highest prevalence index value of 0.90, while Mopani had the lowest prevalence index value of 0.59.

The prevalence of gastro-intestinal disease in Limpopo in 2008 decreased to 15.38%, while the estimated gastro-intestinal disease prevalence index increased to 0.96 (Table 4.4). Waterberg had the lowest gastro-intestinal disease prevalence of 17.78%, while the lowest prevalence was documented for Vhembe (13.22%). The increase in the estimated gastro-intestinal disease prevalence index resulted to only two districts (Mopani and Vhembe) out of the five districts of Limpopo having indices below one. The district with the highest prevalence index value was Capricorn (1.05).

4.2.2.6 Mpumalanga

The prevalence of gastro-intestinal disease among patients in Mpumalanga in 2007 (Table 4.3) was 17.86%. Nkangala had the highest gastro-intestinal disease prevalence with 20.15%, while Gert Sibande followed with 17.78%, leaving Ehlanzeni with 16.24%. The estimated gastro-intestinal disease prevalence index for 2007 was 0.98, a value below one indicating that the prevalence of gastro-intestinal medication claims was relatively small in comparison with the total medicine claims prevalence of the higher income population that may utilise a medical scheme. Nkangala had the highest prevalence index of 1.41, indicating that the prevalence of gastro-intestinal disease medication claims in that district was relatively large in comparison with the total medicine claims prevalence of the higher income population that may utilise a medical scheme. Gert Sibande district had the lowest prevalence index of 0.80.

In 2008 (Table 4.4) the prevalence of gastro-intestinal disease among patients in Mpumalanga decreased to 17.14%, with the highest prevalence in Nkangala (19.81%). The estimated gastro-intestinal disease prevalence index increased in 2008 to 1.18. This prevalence index value higher than one indicates that the prevalence of gastro-intestinal disease medication claims was relatively high in comparison with the total medicine claims prevalence of the higher income population that may utilise a medical scheme. All three districts had prevalence index values higher than one, with Nkangala being the district with the highest prevalence index of 1.69.

4.2.2.7 Northern Cape

In 2007 (Table 4.3) the prevalence of gastro-intestinal disease among patients in the Northern Cape was 19.79%. Siyanda had the highest gastro-intestinal disease prevalence with 23.59%, while Namakwa had the lowest gastro-intestinal disease prevalence at 12.78%. The estimated gastro-intestinal disease prevalence index calculated for 2007 was 1.63, a

value larger than one. The prevalence index value larger than one indicated that the prevalence of gastro-intestinal medication claims was relatively large in comparison with the total medicine claims prevalence of the higher income population that may utilise a medical scheme. Siyanda had the highest prevalence index of 2.75, while Frances Baard had the lowest prevalence index at 0.50.

The prevalence of gastro-intestinal disease among patients in the Northern Cape decreased in 2008 (Table 4.4) to 16.97%, while the estimated gastro-intestinal disease prevalence index also decreased to 1.59. Pixley ka Seme had the highest prevalence of gastro-intestinal disease with 18.82%, while the lowest gastro-intestinal disease prevalence was reported for Kgalagadi (12.93%). The gastro-intestinal disease prevalence index was the highest for Namakwa with 3.67, while the smallest index was calculated for Frances Baard (0.59).

4.2.2.8 North West

The prevalence of gastro-intestinal disease among patients in North West in 2007 (Table 4.3) was 18.32%. The district with the highest gastro-intestinal disease prevalence was Dr Kenneth Kaunda District Municipality with 20.15%, while Bophirima had the lowest prevalence of 13.83%. The estimated gastro-intestinal disease prevalence index calculated for 2008 was 0.71. All four districts of North West had prevalence indices lower than one, indicating that the prevalence of gastro-intestinal disease medication claims was relatively small in comparison with the total medicine claims prevalence of the higher income population that may utilise a medical scheme. Ngaka Modiri Molema District Municipality had the lowest prevalence index of 0.45 in 2007.

In 2008 (Table 4.4) the prevalence of gastro-intestinal disease among patients decreased to 17.72%. Dr Kennith Kaunda District Municipality had the highest gastro-intestinal disease medication prevalence of 20.63%, while Bophirima had the lowest disease prevalence with 12.44%. The estimated gastro-intestinal disease prevalence index increased in 2008 to 0.87, a value still below one. Two of the four districts had estimated gastro-intestinal disease prevalence indices larger than one, namely Dr Kennith Kaunda District Municipality with 1.11 and Bophirima with 1.02. These estimated gastro-intestinal disease prevalence indices larger than one, indicated that the prevalence of gastro-intestinal medication claims was relatively large in comparison with the total medicine claims prevalence of the higher income population that may utilise a medical scheme. Ngaka Modiri Molema District Municipality had the lowest prevalence index of 0.55.

4.2.2.9 Western Cape

The prevalence of gastro-intestinal disease among patients in the Western Cape for 2007 (Table 4.3) was 12.54%. The highest gastro-intestinal disease prevalence among patients was calculated for Central Karoo (19.83%), while the City of Cape Town had the lowest gastro-intestinal disease prevalence of 11.54%. The estimated gastro-intestinal disease prevalence index calculated for the Western Cape was 0.82, a value below one, which indicated that the prevalence of gastro-intestinal medication claims was relatively small in comparison with the total medicine claims prevalence of the higher income population that may utilise a medical aid. Central Karoo had the highest estimated gastro-intestinal disease prevalence index of 2.45, while the lowest prevalence index value was calculated for the City of Cape Town (0.72).

In 2008 (Table 4.4) the prevalence of gastro-intestinal disease among patients in the Western Cape decreased to 12.10%. Central Karoo had the highest gastro-intestinal disease prevalence of 18.94%, while the City of Cape Town had the smallest prevalence of 11.09%. The estimated gastro-intestinal disease prevalence index increased to 0.93, a value still below one. Central Karoo had the highest prevalence index of 2.95, while the City of Cape Town had the lowest value of 0.82.

4.2.2.10 South African districts with the highest gastro-intestinal disease prevalence

According to the information obtained from Table 4.3 and Table 4.4 the following top twenty districts were identified as those districts in which the gastro-intestinal disease prevalence among patients was the highest in 2007 and 2008.

Table 4.5: The twenty districts with the highest gastro-intestinal disease prevalence

2007			2008		
District	**Province**	**Prevalence $_{GI}$ %**	**District**	**Province**	**Prevalence $_{GI}$ %**
Zululand	Kwa-Zulu Natal	25.53	Gert Sibande	Mpumalanga	27.05
Nelson Mandela Bay Metro	Eastern Cape	24.12	Zululand	Kwa-Zulu Natal	26.03
Siyanda	Northern Cape	23.59	Umzinyathi	Kwa-Zulu Natal	23.47

Table 4.5 (continued): The twenty districts with the highest gastro-intestinal disease prevalence

2007			2008		
District	**Province**	**Prevalence $_{GI}$ %**	**District**	**Province**	**Prevalence $_{GI}$ %**
Chris Hani	Eastern Cape	23.15	Nelson Mandela Bay Metro	Eastern Cape	23.37
Umzinyathi	Kwa-Zulu Natal	23.15	Chris Hani	Eastern Cape	22.95
O.R. Thambo	Eastern Cape	22.82	Amajuba	Kwa-Zulu Natal	22.58
Amajuba	Kwa-Zulu Natal	21.94	Sedibeng	Gauteng	21.09
Kgalagadi	Northern Cape	21.93	O.R. Tambo	Eastern Cape	20.66
Sedibeng	Gauteng	21.38	Dr. Kennith Kaunda District Municipality	North West	20.63
Uthungulu	Kwa-Zulu Natal	21.16	Nkangala	Mpumalanga	19.81
Uthukela	Kwa-Zulu Natal	20.89	Uthukela	Kwa-Zulu Natal	19.64
Lejweleputswa	Free State	20.67	Uthungulu	Kwa-Zulu Natal	19.07
Nkangala	Mpumalanga	20.15	City of Tshwane	Gauteng	18.97
Dr. Kenneth Kaunda District Municipality	North West	20.15	Central Karoo	Western Cape	18.94
Bojanala	North West	19.92	Bojanala	North West	18.82
UMgungunglovu	Kwa-Zulu Natal	19.90	Pixley ka Seme	Northern Cape	18.82
Central Karoo	Western Cape	19.83	West Rand district Municipality	Gauteng	18.81
City of Tshwane	Gauteng	19.76	Amatole	Eastern Cape	18.63
Frances Baard	Northern Cape	19.48	Frances Baard	Northern Cape	18.62
West Rand District	Gauteng	19.27	Motheo	Free State	18.30

As indicated in Figure 4.4 and Figure 4.5 respectively, charts were drawn to visualise the representation of each province in the top 20 districts with the highest gastro-intestinal disease in South Africa in 2007 and 2008. In order to determine the province representation (%), the number of times a district of the specified province counted among the top 20 districts, was determined and percentage of the total (in this case 20) was calculated. In 2007 (Figure 4.4) it was observed that Kwa-Zulu Natal accounted for 32% of the districts represented among the top 20 districts with the highest prevalence of gastro-intestinal disease. Eastern Cape, Gauteng and the Northern Cape each accounted for 16% of the top 20 districts. In 2008 (Figure 4.5) Kwa-Zulu Natal represented 25%, the Eastern Cape 20% and Gauteng 15% of the top 20 districts with the highest gastro-intestinal disease prevalence.

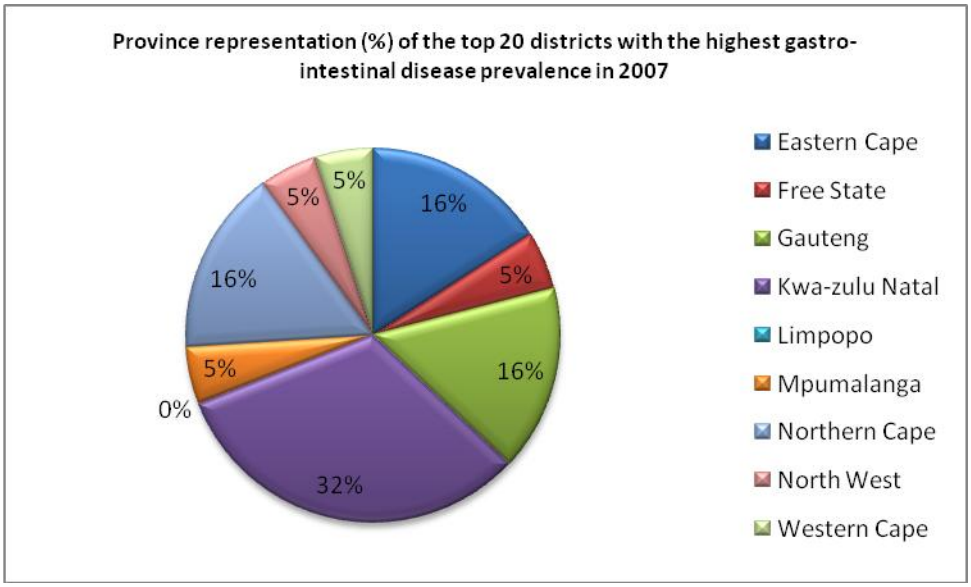

Figure 4.4: Province representation (%) of the top 20 districts with the highest gastro-intestinal disease prevalence in 2007

In Figure 4.5 the province representation of the top twenty districts with the highest gastro-intestinal disease prevalence were visually represented.

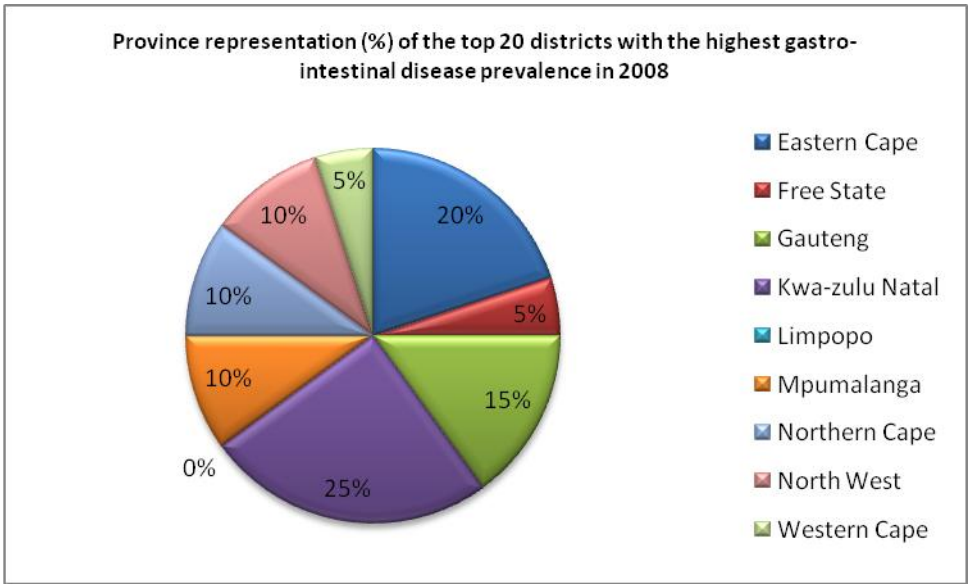

Figure 4.5: Province representation (%) of the top 20 districts with the highest gastro-intestinal disease prevalence in 2008

4.2.2.11 The top twenty districts with the highest estimated gastro-intestinal disease prevalence indices in 2007 and 2008

The top 20 districts with the highest gastro-intestinal disease prevalence indices (Table 4.6) were determined from Table 4.3 and Table 4.4. As the estimated gastro-intestinal disease prevalence index for each of these districts is larger than one, it can be interpreted that the prevalence of gastro-intestinal medication claims is relatively large in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme.

Table 4.6: The twenty districts with the highest estimated gastro-intestinal disease prevalence indices

2007			2008		
District	**Province**	**Estimated gastro-intestinal disease prevalence index**	**District**	**Province**	**Estimated gastro-intestinal disease prevalence index**
Alfred Nzo	Eastern cape	3.20	Namakwa	Northern Cape	3.67
O.R. Tambo	Eastern Cape	3.04	O.R. Tambo	Eastern Cape	3.54
Uthukela	Kwa-Zulu Natal	2.81	Alfred Nzo	Eastern Cape	3.43
Siyanda	Northern Cape	2.75	Uthukela	Kwa-Zulu Natal	3.02
Central Karoo	Western Cape	2.45	Central Karoo	Western Cape	2.95
Zululand	Kwa-Zulu Natal	2.23	Zululand	Kwa-Zulu Natal	2.88
West Coast	Western Cape	2.17	Chris Hani	Eastern Cape	2.43
Chris Hani	Eastern Cape	2.04	Pixley ka Seme	Northern Cape	2.41
Sisonke	Kwa-Zulu Natal	2.01	West Coast	Western Cape	2.31
Namakwa	Northern Cape	1.98	Umzinyathi	Kwa-Zulu Natal	2.18
Pixley ka Seme	Northern Cape	1.94	Amajuba	Kwa-Zulu Natal	2.05
Umkhanyakude	Kwa-Zulu Natal	1.84	Umkhanyakude	Kwa-Zulu Natal	1.84
UMgungunglovu	Kwa-Zulu Natal	1.76	Sisonke	Kwa-Zulu Natal	1.79
Amajuba	Kwa-Zulu Natal	1.71	UMgungunglovu	Kwa-Zulu Natal	1.77
Umzinyathi	Kwa-Zulu Natal	1.71	Amatole	Eastern Cape	1.71
Kgalagadi	Northern Cape	1.56	Nkangala	Mpumalanga	1.69
Nelson Mandela Bay Metro	Eastern Cape	1.50	Nelson Mandela Bay Metro	Eastern Cape	1.68
Amatole	Eastern Cape	1.44	Siyanda	Northern Cape	1.67

Table 4.6 (continued): The twenty districts with the highest estimated gastro-intestinal disease prevalence indices

2007			2008		
District	**Province**	**Estimated gastro-intestinal disease prevalence index**	**District**	**Province**	**Estimated gastro-intestinal disease prevalence index**
Nkangala	Mpumalanga	1.41	Cape Winelands	Western Cape	1.64
Cape Winelands	Western Cape	1.40	Sedibeng	Gauteng	1.52

In Figure 4.6 the province representation of the top twenty districts with the highest estimated gastro-intestinal disease prevalence indices in 2007 were visually represented.

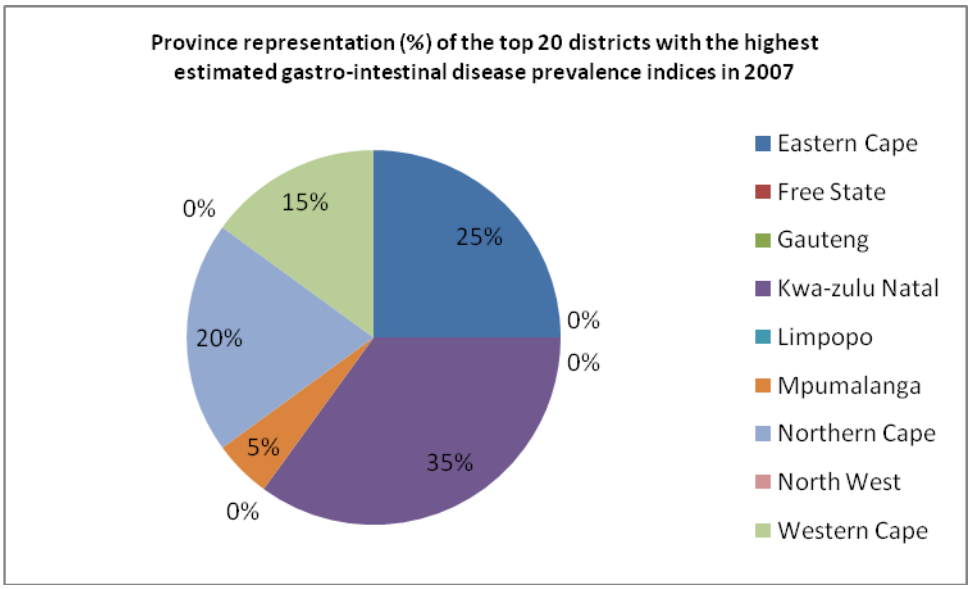

Figure 4.6: Province representation (%) of the top 20 districts with the highest estimated gastro-intestinal disease prevalence indices in 2007

In 2007 (Figure 4.6) the provinces with the highest representation among the top 20 districts with the highest estimated gastro-intestinal disease prevalence indices in 2007 were Kwa-Zulu Natal with 35%, the Eastern Cape with 25%, Northern Cape with 20% and Western Cape with 15%. In 2008 (Figure 4.7) the provinces with the highest representation in the top

20 districts with the highest estimated gastro-intestinal disease prevalence indices in 2008 were Kwa-Zulu Natal with 33%, the Eastern Cape with 24% and the Northern Cape and Western Cape with an equal 14%.

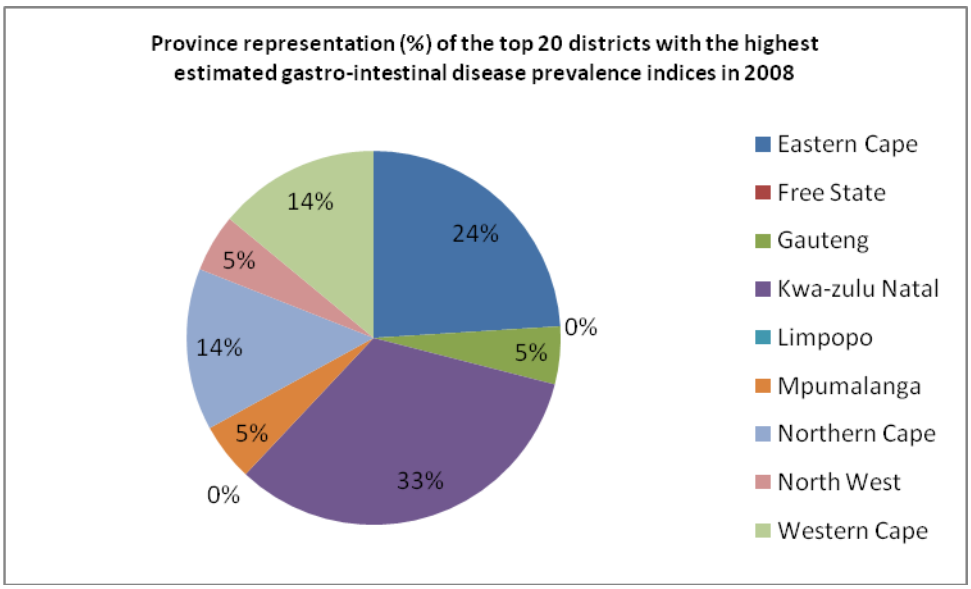

Figure 4.7: Province representation (%) of the top 20 districts with the highest estimated gastro-intestinal disease prevalence indices in 2008

In order to determine whether the high prevalence of gastro-intestinal disease may be attributed to the Blue Drop Score (2010) and the Green Drop Score (2009) of the specific districts where possible, Tables 4.7 and 4.8 were constructed and Figures 4.8 and 4.9 were compiled. It can be concluded that the prevalence of gastro-intestinal disease among patients cannot be attributed to the Blue Drop Score or the Green Drop Score in an absolute manner. For example, Nelson Mandela Bay Metro has a Blue Drop Score of 95.10%, indicating that water quality is managed with excellence (DWA, 2010:10) and a Green Drop Score of 70.00%, indicating that waste water quality performance is adequate (DWA, 2009:17), yet this district had the second highest gastro-intestinal disease prevalence in South Africa in 2007. In the case of O.R. Tambo, the gastro-intestinal disease prevalence (22.82% in 2007 and 20.66% in 2008) may be attributed due to the quality of drinking water and poor waste water management, as the Blue Drop Score was 22.20% and the Green Drop Score was 0.00%.

Table 4.7: The top twenty districts with the highest gastro-intestinal disease prevalence in South Africa in 2007 compared with corresponding Blue Drop (DWA, 2010) and Green Drop Scores (DWA, 2009)

Province	District	Prevalence$_{GI}$ %	Blue Drop Score (DWA, 2010) (%)	Green Drop Score (DWA, 2009) (%)
Kwa-Zulu Natal	Zululand	25.53	59.80	44.00
Eastern Cape	Nelson Mandela Bay Metro	24.12	95.10	70.00
Northern Cape	Siyanda	23.59	41.00	9.50 (Mean)
Eastern Cape	Chris Hani	23.15	53.10	10.00
Kwa-Zulu Natal	Umzinyathi	23.15	66.00	48.00
Eastern Cape	O.R. Tambo	22.82	22.20	0.00
Kwa-Zulu Natal	Amajuba	21.94	56.40	47.00
Northern Cape	Kgalagadi	21.93	33.90 (Mean)	0.00
Gauteng	Sedibeng	21.38	75.63 (Mean)	23.33 (Mean)
Kwa-Zulu Natal	Uthungulu	21.16	37.20	50.00
Kwa-Zulu Natal	Uthukela	20.89	54.40	34.00
Free State	Lejweleputswa	20.67	25.06 (Mean)	0.00
Mpumalanga	Nkangala	20.15	48.28	25.00 (Mean)
North West	Dr. Kenneth Kaunda District Municipality	20.15	63.18 (Mean)	25.60
North West	Bojanala	19.92	44.35 (Mean)	31.75 (Mean)
Kwa-Zulu Natal	UMgungungluvo	19.90	64.70	27.00
Western Cape	Central Karoo	19.83	45.60	0.00
Gauteng	City of Tswane	19.76	96.36	75.00
Northern Cape	Frances Baard	19.48	83.80	1.75 (Mean)
Gauteng	West Rand District Municipality	19.27	90.72 (Mean)	44.00

Prevalence$_{GI}$ %: Number of patients in the gastro-intestinal disease dataset (Dataset A), divided by the number of patients in the total dataset, multiplied by 100

Mean: The sum of the percentages (Blue Drop Score or Green Drop Score where applicable) achieved in the different municipalities in the specified district, divided by the number of municipalities in that district

In Figure 4.8 the top twenty districts with the highest gastro-intestinal disease prevalence in 2007 compared with the Blue Drop Score and the Green Drop Score for that particular districts were visually represented.

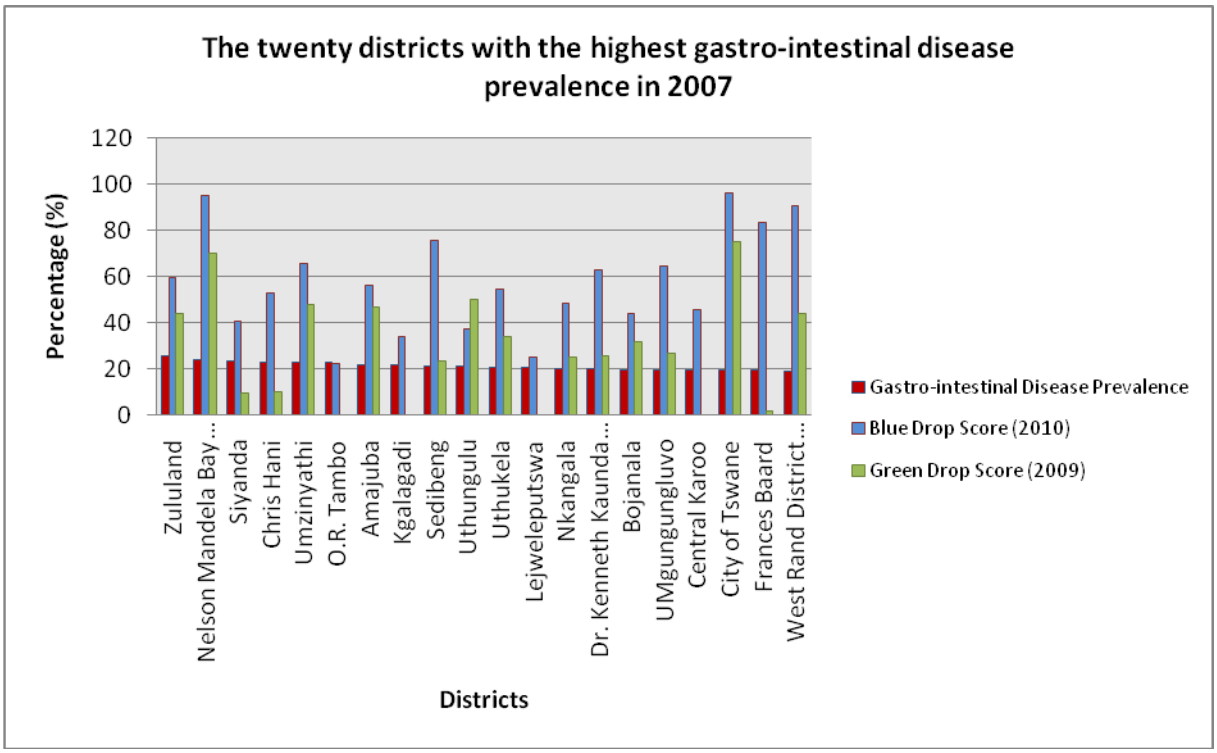

Figure 4.8: The top twenty districts with the highest gastro-intestinal disease prevalence in 2007 compared with the Blue Drop Score (DWA, 2010) and the Green Drop Score (DWA, 2009) for that particular district

In 2008 (Table 4.8 and Figure 4.9) Nelson Mandela Bay Metro was counted as one of the top twenty districts with the highest estimated gastro-intestinal disease prevalence in South Africa. Although the Blue Drop Score as well as the Green Drop Score can be considered as excellent and adequate respectively, the high gastro-intestinal disease prevalence may indicate that other socio-economic factors may play an important role in the prevalence of gastro-intestinal disease. In the case of Gert Sibande, the high gastro-intestinal disease prevalence may be due to poor waste water management in that district (Green Drop Score of 10.83%), even though the Blue Drop Score of 74.80% can be considered as good (DWA, 2010:11).

Table 4.8: The top twenty districts with the highest gastro-intestinal disease prevalence in South Africa in 2008 compared with corresponding Blue Drop (DWA, 2010) and Green Drop Scores (DWA, 2009)

Province	District	$Prevalence_{GI}$ %	Blue Drop Score (DWA, 2010) (%)	Green Drop Score (DWA, 2009) (%)
Mpumalanga	Gert Sibande	27.05	74.80	10.83
Kwa-Zulu Natal	Zululand	26.03	59.80	44.00
Kwa-Zulu Natal	Umzinyathi	23.47	66.00	48.00
Eastern Cape	Nelson Mandela Bay Metro	23.37	95.10	70.00
Eastern Cape	Chris Hani	22.95	53.10	10.00
Kwa-Zulu Natal	Amajuba	22.58	56.40	47.00
Gauteng	Sedibeng	21.09	75.63	23.33
Eastern Cape	O.R. Tambo	20.66	22.22	0.00
North West	Dr. Kennith Kaunda District Municipality	20.63	63.18	25.60
Mpumalanga	Nkangala	19.81	48.28	25.00
Kwa-Zulu Natal	Uthukela	19.64	54.40	34.00
Kwa-Zulu Natal	Uthungulu	19.07	37.20	50.00
Gauteng	City of Tshwane	18.97	96.36	75.00
Western Cape	Central Karoo	18.94	45.60	0.00
North West	Bojanala	18.82	44.35	31.75
Mpumalanga	Pixley ka Seme	18.82	0.00	21.00
Gauteng	West Rand District Municipality	18.81	90.77	44.00
Eastern Cape	Amatole	18.63	68.20	0.00
Northern Cape	Frances Baard	18.62	83.80	1.75
Free State	Montheo	18.30	56.67	18

$Prevalence_{GI}$ %: Number of patients in the gastro-intestinal disease dataset (Dataset A), divided by the number of patients in the total dataset, multiplied by 100

Mean: The sum of the percentages (Blue Drop Score or Green Drop Score where applicable) achieved in the different municipalities in the specified district, divided by the number of municipalities in that district

In Figure 4.9 the top twenty districts with the highest gastro-intestinal disease prevalence in 2008 compared with the Blue Drop Score and the Green Drop Score for each district were visually represented.

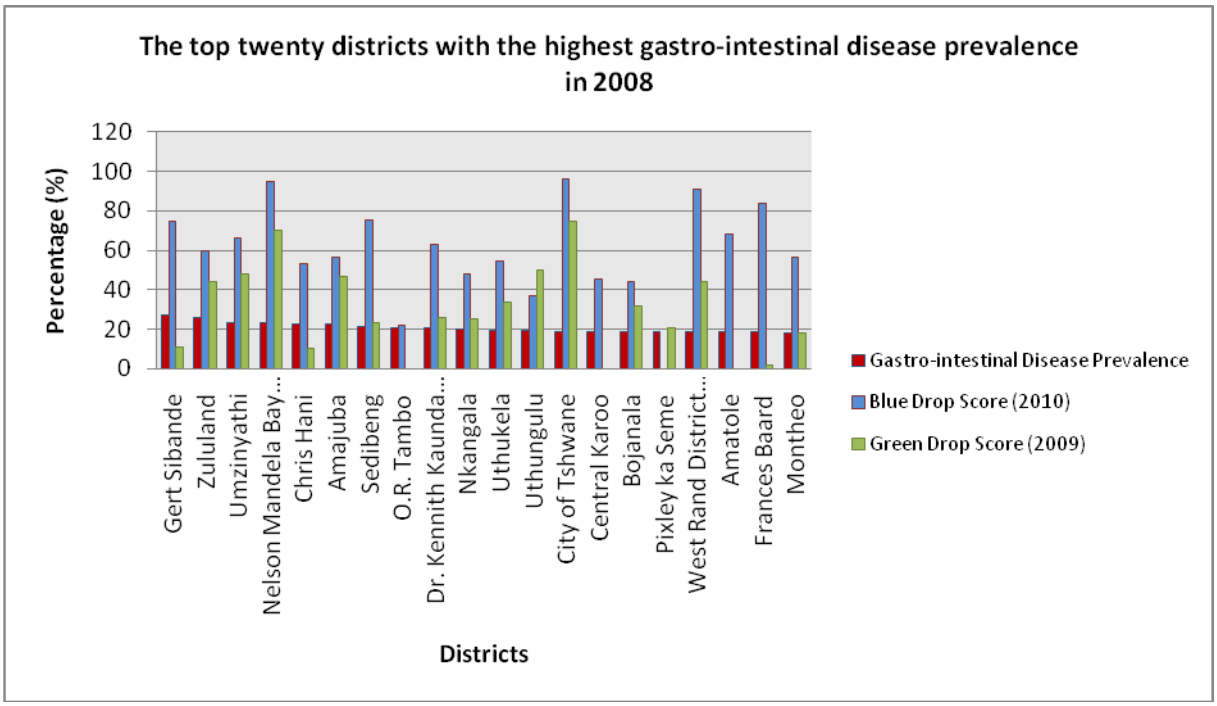

Figure 4.9: The top twenty districts with the highest gastro-intestinal disease prevalence in 2008 compared with the Blue Drop Score (DWA, 2010) and the Green Drop Score (DWA, 2009) for each district

4.2.3 The prevalence of gastro-intestinal disease in the different municipalities of South Africa for 2007 and 2008

In order to determine the prevalence of gastro-intestinal disease in the different municipalities of South Africa as well as the estimated gastro-intestinal disease prevalence index for 2007 and 2008, Table C1 and Table C2 (Appendix C) respectively were constructed. Municipalities were indicated first according to the provinces in which they are located, then according to the district and finally according to alphabetical order. Municipalities of importance will be discussed according to the provinces in which they are located. The estimated gastro-intestinal disease prevalence index, as discussed in section 3.7.4, is interpreted according to the value obtained, namely larger and smaller than one.

In this study the estimated gastro-intestinal disease prevalence index can be interpreted as follows:

- Estimated gastro-intestinal disease prevalence index < 1: the prevalence of gastro-intestinal medication claims is relatively small in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme.

- Estimated gastro-intestinal disease prevalence index = 1: the prevalence of gastro-intestinal medication claims is in equilibrium with the total medicine claims prevalence of the higher income population that may utilise a medical scheme.

- Estimated gastro-intestinal disease prevalence index > 1: the prevalence of gastro-intestinal medication claims is relatively high in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme.

The estimated gastro-intestinal disease prevalence index is based on the study limitation that the medicine claims database covers the private health care sector of South Africa and not the public health care sector. Therefore it is assumed that only persons in a household earning above R76801.00 per year can afford to belong to a medical aid. The representation of the higher income population that may utilise a medical scheme was therefore taken into account when calculating the estimated gastro-intestinal disease prevalence index.

4.2.3.1 Eastern Cape

In the Eastern Cape the prevalence of gastro-intestinal disease among patients was 21.30%, while the estimated gastro-intestinal disease prevalence index was 1.72 for 2007 while in 2008 the prevalence of gastro-intestinal disease among patients was 20.98% and the estimated gastro-intestinal disease prevalence index increased to 2.00. In the Alfred Nzo district it was found that the prevalence of gastro-intestinal disease among patients was 15.89% and the estimated gastro-intestinal disease prevalence index was 3.20 for 2007. In the Alfred Nzo district, Matatiele Local Municipality had the highest prevalence of gastro-intestinal disease among patients with 17.62% and had an estimated gastro-intestinal disease prevalence index of 4.23 in 2007. This high prevalence index of more than one indicates that the prevalence of gastro-intestinal medication claims is relatively large in comparison with the total medicine claims prevalence of the higher income population that may utilise a medical scheme. In 2008 Alfred Nzo district had a prevalence of gastro-intestinal disease among patients of 15.52% and an estimated gastro-intestinal disease prevalence index of 3.43. Matatiele Local Municipality in the Alfred Nzo district had the highest gastro-intestinal disease prevalence for that district of 18.89% and an estimated gastro-intestinal disease prevalence index of 4.54 in 2008.

In 2007 Amatole district presented with a gastro-intestinal disease prevalence among patients of 18.36%. The estimated gastro-intestinal disease prevalence index was 1.34. Mnquma Local Municipality had the highest gastro-intestinal disease prevalence index of

25.55% in that municipality. The highest estimated gastro-intestinal disease prevalence index (4.73) was calculated for Mbhashe Local Municipality in 2007. In 2008 the prevalence of gastro-intestinal disease among patients in the Amatole district was 18.63% and the estimated gastro-intestinal disease prevalence index was 1.58. Mnquma local Municipality in the Amatole district had a gastro-intestinal disease prevalence of 24.21%, while the Great Kei Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 9.26.

In 2007 the Cacadu district was found to have a gastro-intestinal disease prevalence of 16.85% and an estimated gastro-intestinal disease prevalence index of 1.06. Blue Crane Local Municipality had the highest gastro-intestinal disease prevalence index of 23.21%, while the Sundays River Valley Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 1.87 and also had a high gastro-intestinal disease prevalence of 22.99% in 2007. In 2008 Cacadu had a gastro-intestinal disease prevalence of 17.78% while the estimated gastro-intestinal disease prevalence index was 1.37. Baviaans Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 3.86, while the Sundays River Valley Local Municipality had the highest gastro-intestinal disease prevalence for the Cacadu district in 2008 with 28.71.

Chris Hani district presented with a gastro-intestinal disease prevalence of 23.15% and an estimated gastro-intestinal disease prevalence index of 2.04 in 2007. Inxuba Yethemba Local Municipality had the highest gastro-intestinal disease prevalence of 27.73%, while Emalahleni Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 7.06. In 2008 Chris Hani District had a gastro-intestinal disease prevalence of 22.95% and an estimated gastro-intestinal disease prevalence index of 2.43. Inxuba Yethemba Local Municipality had the highest gastro-intestinal disease prevalence of 28.52%, while Emalahleni Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 6.46 in 2008.

In 2007 O.R. Tambo District was found to have a prevalence of gastro-intestinal disease among patients of 22.82% and the estimated gastro-intestinal disease prevalence index was 3.04. Port St Johns Local Municipality had the highest gastro-intestinal disease prevalence index of 20.88%, while Mbizana Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 23.29. In 2008 the gastro-intestinal disease prevalence in the O.R. Tambo District was 20.66% and the estimated gastro-intestinal disease prevalence index was 3.54. Mbizana Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 106.67, while Port St Johns Local Municipality

had the highest gastro-intestinal disease prevalence of 22.52% and an estimated gastro-intestinal disease prevalence index of 16.20 in 2008.

Ukhahlamba District had a gastro-intestinal disease prevalence index of 14.64% and an estimated gastro-intestinal disease prevalence index of 0.89 in 2007. Gariep Local Municipality had the highest gastro-intestinal disease prevalence of 17.41%, while Elundini Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 1.91. The estimated gastro-intestinal disease prevalence index of Elundini Local Municipality was the only prevalence index value above one in that district in 2007. In 2008 the gastro-intestinal disease prevalence was 16.33% and the estimated gastro-intestinal disease prevalence index was 1.27 for the Ukhahlamba District. Gariep Local Municipality had the highest gastro-intestinal disease prevalence of 21.80%, while Elundini Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 2.38 in 2008.

4.2.3.2 Free State

In 2007 the Free State has shown to have a gastro-intestinal disease prevalence of 18.00% and an estimated gastro-intestinal disease prevalence index of 1.13. In 2008 the gastro-intestinal disease prevalence decreased to 17.62% while the estimated gastro-intestinal disease prevalence index increased to 1.30. The estimated gastro-intestinal disease prevalence index larger than one indicates that the prevalence of gastro-intestinal medication claims is relatively large in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme.

The Fezile Dabi District presented with a gastro-intestinal disease prevalence index of 18.10% and an estimated gastro-intestinal disease prevalence index of 1.14 in 2007. Metsimaholo Local municipality had the highest estimated gastro-intestinal disease prevalence index of 1.97, while Ngwathe Local Municipality had the highest gastro-intestinal disease prevalence of 18.39% in 2007. It is of interest to note that although Ngwathe Local Municipality had the highest gastro-intestinal disease prevalence in the Fezile Dabi District for 2007, the estimated gastro-intestinal disease prevalence index for this municipality was 0.96, a value smaller than one. This indicates that the prevalence of gastro-intestinal medication claims is relatively small in comparison with the total medicine claims prevalence of the higher income population that may utilise a medical scheme. In 2008 Fezile Dabi district had a gastro-intestinal disease prevalence index of 17.71% and an estimated gastro-intestinal disease prevalence index of 1.45. Metsimaholo Local Municipality had the highest

gastro-intestinal disease prevalence among patients of that district with 19.12%, as well as the highest estimated gastro-intestinal disease prevalence index of 2.55 for 2008.

In 2007 the Lejweleputswa District had a gastro-intestinal disease prevalence of 20.67% and an estimated gastro-intestinal disease prevalence index of 1.25. Masilonyana Local Municipality had the highest gastro-intestinal disease prevalence in 2007 with 24.69%, while the highest estimated gastro-intestinal disease prevalence index of 1.83 was calculated for Tokologo Local Municipality in 2007. In 2008 the prevalence of gastro-intestinal disease in Lejweleputswa decreased to 17.98% and the estimated gastro-intestinal disease prevalence index also decreased to 1.02. Masilonyana Local Municipality had the highest prevalence of gastro-intestinal disease in 2008 with 22.92% as well as the highest estimated gastro-intestinal disease prevalence index of 2.32 in 2008.

Montheo District has shown to have a gastro-intestinal disease prevalence of 17.77% and an estimated gastro-intestinal disease prevalence index of 1.06 in 2007. Mangaung Local Municipality had the highest gastro-intestinal disease prevalence in that district with 17.88%, while Mantsopa Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 1.70 in 2007. In 2008 Montheo District had an increase in both the gastro-intestinal disease prevalence (18.30%) as well as the estimated gastro-intestinal disease prevalence index of 1.36. Mangaung Local Municipality had the highest gastro-intestinal disease prevalence index of 18.48%, while Mantsopa Local Municipality had the highest estimated gastro-intestinal disease prevalence of 1.88 in the Montheo District in 2008.

Thabo Mofutsanyane District represented with a gastro-intestinal disease prevalence 15.71% and an estimated gastro-intestinal disease prevalence index of 1.11 in 2007. Phumelela Local Municipality had the highest gastro-intestinal disease prevalence of 18.54%, while Nketoana Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 1.52 in 2007. In 2008 Thabo Mofutsanyane District had a gastro-intestinal disease prevalence of 16.08% and an estimated gastro-intestinal disease prevalence index of 1.48, an increase from 2007. In 2008 the Nketoana Local Municipality had the highest gastro-intestinal disease prevalence of 20.25% as well as the highest estimated gastro-intestinal disease prevalence index of 3.16.

In 2007 the Xhariep district has shown a gastro-intestinal disease prevalence index of 12.52% and an estimated gastro-intestinal disease prevalence index of 1.08. Letsemeng Local Municipality had the highest gastro-intestinal disease prevalence index of 8.13% as

well as the highest estimated gastro-intestinal disease prevalence index of 1.73 for the Xhariep district in 2007. The Xhariep district had a decrease in the gastro-intestinal disease prevalence (11.45%) and increase in the estimated gastro-intestinal disease prevalence of 1.19 in 2008. In 2008 Letsemeng Local Municipality had the highest gastro-intestinal disease prevalence of 17.29% and an estimated gastro-intestinal disease prevalence index of 1.76.

4.2.3.3 Gauteng

In 2007 the prevalence of gastro-intestinal disease in Gauteng was 17.54%, while the estimated gastro-intestinal disease prevalence index was 0.71, while in 2008 the gastro-intestinal disease prevalence was 16.79% and the estimated gastro-intestinal disease prevalence index was 0.82. Metsweding District had a gastro-intestinal disease prevalence of 10.39%, while the estimated gastro-intestinal disease prevalence index was 0.27 in 2007. Nokeng tsa Taemane Local Municipality had the highest gastro-intestinal disease prevalence of 14.14% as well as the highest estimated gastro-intestinal disease prevalence index of 0.73 in 2007. In 2008 the prevalence of gastro-intestinal disease in the Metsweding District was 12.61% and the estimated gastro-intestinal disease prevalence index was 0.50. Nokeng tsa Taemane Local Municipality had the highest gastro-intestinal disease prevalence index of 14.78% as well as the highest estimated gastro-intestinal disease prevalence index of 0.92 in 2008.

The Sedibeng District had a gastro-intestinal disease prevalence of 21.38% and an estimated gastro-intestinal disease prevalence index of 1.30 in 2007. Lesedi Local Municipality in Sedibeng had the highest gastro-intestinal disease prevalence of 26.73% and an estimated gastro-intestinal disease prevalence index of 1.56 in 2007. In 2008 Sedibeng had a gastro-intestinal disease prevalence of 21.09% and an estimated gastro-intestinal disease prevalence index of 1.52. Lesedi Local Municipality had the highest gastro-intestinal disease prevalence (25.83%) as well as the highest estimated gastro-intestinal disease prevalence index of 1.67 in 2008.

In 2007 the West Rand District Municipality presented with a gastro-intestinal disease prevalence of 19.27% and an estimated gastro-intestinal disease prevalence index of 0.97. Randfontein Local Municipality had the highest gastro-intestinal disease prevalence in 2007, with 23.29%, while Westonaria Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 1.71. In 2008 the West Rand District Municipality had a gastro-intestinal disease prevalence of 18.81% an estimated gastro-intestinal disease prevalence

index of 1.19. Randfontein Local Municipality Had the highest gastro-intestinal disease prevalence of 22.53% a decrease from 2007, while Westonaria Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 2.10, an increase from 2007.

4.2.3.4 Kwa-Zulu Natal

In 2007 Kwa-Zulu Natal had a gastro-intestinal disease prevalence of 17.43% and an estimated gastro-intestinal disease prevalence index of 1.15. In 2008 the prevalence of gastro-intestinal disease decreased to 16.47%, while the estimated gastro-intestinal disease prevalence index increased to 1.29.

Amajuba district was found to have a gastro-intestinal disease prevalence index of 21.94% and an estimated gastro-intestinal disease prevalence index of 1.71 in 2007. In that district Newcastle Local Municipality had the highest gastro-intestinal disease prevalence index of 22.74%as well as the highest estimated gastro-intestinal disease prevalence index of 1.57 in 2007. In 2008 Amajuba had a gastro-intestinal disease prevalence of 22.58% and an estimated gastro-intestinal disease prevalence index of 2.05, an increase from 2007. In the Amajuba District, Newcastle Local Municipality had the highest gastro-intestinal disease prevalence index of 23.53% and an estimated gastro-intestinal disease prevalence index of 1.93 in 2008.

In 2007 the Sisonke District obtained a gastro-intestinal disease prevalence of 19.16% and an estimated gastro-intestinal disease prevalence index of 2.01. Ubuhlebezwe Local Municipality had the highest gastro-intestinal disease prevalence (26.58%) as well as estimated gastro-intestinal disease prevalence index (2.41) in that district for 2007. In 2008 the Sisonke District had a gastro-intestinal disease prevalence of 14.56% and an estimated gastro-intestinal disease prevalence index of 1.79. Ubuhlebezwe Local Municipality had the highest gastro-intestinal disease prevalence of 21.29% as well as estimated gastro-intestinal disease prevalence index of 2.51 for that district in 2008.

UMgungunglovu District presented with a gastro-intestinal disease prevalence of 19.90% and an estimated gastro-intestinal disease prevalence index of 1.80 in 2007. Mkhambathini Local Municipality had the highest gastro-intestinal disease prevalence of 22.06%, while Richmond Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 3.20 in 2007. In 2008 Umgungunglovu had a gastro-intestinal disease prevalence index of 18.04% and an estimated gastro-intestinal disease prevalence index of 1.81. The Musunduzi Local Municipality had the highest gastro-intestinal disease prevalence of

19.93%, while Richmond Local Municipality had the highest gastro-intestinal disease prevalence index of 3.58 in 2008.

Ugu District had a gastro-intestinal disease prevalence of 14.34% and estimated gastro-intestinal disease prevalence index of 0.77 in 2007. In that district uMuziwabantu Local Municipality had the highest gastro-intestinal disease prevalence of 15.32%, while Ezingoleni Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 3.44 in 2007. In 2008 Ugu had a gastro-intestinal disease prevalence index of 14.28% and an estimated gastro-intestinal disease prevalence index of 0.83. Hibiscus Coast Local Municipality had the highest gastro-intestinal disease prevalence of 15.22%, while Ezingoleni Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 28.41 in 2008.

Umkhanyakude District has shown to have a gastro-intestinal disease prevalence of 18.18% and an estimated gastro-intestinal disease prevalence index of 1.84 in 2007. In 2007 Hlabisa Local Municipality had the highest gastro-intestinal disease prevalence of 23.68%, while Jozini Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 2.28. In 2008 Umkhanyakude District had a gastro-intestinal disease prevalence of 14.90% and an estimated gastro-intestinal disease prevalence index of 1.84. The municipality with the highest gastro-intestinal disease prevalence in that district in 2008 was The Big 5 False Bay Local Municipality with 16.03%, while Jozini Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 1.89.

In 2007 the Umzinyathi District presented with a gastro-intestinal disease prevalence of 23.15% and an estimated gastro-intestinal disease prevalence index of 1.71. In that district Endumeni Local Municipality had the highest gastro-intestinal disease prevalence of 29.23% While Msinga Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 30.43. In 2008 Umzinyathi district had a gastro-intestinal disease prevalence of 23.47% and an estimated gastro-intestinal disease prevalence index of 2.18. Endumeni Local Municipality had the highest gastro-intestinal disease prevalence of 29.07%, while Msinga Local Municipality had an estimated gastro-intestinal disease prevalence index of 12.17 in 2008.

Uthukela District had a gastro-intestinal disease prevalence of 20.89% and an estimated gastro-intestinal disease prevalence index of 2.81 in 2007. Emnambithi/Ladysmith Local Municipality had a gastro-intestinal disease prevalence of 21.78%, while Okhahlamba Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 4.90 for

that district in 2007. In 2008 Uthukela had a gastro-intestinal disease prevalence of 19.64% and an estimated gastro-intestinal disease prevalence index of 3.02. Emnambithi/Ladysmith Local Municipality had the highest gastro-intestinal disease prevalence index of 21.77%, while Okhahlamba Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 4.41 in 2008.

In 2007 Uthungulu represented a gastro-intestinal disease prevalence of 21.16% and an estimated gastro-intestinal disease prevalence index of 1.24. Nkandla Local Municipality had the highest gastro-intestinal disease prevalence of 30.38% as well as the highest estimated gastro-intestinal disease prevalence index of 2.20 for that district. In 2008 Uthungulu had a gastro-intestinal disease prevalence of 19.07% and an estimated gastro-intestinal disease prevalence index of 1.42. In that district in 2008 uMlalazi Local Municipality had the highest gastro-intestinal disease prevalence of 23.15%, while Nkandla Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 2.15.

In 2007 Zululand has shown to have a gastro-intestinal disease prevalence of 25.53% and an estimated gastro-intestinal disease prevalence index of 2.23. Ulundi Local Municipality had the highest gastro-intestinal disease prevalence of 33.72% as well as the highest estimated gastro-intestinal disease prevalence index of 5.45. In 2008 Zululand had a gastro-intestinal disease prevalence of 26.03% and an estimated gastro-intestinal disease prevalence index of 2.88. Ulundi Local Municipality had the highest gastro-intestinal disease prevalence of 31.82% and an estimated gastro-intestinal disease prevalence index of 6.59 for 2008.

In 2007 the gastro-intestinal disease prevalence for the iLembe district was 14.57% and the estimated gastro-intestinal disease prevalence was 1.22. Mandeni Local Municipality had the highest gastro-intestinal disease prevalence of 19.69% and an estimated gastro-intestinal disease prevalence of 1.63. In 2008 iLembe District had a gastro-intestinal disease prevalence of 13.31% and an estimated gastro-intestinal disease prevalence of 1.41. The municipality with the highest gastro-intestinal disease prevalence and estimated gastro-intestinal disease prevalence index in this district for 2008 was Mandeni Local Municipality with 18.05% and 1.95 respectively.

4.2.3.5 Limpopo

In 2007 Limpopo had a gastro-intestinal disease prevalence of 16.17% and an estimated gastro-intestinal disease prevalence index of 0.77. In 2008 the gastro-intestinal disease

prevalence was 15.38% and an estimated gastro-intestinal disease prevalence index was 0.96.

Capricorn District has shown a gastro-intestinal disease prevalence of 16.92% and an estimated gastro-intestinal disease prevalence index of 0.79 in 2007. Polokwane Local Municipality had the highest gastro-intestinal disease prevalence of 18.13%, while Blouberg Local Municipality had the highest gastro-intestinal disease prevalence index of 1.91 for 2007. In 2008 Capricorn District had a gastro-intestinal disease prevalence of 16.73% and an estimated gastro-intestinal disease prevalence index of 1.05. In 2008 Polokwane Local Municipality had the highest gastro-intestinal disease prevalence of 17.89, while Blouberg Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 4.60.

In 2007 the gastro-intestinal disease prevalence and estimated gastro-intestinal disease prevalence index were 16.12% and 0.90 respectively in the Greater Sekhukhune District. Elias Motsoaledi Local Municipality had the highest gastro-intestinal disease prevalence of 18.03%, while Makhuduthamaga Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 2.78 in 2007. In 2008 the Greater Sekhukhune District had a gastro-intestinal disease prevalence of 13.95% and an estimated gastro-intestinal disease prevalence index of 1.02. The Greater Marble Hall Local Municipality had the highest gastro-intestinal disease prevalence of 18.26%, while Mukhuduthamaga Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 2.63 in 2008.

Mopani District was found to have a gastro-intestinal disease prevalence of 15.86% and an estimated gastro-intestinal disease prevalence index of 0.59 in 2007. In this district the Greater Letaba Local Municipality had the highest gastro-intestinal disease prevalence of 19.97% as well as the highest estimated gastro-intestinal disease prevalence index of 2.10. In 2008 Mopani had a gastro-intestinal disease prevalence of 14.52% and an estimated gastro-intestinal disease prevalence index of 0.68. The Greater Letaba Local Municipality had the highest gastro-intestinal disease prevalence of 16.81% and estimated gastro-intestinal disease prevalence index of 2.30 in 2008.

Vhembe District represented a gastro-intestinal disease prevalence of 13.76% and an estimated gastro-intestinal disease prevalence index of 0.77 in 2007. In this district Musina Local Municipality had the highest gastro-intestinal disease prevalence as well as estimated gastro-intestinal disease prevalence index of 20.68% and 1.92 respectively in 2007. In 2008

Vhembe District had a gastro-intestinal disease prevalence of 13.22% and an estimated gastro-intestinal disease prevalence index of 0.97. Musina Local Municipality had the highest gastro-intestinal disease prevalence of 22.05% as well as the highest gastro-intestinal disease prevalence index of 3.22 in 2008.

In the Waterberg District the gastro-intestinal disease prevalence and estimated gastro-intestinal disease prevalence index were 17.89% and 0.80 respectively for 2007. In that district Mookgopong Local Municipality had the highest gastro-intestinal disease prevalence of 26.00%, while Mogalakwena Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 1.36 in 2007. In 2008 Waterberg district had a gastro-intestinal disease prevalence of 17.78% and an estimated gastro-intestinal disease prevalence index of 1.03. Mookgopong local Municipality had the highest gastro-intestinal disease prevalence of 22.81%, while Mogalakwena Local Municipality had the highest gastro-intestinal disease prevalence index of 2.07 in 2008.

4.2.3.6 Mpumalanga

In 2007 Mpumalanga had a gastro-intestinal disease prevalence of 17.86% and an estimated gastro-intestinal disease prevalence index of 0.98. In 2008 the gastro-intestinal disease prevalence decreased to 17.14%, while the estimated gastro-intestinal disease prevalence index increased to 1.18.

In 2007 Ehlanzeni District has shown a gastro-intestinal disease prevalence of 16.24% and an estimated gastro-intestinal disease prevalence index of 0.86. Thaba Chweu Local Municipality had the highest gastro-intestinal disease prevalence in the Ehlanzeni District in 2007 with 23.29%, while Nkomazi Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 1.12. In 2008 Ehlanzeni District had a gastro-intestinal disease prevalence of 15.33% and an estimated gastro-intestinal disease prevalence index of 1.06. Thaba Chweu Local Municipality had the highest gastro-intestinal disease prevalence of 20.67%, while Nkomazi local Municipality had the highest gastro-intestinal disease prevalence index of 1.32 in 2008.

Gert Sibande District presented with a gastro-intestinal disease prevalence of 17.78% and an estimated gastro-intestinal disease prevalence index of 0.80 in 2007. Albert Luthuli Local Municipality had the highest gastro-intestinal disease prevalence in the Gert Sibande District with 30.07%, while Lekwa Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 1.98 in 2007. In 2008 Gert Sibande District had a gastro-

intestinal disease prevalence of 16.85% and an estimated gastro-intestinal disease prevalence index of 0.91. Albert Luthuli Local Municipality had the highest gastro-intestinal disease prevalence of 30.27%, while Lekwa Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 2.27 in 2008.

Nkangala district was found to have a gastro-intestinal disease prevalence of 20.15% and an estimated gastro-intestinal disease prevalence index of 1.41 in 2007. Emalahleni Local Municipality had the highest gastro-intestinal disease prevalence of 23.24%, while Thembisile Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 1.51 in 2007. In 2008 Nkangala District had a gastro-intestinal disease prevalence of 19.81% and an estimated gastro-intestinal disease prevalence index of 1.69. Emakhazeni Local Municipality had the highest gastro-intestinal disease prevalence as well as the highest estimated gastro-intestinal disease prevalence index of 22.16% and 1.91 respectavely for 2008.

4.2.3.7 Northern Cape

In 2007 the Northern Cape had a gastro-intestinal disease prevalence of 19.79% and an estimated gastro-intestinal disease prevalence index of 1.63. In 2008 the prevalence of gastro-intestinal disease among patients decreased to 16.97% and the estimated gastro-intestinal disease prevalence index decreased to 1.59.

Frances Baard District presented with a gastro-intestinal disease prevalence of 19.48% and an estimated gastro-intestinal disease prevalence index of 1.25 in 2007. In this district the Magareng Local Municipality had the highest gastro-intestinal disease prevalence of 22.50%, while Dikgatlong Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 2.52 in 2007. In 2008 Frances Baard District had a gastro-intestinal disease prevalence if 18.62% and an estimated gastro-intestinal disease prevalence index of 1.48. Magareng Local Municipality had the highest gastro-intestinal disease prevalence of 19.57%, while Sol Plaatjie Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 2.28 in 2008.

In 2007 the Kgalagadi District had a gastro-intestinal disease prevalence of 21.93% and an estimated gastro-intestinal disease prevalence index of 1.56. Ga-Segonyana Local Municipality had the highest gastro-intestinal disease prevalence of 22.80% as well as the highest estimated gastro-intestinal disease prevalence index of 1.13 in this district for 2007. In 2008 Kgalagadi District had a gastro-intestinal disease prevalence of 12.93% and an

estimated gastro-intestinal disease prevalence index of 0.80, a decrease from 2007. The Ga-Segonyana Local Municipality had the highest gastro-intestinal disease prevalence as well as the highest estimated gastro-intestinal disease prevalence index of 13.40% and 0.61 respectively. The decrease in the estimated gastro-intestinal disease prevalence index from a value above one in 2007 to a value below one in 2008 indicates that the prevalence of gastro-intestinal medication claims was relatively small in comparison to the total medicine claims prevalence of the higher income population that may utilise a medical scheme.

Namakwa District has shown to have a gastro-intestinal disease prevalence of 12.78% and an estimated gastro-intestinal disease prevalence index of 1.98 in 2007. Kamiesberg Local Municipality had the highest gastro-intestinal disease prevalence as well as the highest estimated gastro-intestinal disease prevalence index of 25.00% and 138.89 respectively. It should, however, be noted that the total dataset of this municipality contained only four patients. In 2008 Namakwa District had a gastro-intestinal disease prevalence of 14.22% and an estimated gastro-intestinal disease prevalence index of 3.67. Kamiesberg Local Municipality had only one patient in the total dataset, therefore the municipality with the highest gastro-intestinal disease prevalence in 2008 in this district was the Hantam Local Municipality with 15.56%, while the Karoo Hoogland Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 6.07 in 2008.

Pixley ka Seme District presented with a gastro-intestinal disease prevalence of 19.03% and an estimated gastro-intestinal disease prevalence index of 0.04 in 2007. Siyathemba Local Municipality had the highest gastro-intestinal disease prevalence of 24.35%, while Emthanjeni Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 7.05 in 2007. In 2008 Pixley ka Seme District had a gastro-intestinal disease prevalence of 18.82% and an estimated gastro-intestinal disease prevalence index of 0.05. Siyancuma Local Municipality had the highest gastro-intestinal disease prevalence of 24.66%, while Emthanjeni Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 8.50 for this district in 2008.

In 2007 Siyanda district has shown to have a gastro-intestinal disease prevalence of 23.59% and an estimated gastro-intestinal disease prevalence index of 2.75. Tsantsabane Local Municipality had the highest gastro-intestinal disease prevalence of 28.36%, while Kgatelopele Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 7.24 in 2007. In 2008 the Siyanda District had a gastro-intestinal disease prevalence of 16.01% and an estimated gastro-intestinal disease prevalence index of 1.67. //Khara Hais Local Municipality had the highest gastro-intestinal disease prevalence

of 21.58%, while Kgatelopele Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 3.17 in 2008.

4.2.3.8 North West

In 2007 the gastro-intestinal disease prevalence and estimated gastro-intestinal disease prevalence index for North West were 18.32% and 0.71 respectively. In 2008 North West had a gastro-intestinal disease prevalence of 17.72% and an estimated gastro-intestinal disease prevalence index of 0.87.

In 2007 in Bojanala the gastro-intestinal disease prevalence was 19.92% and the estimated gastro-intestinal disease prevalence index was 0.82. Rustenburg Local Municipality had the highest gastro-intestinal disease prevalence of 23.02%, while Moses Kotane Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 1.19 in 2007. In 2008 the Bojanala District had a gastro-intestinal disease prevalence 18.82%, while the gastro-intestinal disease prevalence index was 0.91. Rustenburg Local Municipality had the highest gastro-intestinal prevalence of 20.10%, while Moses Kotane Local Municipality had the highest gastro-intestinal disease prevalence index of 1.66 in 2008.

In 2007 Bophirima District presented with a gastro-intestinal disease prevalence of 13.83% and an estimated gastro-intestinal disease prevalence index of 0.84. Lekwa-Teemane Local Municipality had the highest gastro-intestinal disease prevalence of 24.20% as well as the highest estimated gastro-intestinal disease prevalence index of 1.27 in the Bophirima District in 2007. In 2008 the Bophirima District had a gastro-intestinal disease prevalence of 12.44% and an estimated gastro-intestinal disease prevalence index of 1.02. Lekwa-Teemane Local Municipality had the highest gastro-intestinal disease prevalence of 20.76% as well as the highest estimated gastro-intestinal disease prevalence index of 1.68 in 2008.

In 2007 Dr. Kennith Kaunda District Municipality has shown to have a gastro-intestinal disease prevalence of 20.15% and an estimated gastro-intestinal disease prevalence index of 0.85. In this district, Maquassi Hills Local Municipality had the highest gastro-intestinal disease prevalence of 25.02% as well as the highest estimated gastro-intestinal disease prevalence index of 1.28 in 2007. In 2008 Dr. Kennith Kaunda District Municipality had a gastro-intestinal disease prevalence of 20.63% and an estimated gastro-intestinal disease prevalence index of 1.11. In this district in 2008, the City of Tlokwe had the highest gastro-intestinal disease prevalence of 23.62%, while the City of Matlosana had the highest estimated gastro-intestinal disease prevalence index of 1.23.

Ngaka Modiri Molema District Municipality was found to have a gastro-intestinal disease prevalence of 15.49%, while the estimated gastro-intestinal disease prevalence index was 0.45. The municipality with the highest gastro-intestinal disease prevalence and estimated gastro-intestinal disease prevalence index in 2007 in this district was Ditsobotla Local Municipality with 16.18% and 0.74 respectively. In 2008 the Ngaka Modiri Molema District Municipality had a gastro-intestinal disease prevalence of 14.30% and an estimated gastro-intestinal disease prevalence index of 0.55. Ditsobotla Local Municipality had the highest gastro-intestinal disease prevalence of 16.72%, as well as the highest gastro-intestinal disease prevalence index of 1.07 in 2008.

4.2.3.9 Western Cape

In 2007 the Western Cape had a gastro-intestinal disease prevalence of 12.54% and an estimated gastro-intestinal disease prevalence index of 0.82. In 2008 the Western Cape had a gastro-intestinal disease prevalence of 12.10% and an estimated gastro-intestinal disease prevalence index of 0.93.

The Cape Winelands District presented with a gastro-intestinal disease prevalence of 14.81% and an estimated gastro-intestinal disease prevalence index of 1.40 in 2007. The Breede River / Winelands local Municipality had the highest gastro-intestinal disease prevalence of 18.09%, while Witzenberg Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 2.90 in this district in 2007. In 2008 the Cape Winelands District had a gastro-intestinal disease prevalence of 14.62% and an estimated gastro-intestinal disease prevalence index of 1.64. Witzenberg local Municipality had the highest gastro-intestinal disease prevalence of 25.09% as well as the highest estimated gastro-intestinal disease prevalence index of 5.64 in 2008.

In 2007 Central Karoo district was found to have a gastro-intestinal disease prevalence of 19.83% and an estimated gastro-intestinal disease prevalence of 2.46. Beaufort West Local Municipality had the highest gastro-intestinal disease prevalence of 22.58% as well as the highest estimated gastro-intestinal disease prevalence index of 3.13 for this district in 2007. In 2008 the Central Karoo District had a gastro-intestinal disease prevalence of 18.94% and an estimated gastro-intestinal disease prevalence index of 2.95. Laingsburg Local Municipality had the highest gastro-intestinal disease prevalence of 25.00% as well as the highest estimated gastro-intestinal disease prevalence index of 4.90 in 2008.

Eden District presented with a gastro-intestinal disease prevalence of 16.56% and an estimated gastro-intestinal disease prevalence index of 0.82 in 2007. In this district, Oudshoorn Local Municipality had the highest gastro-intestinal disease prevalence of 21.62% as well as the highest estimated gastro-intestinal disease prevalence index of 2.32 in 2007. In 2008 Eden District had a gastro-intestinal disease prevalence of 16.03% and an estimated gastro-intestinal disease prevalence index of 0.91. Oudshoorn Local Municipality had the highest gastro-intestinal disease prevalence of 20.48% as well as the highest estimated gastro-intestinal disease prevalence index of 2.49 in 2008.

In 2007 Overberg District was found to have a gastro-intestinal disease prevalence of 15.12% and an estimated gastro-intestinal disease prevalence index of 0.98. In this district, the Theewaterskloof Local Municipality had the highest gastro-intestinal disease prevalence of 19.39%, while Swellendam Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 2.07 in 2007. In 2008 Overberg District had a gastro-intestinal disease prevalence of 15.00% and an estimated gastro-intestinal disease prevalence index of 1.16. Theewaterskloof Local Municipality had the highest gastro-intestinal disease prevalence of 19.33%, while Swellendam Local Municipality had the highest estimated gastro-intestinal disease prevalence index of 2.62 in 2008.

The West Coast District had a gastro-intestinal disease prevalence of 17.10% and an estimated gastro-intestinal disease prevalence index of 2.17 in 2007. Swartland Local Municipality had the highest gastro-intestinal disease prevalence as well as the highest estimated gastro-intestinal disease prevalence index of 21.08% and 2.98 respectively for 2007. In 2008 the West Coast District had a gastro-intestinal disease prevalence of 15.90% and an estimated gastro-intestinal disease prevalence index of 2.31. In this district in 2008, Bergrivier Local Municipality had the highest gastro-intestinal disease prevalence of 21.26%, as well as the highest estimated gastro-intestinal disease prevalence index of 3.10.

4.2.3.10 The twenty municipalities with the highest gastro-intestinal disease prevalence in 2007 and 2008

In order to identify areas where possible water quality and sanitation problems might exist, the top twenty municipalities in which the prevalence of gastro-intestinal disease was the highest during 2007 and 2008 were identified and presented in Table 4.9.

Table 4.9: The twenty municipalities with the highest gastro-intestinal disease prevalence in 2007 and 2008

2007			2008		
District	**Province**	**Prevalence $_{GI}$ %**	**District**	**Province**	**Prevalence$_{GI}$ %**
Ulundi Local Municipality	Kwa-Zulu Natal	33.72	Ulundi Local Municipality	Kwa-Zulu Natal	31.82
Nkandla Local Municipality	Kwa-Zulu Natal	30.38	Nongoma Local Municipality	Kwa-Zulu Natal	30.81
Albert Luthuli Local Municipality	Mpumalanga	30.07	Albert Luthuli Local Municipality	Mpumalanga	30.27
Endumeni Local Municipality	Kwa-Zulu Natal	29.23	Endumeni Local Municipality	Kwa-Zulu Natal	29.07
Tsantsabane Local Municipality	Northern Cape	28.36	Sundays River Valley Local Municipality	Eastern Cape	28.71
Inxuba Yethemba Local Municipality	Eastern Cape	27.73	Inxuba Yethemba Local Municipality	Eastern Cape	28.52
Lesedi Local Municipality	Gauteng	26.73	Abaqulusi Local Municipality	Kwa-Zulu Natal	26.64
Nongoma Local Municipality	Kwa-Zulu Natal	26.67	Lesedi Local Municipality	Gauteng	25.83
Ubuhlebezwe Local Municipality	Kwa-Zulu Natal	26.58	Witzenberg Local Municipality	Western Cape	25.09
Mookgopong Local Municipality	Limpopo	26.00	Laingsburg Local Municipality	Western Cape	25.00
Mnquma Local Municipality	Eastern Cape	25.55	Siyancuma Local Municipality	Northern Cape	24.66
Emalahleni Local Municipality	Eastern Cape	25.20	Mnquma Local Municipality	Eastern Cape	24.21
uMlalazi local Municipality	Kwa-Zulu Natal	25.20	City of Tlokwe	North West	23.62

Table 4.9 (continued): The twenty municipalities with the highest gastro-intestinal disease prevalence in 2007 and 2008

2007			2008		
District	**Province**	**Prevalence $_{GI}$ %**	**District**	**Province**	**Prevalence$_{GI}$ %**
Maquassi Hills Local Municipality	North West	25.02	Newcastle Local Municipality	Kwa-Zulu Natal	23.53
Kamiesberg Local Municipality	Northern Cape	25.00	Maquassi Hills Local Municipality	North West	23.18
Masilonyana Local Municipality	Free State	24.69	uMlalazi Local Municipality	Kwa-Zulu Natal	23.15
Abaqulusi Local Municipality	Kwa-Zulu Natal	24.64	Masilonyana Local Municipality	Free State	22.92
Engcobo Local Municipality	Eastern Cape	24.44	Lukanji Local Municipality	Eastern Cape	22.89
Siyathemba Local Municipality	Northern Cape	24.35	Mookgopong Local Municipality	Limpopo	22.81
Lekwa-Teemane Local Municipality	North West	24.20	Randfontein Local Municipality	Gauteng	22.53

As indicated in Figure 4.10, it can be seen that in 2007, 35% of the municipalities listed in Table 4.9 identifying the top 20 municipalities with the highest gastro-intestinal disease prevalence in South Africa, consisted out of municipalities located in Kwa-Zulu Natal, 20% were located in the Eastern Cape and 15% in the Northern Cape. In 2008 (Figure 4.11) 30% of the top 20 municipalities with the highest gastro-intestinal disease prevalence in South Africa (Table 4.9) were located in Kwa-Zulu Natal, 20% in the Eastern Cape and 10% in both Gauteng and the Western Cape.

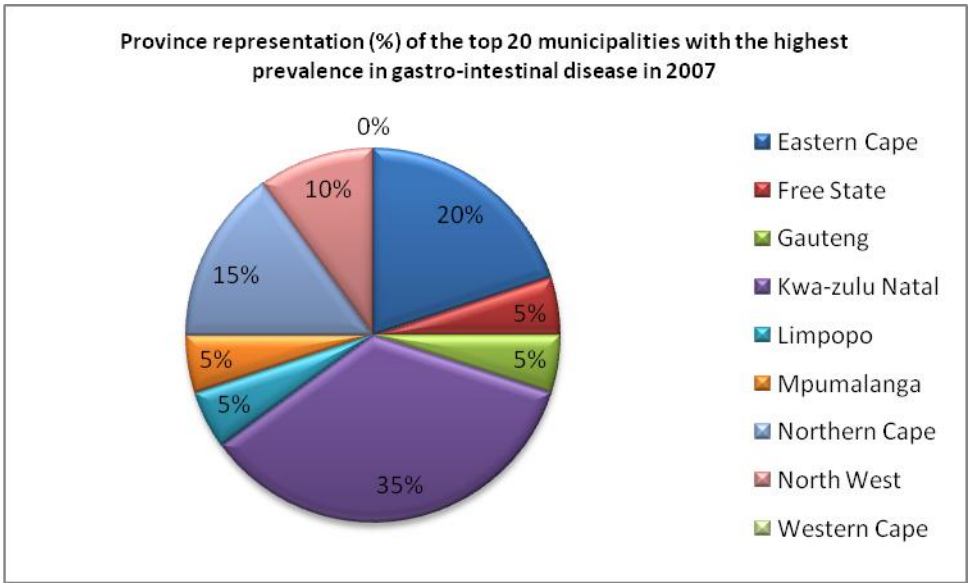

Figure 4.10: Province representation (%) of the top 20 municipalities with the highest prevalence in gastro-intestinal disease in 2007

In Figure 4.11 the province representation of the top twenty municipalities with the highest prevalence in gastro-intestinal disease in 2008 were visually represented.

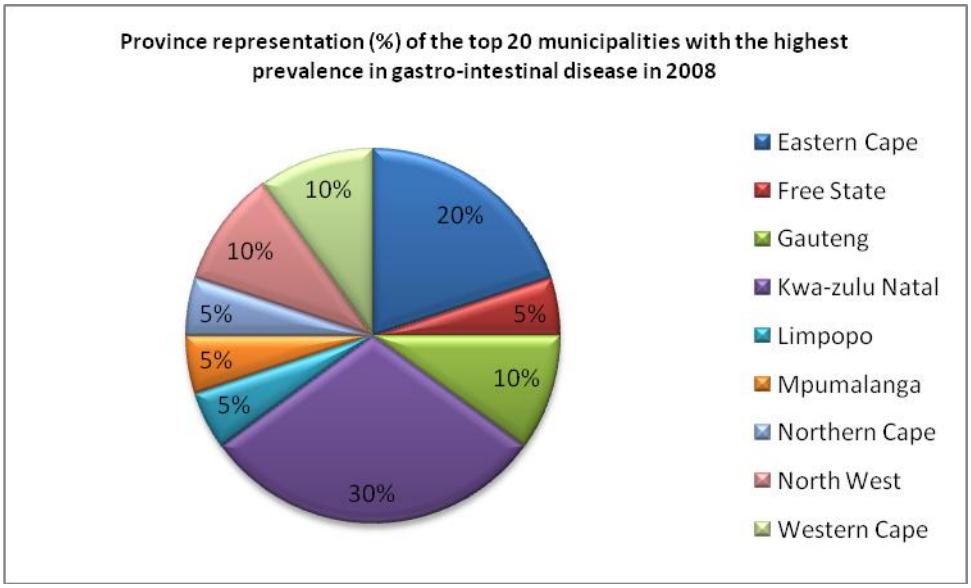

Figure 4.11: Province representation (%) of the top 20 municipalities with the highest prevalence in gastro-intestinal disease in 2008

In order to determine which municipalities may have problems regarding the prevalence of gasto-intestinal disease in a particular municipality by taking into account that the population covered by a medical scheme may be in the higher income population, the top 20

municipalities with the highest estimated gastro-intestinal disease prevalence indices for 2007 and 2008 were tabulated in Table 4.10. An estimated gastro-intestinal disease prevalence index of larger than one, indicates that the prevalence of gastro-intestinal medication claims is relatively large in comparison with the total medicine claims prevalence of the higher income population that may utilise a medical scheme.

Table 4.10: The twenty municipalities with the highest estimated gastro-intestinal disease prevalence indices in 2007 and 2008

2007			2008		
District	**Province**	**Estimated gastro-intestinal disease prevalence index**	**District**	**Province**	**Estimated gastro-intestinal disease prevalence index**
Kamiesberg Local Municipality	Northern Cape	138.89	Mbizana Local Municipality	Eastern Cape	106.67
Msinga Local Municipality	Kwa-Zulu Natal	30.43	Ezingoleni Local Municipality	Kwa-Zulu Natal	28.41
Mbizana Local Municipality	Eastern Cape	23.29	Port St Johns Local Municipality	Eastern Cape	16.20
Mhlontlo Local Municipality	Eastern Cape	14.67	Mhlontlo Local Municipality	Eastern Cape	15.16
Port St Johns Local Municipality	Eastern cape	9.16	Msinga Local Municipality	Kwa-Zulu Natal	12.17
Quakeni Local Municipality	Eastern Cape	8.36	Quakeni Local Municipality	Eastern Cape	11.41
Kgatelopele Local Municipality	Northern Cape	7.24	Emnambithi/Ladysmith Local Municipality	Kwa-Zulu Natal	10.94
Emalahleni Local Municipality	Eastern Cape	7.06	Great Kei Local Municipality	Eastern Cape	9.26

Table 4.10 (continued): The twenty municipalities with the highest estimated gastro-intestinal disease prevalence indices in 2007 and 2008

2007			2008		
District	**Province**	**Estimated gastro-intestinal disease prevalence index**	**District**	**Province**	**Estimated gastro-intestinal disease prevalence index**
Emthanjeni Local Municipality	Northern Cape	7.05	Emthanjeni Local Municipality	Northern Cape	8.50
Ulundi Local Municipality	Kwa-Zulu Natal	5.45	Mbhashe Local Municipality	Eastern Cape	8.46
Sakhisizwe Local Municipality	Eastern Cape	5.13	Ntabankulu Local Municipality	Eastern Cape	7.90
Tsolwana Local Municipality	Eastern Cape	5.01	Tsolwana Local Municipality	Eastern Cape	7.72
Great Kei Local Municipality	Eastern Cape	4.90	Ubuntu Local Municipality	Northern Cape	6.65
Okhahlamba Local Municipality	Kwa-Zulu Natal	4.90	Ulundi Local Municipality	Kwa-Zulu Natal	6.59
Mbhashe Local Municipality	Eastern Cape	4.73	Emalahleni Local Municipality	Eastern Cape	6.46
Ubuntu Local Municipality	Northern Cape	4.67	Karoo Hoogland Local Municipality	Northern Cape	6.07
Amahlathi Local Municipality	Eastern Cape	4.41	Hantam Local Municipality	Northern Cape	5.64
Matatiele Local Municipality	Eastern Cape	4.23	Witzenberg Local Municipality	Western Cape	5.64
Ntabankulu Local Municipality	Eastern Cape	3.91	Sakhisizwe Local Municipality	Eastern Cape	5.04
Mnquma Local Municipality	Eastern Cape	3.63	Amalathi Local Municipality	Eastern Cape	4.97

As indicated in Figure 4.12 representing the province representation of the top 20 municipalities with the highest estimated gastro-intestinal disease prevalence indices in 2007, 65% of the top 20 municipalities were located in the Eastern Cape, 20% in the Northern Cape and 15% in Kwa-Zulu Natal. In 2008 (Figure 4.13) 55% of the top 20 municipalities with the highest estimated gastro-intestinal disease prevalence indexes, were located in the Eastern Cape and 20% in Kwa-Zulu Natal and the Northern Cape.

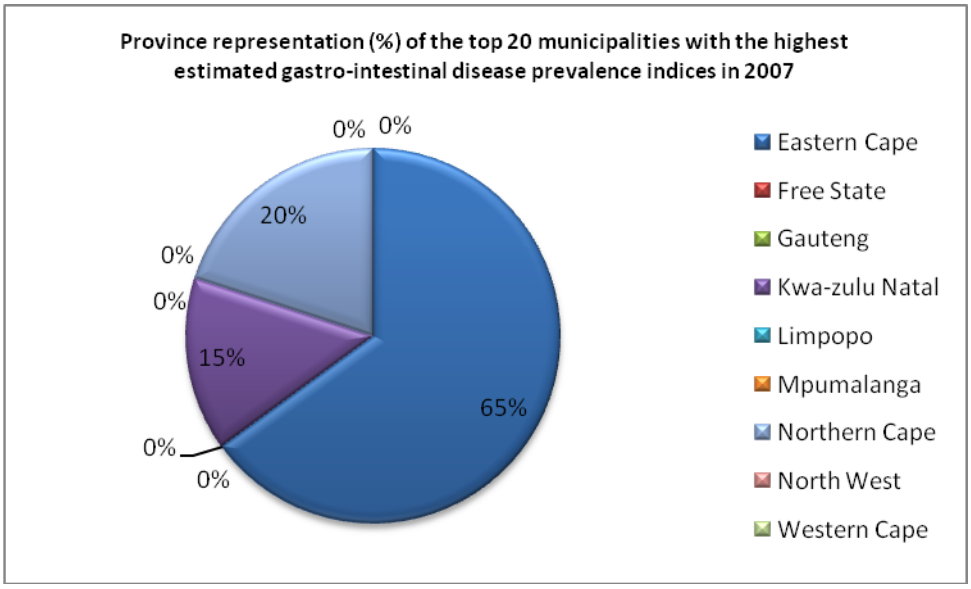

Figure 4.12: Province representation (%) of the top 20 municipalities with the highest estimated gastro-intestinal disease prevalence indices in 2007

In Figure 4.13 the province representation of the top twenty municipalities with the highest estimated gastro-intestinal disease prevalence indexes in 2008 were visually represented. Note that the Free State, Limpopo, Mpumalanga, North West and Western Cape had no municipalities in the top twenty.

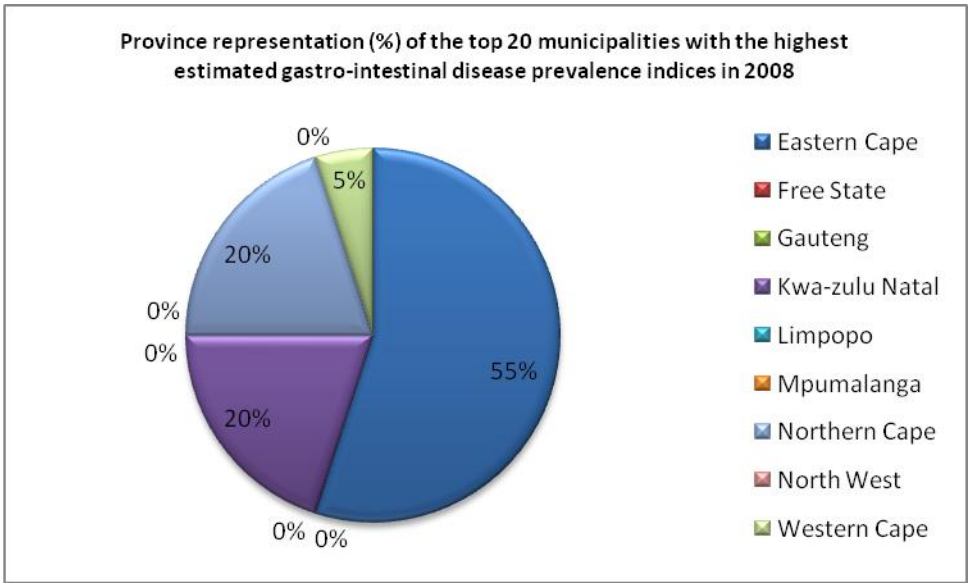

Figure 4.13: Province representation (%) of the top 20 municipalities with the highest estimated gastro-intestinal disease prevalence indices in 2008

In Tables 4.11 and 4.12 as well as Figures 4.14 and 4.15, the top twenty municipalities with the highest gastro-intestinal disease prevalence as well as their corresponding Blue Drop (2010) and Green Drop Scores (2009) were indicated. It can be concluded that the prevalence of gastro-intestinal disease cannot absolutely be attributed to the drinking water quality or the waste water management in each municipality, but that either one or both may lead to a high prevalence of gastro-intestinal disease. In 2007 Ulundi Local Municipality had the highest prevalence of gastro-intestinal disease with 33.72%. This high gastro-intestinal disease prevalence may have been caused by other socio-economic factors as the Blue Drop Score of 85.00% can be considered as very good dinking water management (DWA, 2010:10) and although the Green Drop Score of 45% was not satisfacory (DWA, 2009:58), it cannot be concluded that poor waste water management was the most important cause of a high gastro-intestinal disease prevalence. Albert Luthuli Local Municipality, with had the third highest gastro-intestinal disease prevalence in 2007 (30.07%), the high gastro-intestinal disease prevalence may have been caused by poor drinking water quality (Blue Drop Score of 8.20%) and poor waste water management (Green Drop Score of 0.00%).

Table 4.11: The top twenty municipalities with the highest gastro-intestinal disease prevalence in South Africa in 2007 compared with corresponding Blue Drop (DWA, 2010) and Green Drop Scores (DWA, 2009)

Municipality	$Prevalence_{GI}$ %	Blue Drop Score (DWA, 2010) (%)	Green Drop Score (DWA, 2009) (%)
Ulundi Local Municipality	33.72	85.00	45.00
Nkandla Local Municipality	30.38	41.56	53.00
Albert Luthuli Local Municipality	30.07	8.20	0.00
Endumeni Local Municipality (Umzinyathi District)*	29.23	66.00	48.00
Tsantsabane Local Municipality	28.36	74.70	13.00
Inxuba Yethemba Local Municipality (Cradock & Middelburg)*	27.73	36.13	0.00
Lesedi Local Municipality	26.73	58.80	55.00
Nongoma Local Municipality	26.67	91.00	42.00
Ubuhlebezwe Local Municipality (Sisonke)*	26.58	53.60	34.00
Mookgopong Local Municipality	26.00	44.90	0.00
Mnquma Local Municipality (Amathole District Municipality)*	25.55	68.20	0.00
Emalahleni Local Municipality	25.20	29.70	18.00
uMlalazi Local Municipality (Systems mean)*	25.20	42.75	92.00
Maquassi Hills Local Municipality	25.02	64.90	0.00
Kamiesberg Local Municipality	25.00	29.30	87.00
Masilonyana Local Municipality	24.69	6.20	0.00
Abaqulusi Local Municipality (Zululand)*	24.64	59.80	44.00
Engobo Local Municipality (Chris Hani District Municipality)*	24.44	53.10	10.00
Siyathemba Local Municipality	24.35	52.80	67.00
Lekwa-Teemane Local Municipality (Bloemhof & Christiana)*	24.20	Not assessed	2.00

*Note that in cases where a name of a district, town or system is included, the municipality is not mentioned or indicated as a single system in the Blue Drop Report (DWA, 2010) or the Green Drop Report (DWA, 2009).

$Prevalence_{GI}$ %: Number of patients in the gastro-intestinal disease dataset (Dataset A), divided by the number of patients in the total dataset, multiplied by 100

Mean: The sum of the percentages (Blue Drop Score or Green Drop Score where applicable) achieved in the different towns or systems, divided by the number of towns or systems in that municipality

In Figure 4.14 the top twenty municipalities with the highest gastro-intestinal disease prevalence in 2007 compared with the Blue Drop Score and the Green Drop Score of each municipality were visually represented.

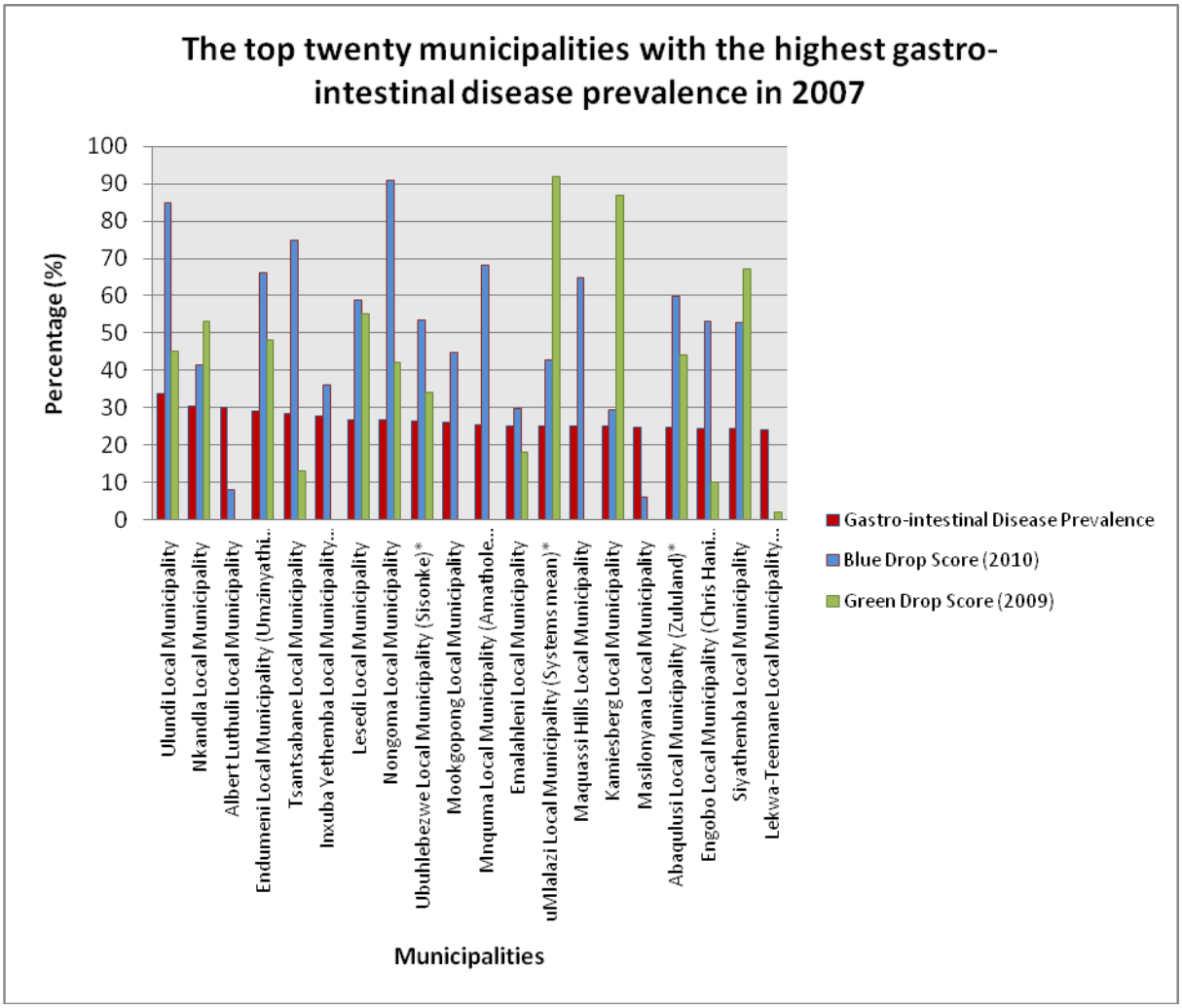

Figure 4.14: The top twenty municipalities with the highest gastro-intestinal disease prevalence in 2007 compared with the Blue Drop Score (DWA, 2010) and the Green Drop Score (DWA, 2009) of each municipality

As in 2007, it cannot be stated that a low Blue Drop Score and Green Drop Score may cause a high prevalence in gastro-intestinal disease prevalence in 2008 (Table 4.12 and Figure 4.15). Randfontein Local Municipality counted as one of the top twenty municipalities with the highest gastro-intestinal disease prevalences in 2008 with 22.81%, while the Blue Drop Score of 87.60% can be considered as very good drinking water quality management (DWA, 2010:10) and the Green Drop Score indicating the quality of waste water management was 66.00%. Albert Luthuli Local Municipality's high gastro-intestinal disease prevalence may be caused by the poor drinking water quality management and waste water management. As the Blue Drop Report and the Green Drop Report are not conclusive and cannot be absolutely linked to gasto-intestinal disease, further research in this sector is requred as well as on the influence of other socio-economic factors on gastro-intestinal disease.

Table 4.12: The top twenty municipalities with the highest gastro-intestinal disease prevalence in South Africa in 2008 compared with corresponding Blue Drop (DWA, 2010) and Green Drop Scores (DWA, 2009)

Municipality	$Prevalence_{GI}$ %	Blue Drop Score (DWA, 2010) (%)	Green Drop Score (DWA, 2009) (%)
Ulundi Local Municipality	31.82	85.00	45.00
Nongoma Local Municipality	30.81	91.00	42.00
Albert Luthuli Local Municipality	30.27	8.20	0.00
Endumeni Local Municipality (Umzinyathi District)*	29.07	66.00	48.00
Sunday's River Valley Local Municipality	28.71	46.90	0.00
Inxuba Yethemba Local Municipality (Cradock & Middelburg)*	28.52	36.13	Not assessed
Abaqulusi Local Municipality (Zululand District Municipality)*	26.64	59.80	44.00
Lesedi Local Municipality	25.83	58.80	55.00
Witzenberg Local Municipality	25.09	93.30	67.00
Laingsburg Local Municipality	25.00	63.90	77.00
Siyancuma Local Municipality	24.66	54.60	0.00
Mnquma Local Municipality (Amathole District Municipality)*	24.21	68.20	0.00
City of Tlokwe	23.62	95.10	78.00
Newcastle Local Municipality	23.53	74.80	41.00
Maquassi Hills Local Municipality	23.47	64.90	0.00
uMlalazi Local Municipality (Systems mean)*	23.18	42.75	92.00
Masilonyana Local Municipality	23.15	6.20	0.00
Lukanji Local Municipality (Queenstown)*	22.92	62.56	Not assessed
Mookgopong Local Municipality	22.89	44.90	0.00
Randfontein Local Municipality	22.81	87.30	66.00

*Note that in cases where a name of a district, town or system is included, the municipality is not mentioned or indicated as a single system in the Blue Drop Report (DWA, 2010) or the Green Drop Report (DWA, 2009).

$Prevalence_{GI}$ %: Number of patients in the gastro-intestinal disease dataset (Dataset A), divided by the number of patients in the total dataset, multiplied by 100

Mean: The sum of the percentages (Blue Drop Score or Green Drop Score where applicable) achieved in the different towns or systems, divided by the number of towns or systems in that municipality

In Figure 4.15 the top twenty municipalities with the highest gastro-intestinal disease prevalence in 2008 compared with the Blue Drop Score and the Green Drop Score of each municipality were visually represented.

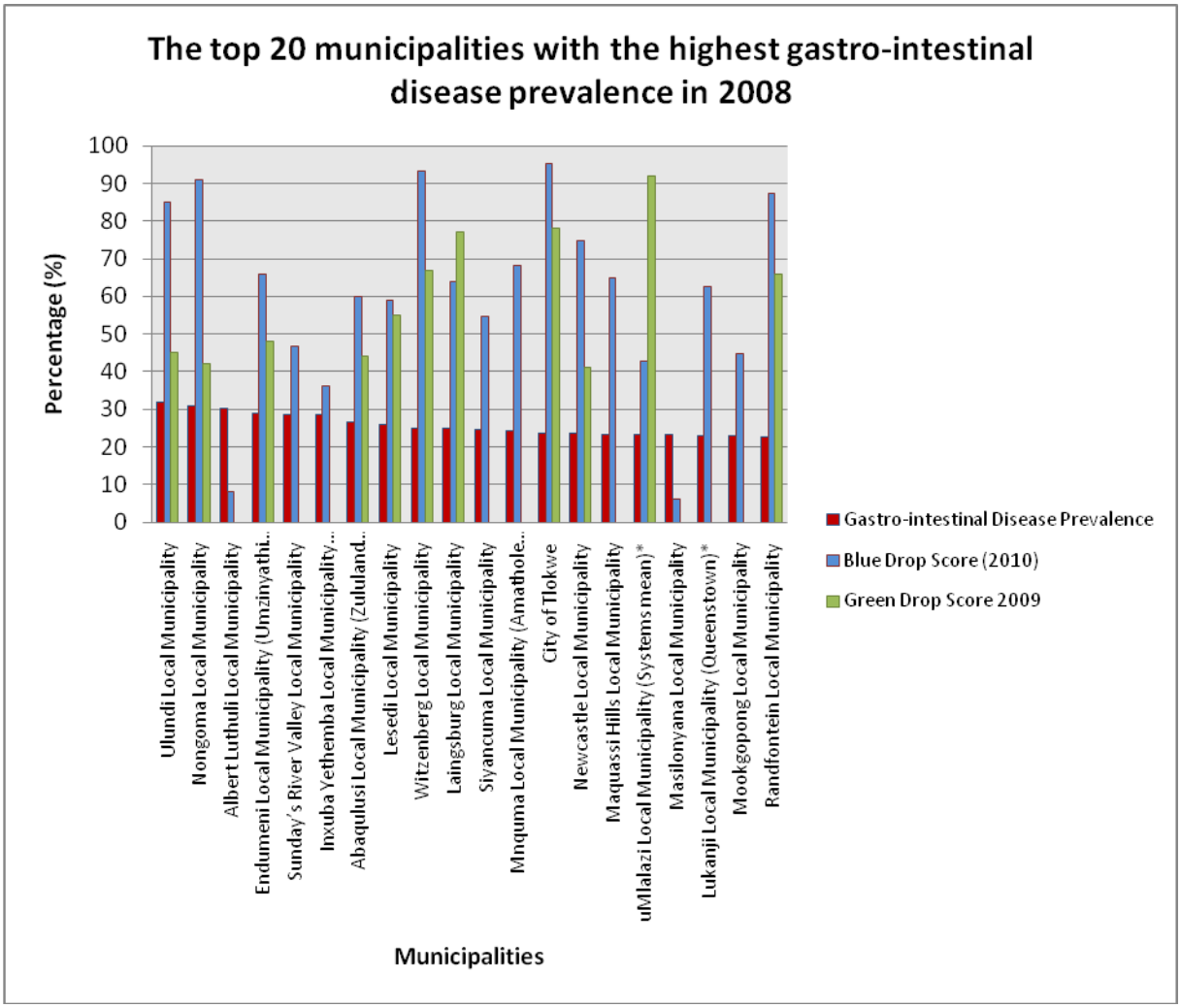

Figure 4.15: The top twenty municipalities with the highest gastro-intestinal disease prevalence in 2008 compared with the Blue Drop Score (DWA, 2010) and the Green Drop Score (DWA, 2009) of each municipality

4.3 The prevalence of gastro-intestinal disease in different age groups in South Africa

As indicated in Tables B1 and B2 in Appendix B the different age groups are indicated, the percentage and prevalence are calculated for the patients as well as the number of prescriptions for patients up to the provincial level. More detailed analysis of the prevalence of gastro-intestinal disease will not be performed as numbers of patients become too small to be of any significance for this study. In South Africa in 2007 (Figure 4.16) the prevalence of gastro-intestinal disease is the highest in the age group 0 - ≤ 5 years (9.07%) and the lowest in the age group > 60 years with 2.52%.

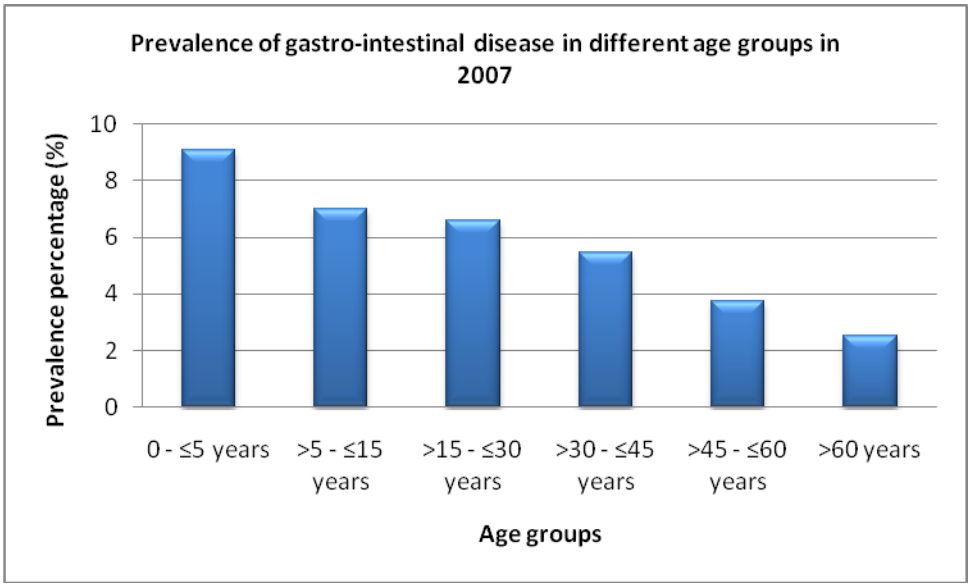

Figure 4.16: The prevalence of gastro-intestinal disease in different age groups in South Africa in 2007

In 2008 (Figure 4.17) the age group with the highest prevalence in gastro-intestinal disease was the 0 - ≤ 5 years group, with 8.49%. The age group with the lowest prevalence in gastro-intestinal disease was > 60 years with 2.48%. Refer to Chapter 3, section 3.5 (Study population) as well as Chapter 2 (section 2.5 to 2.7) for further information regarding the epidemiology of gastro-intestinal diseases with special emphasis on age groups. The results obtained partly comply with the findings of Bates (2000:34) in which it was found that the highest consumption of bottled water is among children and the sick and elderly for the purpose of taking their medication. It is important to note that these age groups that consume the most water (children and the elderly) also have the weakest immune systems and by consuming more drinking water, they are exposed to more water-borne pathogens.

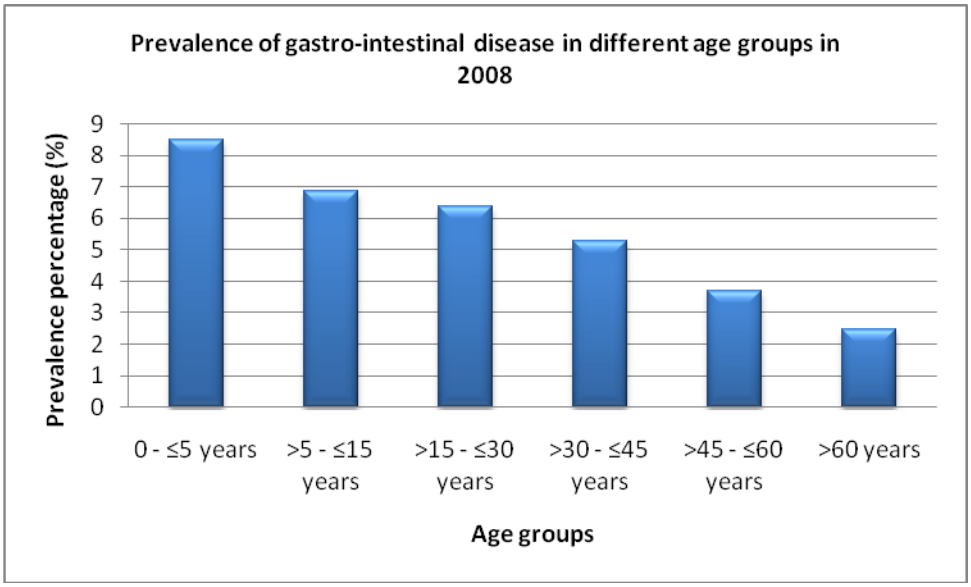

Figure 4.17: The prevalence of gastro-intestinal disease in different age groups in South Africa in 2008

4.4 The prevalence of gastro-intestinal disease according to gender

In order to determine the prevalence of gastro-intestinal disease in different genders, the relative risk and the odds ratio was calculated for patients up to the provincial and district level (Appendix A). No further calculations were done to include municipal level, as trends of importance in this study can be determined from provincial data. Calculations regarding the prevalence of gastro-intestinal disease, relative risk and odds ratio were not performed up to municipal level as numbers will be too small in certain municipalities, e.g. Ngqushwa Local Municipality with a total patient representation of four patients, to be of significance. The relative risk determines the risk of female patients developing gastro-intestinal disease compared to the risk of male patients developing gastro-intestinal disease. A relative risk larger than one indicates that the risk of females developing gastro-intestinal disease is larger than that of males. A relative risk equal to one indicates that the risk for developing gastro-intestinal disease is equal for both genders. By determining the odds ratio, the odds of females developing gastro-intestinal disease is compared to the odds of males developing gastro-intestinal disease. An odds ratio larger than one indicates greater odds for females to develop gastro-intestinal disease than males.

As indicated in Table 4.13 the relative risk in 2007 ranges from 1.11 to 1.17. The Western Cape had the lowest relative risk of 1.11, while Gauteng had the highest relative risk of 1.17. Although the relative risks in all the provinces are slightly higher than one, it is relevant to

note that the risk for females developing gastro-intestinal disease is higher than that of males. The odds ratio calculated for each province in 2007 (Table 4.13) ranges from 1.13 (Western Cape) to 1.21 (Gauteng). This also indicates that the odds for females to develop gastro-intestinal disease are higher than those of males. The ratio of females to males receiving gastro-intestinal disease medication is ranging from 1.31:1 to 1.54:1. Table 4.14 indicates the prevalence of gastro-intestinal disease in different genders in 2008. The relative risk for females to develop gastro-intestinal disease compared to males ranged from 1.10 (Western Cape) to 1.40 (Northern Cape). Females therefore have a higher risk for developing gastro-intestinal disease than males. The odds ratio for females to males ranges from 1.12 (Western Cape) to 1.50 in the Northern Cape. This high odds ratio for the Northern Cape indicates that the odds for females to develop gastro-intestinal disease are 1.50:1. The ratio of females to males receiving gastro-intestinal disease medication ranges from 1.27:1 (North West) to 1.62:1 in the Northern Cape.

It can be concluded that the odds ratio for females to males for developing gastro-intestinal disease in South Africa indicates only a small effect. Steyn (2009:40) indicated that a value of 1.5 indicates a small effect, 2.5 indicates a medium effect and 4.25 indicates a large effect. Only an odds ratio of 2.2 can be considered as being statistically significant.

Table 4.13: The prevalence of gastro-intestinal disease in different genders in 2007

2007	Number of patients in the total database		Number of patients receiving gastro-intestinal disease medication		Prevalence		Ratio Female:Male receiving gastro-intestinal disease medication	Relative risk	Odds ratio
Province	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**		**Female : Male**	**Female : Male**
South Africa	880825	674551	158003	105388	17.94	15.62	1.50:1	1.15	1.18
Eastern Cape	49017	36918	11051	7264	22.55	19.68	1.52:1	1.14	1.19
Free State	33398	25126	6387	4149	19.12	16.51	1.54:1	1.16	1.19
Gauteng	349269	269092	65422	43078	18.73	16.01	1.52:1	1.17	1.21
Kwa-Zulu Natal	138419	102497	25402	16532	18.35	16.13	1.54:1	1.14	1.17
Limpopo	62508	49682	10657	7452	17.05	15.00	1.43:1	1.14	1.16
Mpumalanga	49126	43099	9327	7146	18.99	16.58	1.31:1	1.14	1.18
Northern Cape	11632	8908	2429	1636	20.88	18.37	1.48:1	1.14	1.17
North West	55993	41565	10805	7071	19.30	17.01	1.53:1	1.13	1.17
Western Cape	126208	93755	16523	11060	13.09	11.80	1.49:1	1.11	1.13

Table 4.13 (continued): The prevalence of gastro-intestinal disease in different genders in 2007

Prevalence: The number of patients (female or male) receiving gastro-intestinal disease medication, divided by the corresponding number of patients (female or male) in the total database, multiplied by 100.

Relative risk = P_1 / P_2

P_1= Number of female patients receiving gastro-intestinal disease medication / Total number of female patients

P_2= Number of male patients receiving gastro-intestinal disease medication / Total number of male patients

Odds ratio = θ

$$\Theta = \frac{\frac{P_1}{1-p_1}}{\frac{P_2}{1-P_2}}$$

Table 4.14 represented the prevalence of gastro-intestinal disease in different genders in 2008.

Table 4.14: The prevalence of gastro-intestinal disease in different genders in 2008

2008	Number of patients in the total database		Number of patients receiving gastro-intestinal disease medication		Prevalence		Ratio Female:Male receiving gastro-intestinal disease medication	Relative risk	Odds ratio
Province	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**		**Female : Male**	**Female : Male**
South Africa	728051	561966	126147	83734	17.33	14.90	1.51:1	1.16	1.20
Eastern Cape	41400	31205	9155	6079	22.11	19.48	1.51:1	1.14	1.17
Free State	28542	21354	5339	3455	18.71	16.18	1.55:1	1.16	1.19
Gauteng	289589	226236	52234	34375	18.04	15.19	1.52:1	1.19	1.23
Kwa-Zulu Natal	115674	87086	20184	13205	17.45	15.16	1.53:1	1.15	1.18
Limpopo	47973	37935	7788	5422	16.23	14.29	1.44:1	1.14	1.16
Mpumalanga	38688	35405	7166	5533	18.52	15.63	1.30:1	1.19	1.23
Northern Cape	9679	8390	1895	1171	19.58	13.96	1.62:1	1.40	1.50
North-West	44776	33054	8461	5330	18.90	16.13	1.27:1	1.17	1.21
Western Cape	107746	78491	13583	8958	12.61	11.41	1.52:1	1.10	1.12

Prevalence: The number of patients (female or male) receiving gastro-intestinal disease medication, divided by the corresponding number of patients (female or male) in the total database, multiplied by 100.

Relative risk = P_1 / P_2

Table 4.14 (continued): The prevalence of gastro-intestinal disease in different genders in 2008

P_1= Number of female patients receiving gastro-intestinal disease medication / Total number of female patients

P_2= Number of male patients receiving gastro-intestinal disease medication / Total number of male patients

Odds ratio = θ

$$\Theta = \frac{\frac{P_1}{1-p_1}}{\frac{P_2}{1-P_2}}$$

4.5 Seasonal prescribing patterns of gastro-intestinal disease medication

In order to determine whether possible seasonal prescribing patterns of gastro-intestinal medication can be observed from the data, the dataset B was constructed in which a patient was defined as a person that submitted a claim that was paid for by the PBM once, or more times, during a period of one month in a specific geographical area. Firstly the prevalence of gastro-intestinal disease according to the number of patients that claimed gastro-intestinal disease medication items, the number of gastro-intestinal medication prescriptions processed and the number of gastro-intestinal disease medication items claimed, during each month of 2007 and 2008 for South Africa, then the different provinces of South Africa and lastly the different districts of South Africa will be reported and discussed in the sections below.

4.5.1 Prevalence of gastro-intestinal disease in South Africa during different months of 2007 and 2008

Table 4.15 contains information regarding the prevalence of gastro-intestinal disease in South Africa during each month of 2007 and 2008. Prevalence was calculated by dividing the number of patients that received gastro-intestinal disease medication during each month, by the corresponding total number of patients during each month of 2007 and 2008, multiplied by 100.

As can be seen from Table 4.15 the prevalence of gastro-intestinal disease according to the number of patients that entered one or more gastro-intestinal disease medication claims decreased from January to December in both 2007 and 2008. The mean prevalence (%) of

gastro-intestinal disease in 2007 was 5.61% ± 1.96% SD and in 2008 the mean prevalence was 5.16% ± 1.89% SD with an effect size (d-value) of 0.23 indicating that the statistical significance in the prevalence of gastro-intestinal disease among patients in 2007 and 2008 is small. In 2007 the prevalence was higher than in 2008, probably due to the larger number of patients in the total database for 2007 (5717420 (n)) compared to 4871399 (n) in 2008.

In order to obtain seasonal trends in the prevalence of gastro-intestinal disease among patients it is necessary to observe a trend in the prescribing patterns of the gastro-intestinal disease medications. From Table 4.15 and Figure 4.18 it is observed that the number of patients receiving gastro-intestinal disease medication decreases from 53432 in January 2007 to 13414 in December 2007. The same trend was observed in 2008 where the number of patients decreased from 44372 in January to 10662 in December.

Table 4.15 : Prevalence of gastro-intestinal disease in South Africa during each month of 2007 and 2008

	2007			2008		
Month	**Total number of patients**	**Number of gastro-intestinal disease patients**	**Prevalence (%)***	**Total number of patients**	**Number of gastro-intestinal disease patients**	**Prevalence (%)***
January	524834	53432	**10.18**	463726	44372	**9.57**
February	487205	38976	**8.00**	442978	33652	**7.60**
March	516857	36308	**7.02**	438943	27910	**6.36**
April	489865	29275	**5.98**	444207	24385	**5.49**
May	534601	31860	**5.96**	439147	23197	**5.28**
June	495928	25502	**5.14**	423400	20064	**4.74**
July	493008	23060	**4.68**	428811	19154	**4.47**
August	512883	24077	**4.69**	410358	16892	**4.12**
September	442971	18438	**4.14**	375433	14338	**3.82**
October	445295	17517	**3.93**	361608	13331	**3.69**
November	412641	15987	**3.87**	330268	10949	**3.32**
December	361332	13414	**3.71**	312520	10662	**3.41**
TOTAL	5717420	327746	**5.73**	4871399	258906	**5.31**

*Prevalence %: Number of gastro-intestinal disease patients divided by the corresponding number of patients in the total database, multiplied by 100

In Figure 4.18 the gastro-intestinal disease prevalence according to the number of patients in the different months of 2007 and 2008 were represented visually.

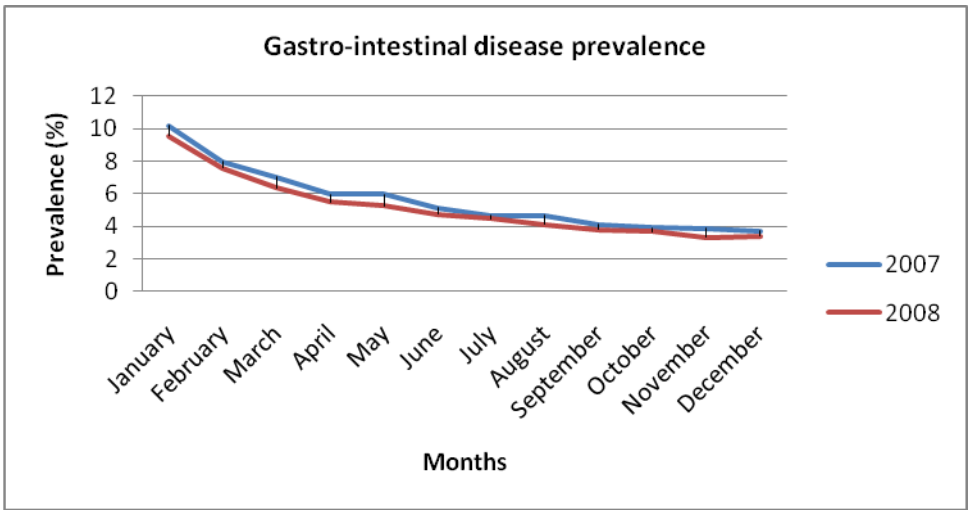

Figure 4.18: Gastro-intestinal disease prevalence according to the number of patients in 2007 and 2008

According to Andrade *et al.* (2009:506), there is a positive correlation between, rainfall, season and the number of hospitalisations due to diarrhoea in Brazil. In order to visualise a seasonal trend in gastro-intestinal disease prevalence, one would expect that more patients would enter claims for gastro-intestinal disease medication during summer months than winter months. Dey *et al.* (2007:220) observed that infections caused by noroviruses increased and had a higher incidence during winter months and rain seasons in Bangladesh.

Although the data showed a higher prevalence in January than June for both 2007 and 2008, there was no increase from June to December in 2007 as well as in 2008. A possible reason for this may be that the data received covered the private health care sector of South Africa and funds do get depleted toward the end of a year, causing that the PBM would not process some of the claims. Patients often also do not claim when they realise that their benefits have been depleted (Reference in possession of the author, 2010). Figure 4.19, obtained from the PBM that was used (Reference in possession of the author, 2010), provided the prevalence per month for 2006, 2007 and 2008. Prevalence is defined by the PBM as the proportion of the beneficiaries that entered a claim, or the number of utilising beneficiaries, indicated on Figure 4.19 as a percentage of the total number of beneficiaries in a population (Reference in possession of the author, 2009). Prevalence as defined by the PBM and prevalence of gastro-intestinal disease, as used in this study, should not be confused. According to Figure 4.19 the prevalence (proportion of beneficiaries that claimed) also showed an increase from January to May, but then decreased from May to December for 2006, 2007, as well as 2008.

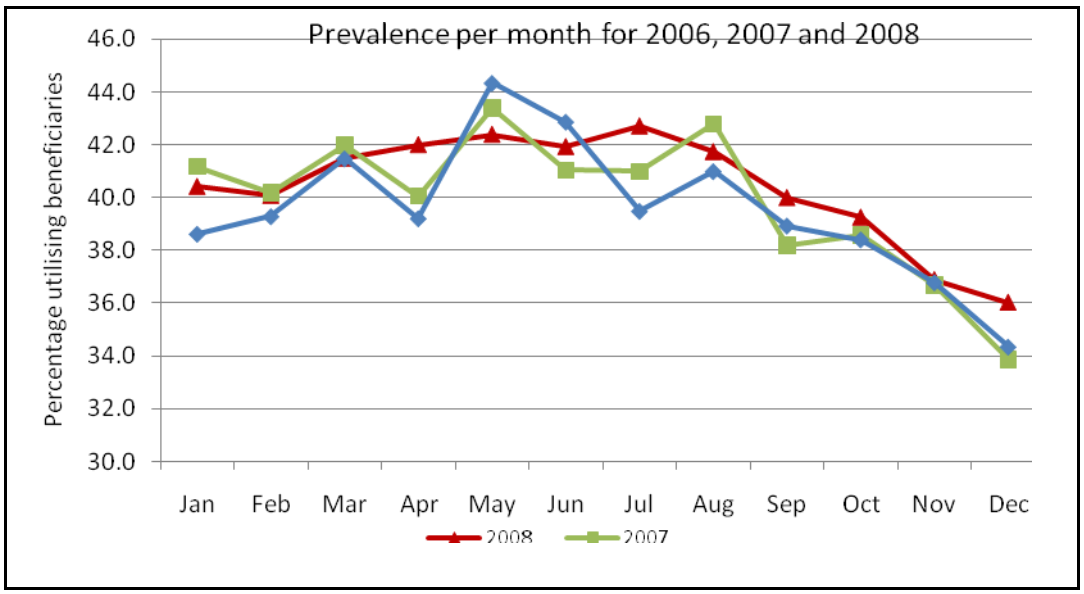

Figure 4.19: Prevalence of beneficiaries that entered a claim per month for 2006, 2007 and 2008 as taken from the PBM that was used (Source in possession of the author, 2009)

According to the results obtained from the primary database, as can be seen in Table 4.16 and Figure 4.20, the prevalence of gastro-intestinal disease medication prescriptions processed, decreased from January 2007 (57232 prescriptions) to 14077 gastro-intestinal disease medication prescriptions claimed in December 2007. The prevalence percentage of the gastro-intestinal disease medication prescriptions claimed decreased from 7.24% in January 2007 to 2.88% in December 2007 with a total prevalence of 4.18% and mean prevalence percentage of 4.09% ± 1.39%.

In 2008 the number of gastro-intestinal disease medication prescriptions claimed decreased from 47404 prescriptions in January 2008 to 11180 prescriptions in December 2008. The prevalence percentage of the gastro-intestinal disease medication prescriptions claimed decreased from 6.69% in January 2008 to 2.51% in December 2008. The total prevalence percentage in 2008 was 3.83% with a mean prevalence percentage of 3.71% ± 1.31%. Although the prevalence of gastro-intestinal disease medication prescriptions claimed in 2008 (3.83%) was lower than in 2007 (4.18%), the d-value of 0.28 indicated that the difference was small and not statistically significant.

Table 4.16 : Prevalence of gastro-intestinal disease in South Africa according to the number of prescriptions processed in each month of 2007 and 2008

	2007			2008		
Month	**Number of prescriptions (N)**	**Number of gastro-intestinal medication prescriptions (N)**	**Prevalence % ***	**Number of prescriptions**	**Number of gastro-intestinal medication prescriptions**	**Prevalence % ***
January	790350	57232	**7.24**	708237	47404	**6.69**
February	686312	40850	**5.95**	643105	35469	**5.52**
March	757382	38237	**5.05**	640797	29375	**4.58**
April	692454	30678	**4.43**	655868	25660	**3.91**
May	786318	33583	**4.27**	641107	24309	**3.79**
June	715811	26723	**3.73**	615639	21054	**3.42**
July	718957	24210	**3.37**	636889	20123	**3.16**
August	757733	25333	**3.34**	596867	17698	**2.97**
September	621142	19373	**3.12**	543190	15128	**2.79**
October	649077	18489	**2.85**	530149	14067	**2.65**
November	588423	16918	**2.88**	463475	11452	**2.47**
December	497006	14077	**2.83**	444723	11180	**2.51**
TOTAL	8260965	345703	**4.18**	7120046	272919	**3.83**

*Prevalence %: Number of gastro-intestinal medication prescriptions divided by the corresponding number of prescriptions for the total database, multiplied by 100

In Figure 4.20 the gastro-intestinal disease prevalence according to the number of prescriptions processed in the different months of 2007 and 2008 were represented visually.

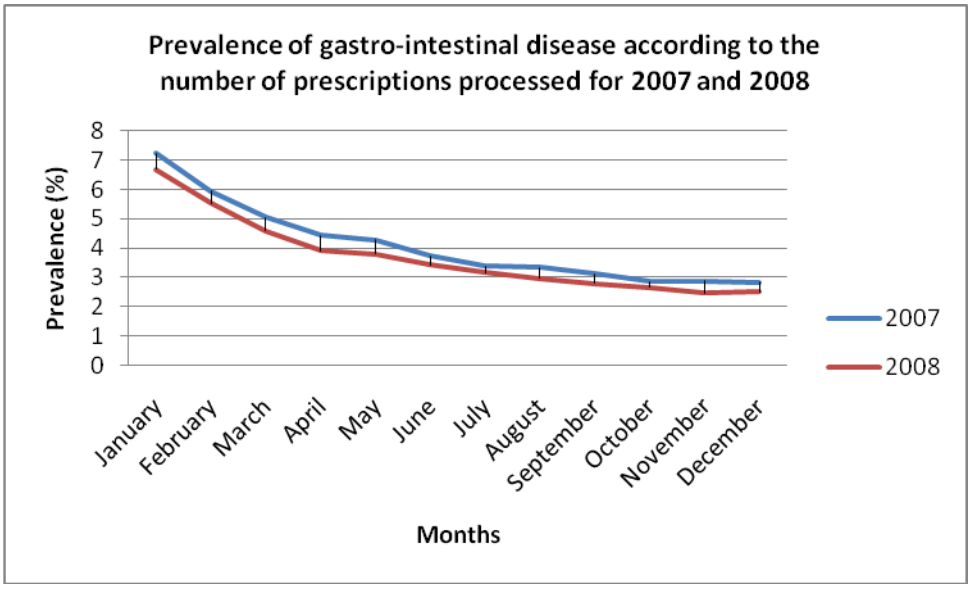

Figure 4.20 : Prevalence of gastro-intestinal disease in South Africa according to the number of prescriptions processed for 2007 and 2008

According to Table 4.17 and Figure 4.21 the prevalence of gastro-intestinal disease in South Africa decreased form 2007 to 2008 when considering the number of gastro-intestinal disease medication items claimed. In 2007, 430087 gastro-intestinal disease medication items were claimed and the prevalence percentage of the gastro-intestinal disease medication items claimed was 2.25%. In 2008 the number of gastro-intestinal disease medication items claimed was 340921 and covered a percentage of 2.07% of the total number of items claimed in 2008. The d-value between the prevalence percentage of gastro-intestinal medication items claimed in 2007 and 2008 was 0.28% and can therefore be considered to be statistically small. The mean prevalence percentages of gastro-intestinal medication items claimed in 2007 and 2008 were 2.21% ± 0.72% and 2.01% ± 0.70% respectavely.

In 2007 the prevalence percentage of gastro-intestinal medication items claimed decreased from 3.86% in January to 1.67% in December. In 2008 it was observed that the prevalence percentage of gastro-intestinal medication items claimed, decreased from January (3.61%) to 1.45% in December.

Table 4.17 : Prevalence of gastro-intestinal disease medication items claimed in 2007 and 2008

	2007			2008		
Month	**Number of items**	**Number of gastro-intestinal medication items**	**Prevalence % ***	**Number of items**	**Number of gastro-intestinal medication items**	**Prevalence % ***
January	1843586	71186	**3.86**	1651162	59663	**3.61**
February	1579620	50401	**3.19**	1484928	44492	**3.00**
March	1724480	47215	**2.74**	1467063	36856	**2.51**
April	1581565	37650	**2.38**	1502086	31377	**2.09**
May	1843927	41514	**2.25**	1486470	30066	**2.02**
June	1668315	32636	**1.96**	1441344	25729	**1.79**
July	1672629	29359	**1.76**	1496847	24523	**1.64**
August	1796344	30972	**1.72**	1392773	21839	**1.57**
September	1436540	24531	**1.71**	1256678	18947	**1.51**
October	1479219	23582	**1.59**	1204073	18156	**1.51**
November	1334495	22398	**1.68**	1045783	14625	**1.40**
December	1115004	18643	**1.67**	1010046	14648	**1.45**
TOTAL	19075724	430087	**2.25**	16439253	340921	**2.07**

*Prevalence %: Number of gastro-intestinal medication items divided by the corresponding number of items for the total database, multiplied by 100

In Figure 4.21 the gastro-intestinal disease prevalence according to the number of items claimed in the different months of 2007 and 2008 were represented visually.

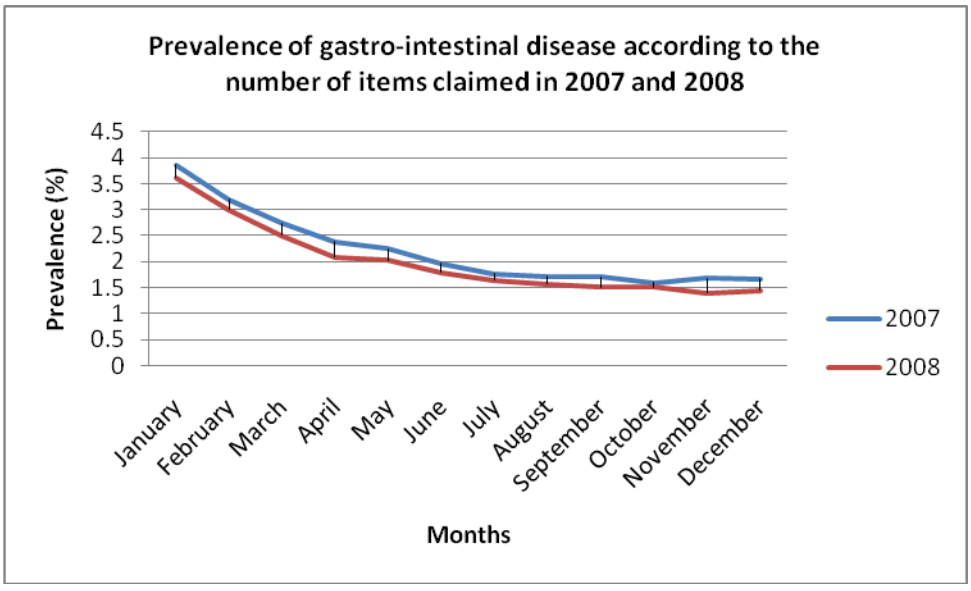

Figure 4.21 : Prevalence of gastro-intestinal disease in South Africa according to the number of items claimed in 2007 and 2008

From the data obtained and observed regarding the prevalence of gasto-intestinal disease in the different months of 2007 and 2008, it can be concluded that the prevalence of gastro-intestinal disease in South Africa decreased from January to December in both the study periods of 2007 and 2008. This does not comply with the findings in the literature according to which that some gastro-intestinal diseases have a higher prevalence during certain months of the year. The general observation does, however, comply with the data obtained from the PBM that was used, as indicated in Figure 4.19 and it may then be stated that the data were not sufficient in order to indicate seasonal trends in the prevalence of gastro-intestinal disease. This is a limitation of the study as the depletion of funds of beneficiaries may influence the way in which patients claim gastro-intestinal disease medication.

4.5.2 Prevalence of gastro-intestinal disease in the different provinces of South Africa during different months of 2007 and 2008

In order to determine the seasonal trends of gastro-intestinal medication prescribing patterns in South Africa, it must be empasised that the seasonal prescribing trends cannot be determined according to the limitation determined in 4.5.1 where the depletion of beneficiaries' funds have an impact on the number of claims processed during different times of the year. Dataset B, constructed by using monthly claim information, will however still be analysed in order to deremine gastro-intestinal medicaton prescribing patterns. The prevalence percentage of the number of patients that claimed gastro-intestinal disease medication and the the number of gastro-intestinal medication prescriptions processed during each month in the different provinces during 2007 and 2008 will be discussed. Prevalence percentage was defined as the number of gastro-intestinal medication patients, prescriptions or items, divided by the corresponding number of patients, prescriptions or items in the total database, multiplied by 100.

According to Table 4.18 it was observed that the total number of patients in dataset B decreased from 5717420 in 2007 to 4871399 in 2008. The number of gastro-intestinal disease patients consequently also decreased form 327846 in 2007 to 258906 in 2008. In each province the number of gastro-intestinal disease patients decreased from 2007 to 2008. It can, however, be observed that the prevalence of gasto-intestinal disease was the highest in Mpumalanga in 2007, with a prevalence percentage of 6.52%. The Western Cape had the lowest prevalence percentage of 4.26% in 2007. In 2008, Limpopo had the highest prevalence percentage of gastro-intestinal disease of 6.09%, while the Western Cape had the lowest prevalence percentage of 4.05%. The results can also be visualised on Figure

4.22 where the prevalence percentage of gastro-intestinal disease according to the number of patients that claimed for gastro-intestinal disease medication in 2007 and 2008 in the different provinces of South Africa was plotted.

Table 4.18 : The prevalence of gastro-intestinal disease in the different provinces of South Africa in 2007 and 2008

Province	2007			2008		
	Number of patients in the total database	**Number of gastro-intestinal disease patients**	**Prevalence (%)***	**Number of patients in the total database**	**Number of gastro-intestinal disease patients**	**Prevalence (%)***
Eastern Cape	377767	23583	**6.24**	324061	19527	**6.03**
Free State	253703	13813	**5.44**	217080	11230	**5.17**
Gauteng	2293824	132931	**5.80**	1975447	106214	**5.38**
Kwa-Zulu Natal	892312	52860	**5.92**	771355	41307	**5.36**
Limpopo	339298	22019	**6.49**	259864	15827	**6.09**
Mpumalanga	304961	19881	**6.52**	255845	15292	**5.98**
Northern Cape	80649	5081	**6.30**	75272	3827	**5.08**
North-West	347400	22055	**6.35**	286993	17011	**5.93**
Western Cape	811746	34655	**4.26**	693468	28069	**4.05**
TOTAL	5717420	327846	**5.73**	4871399	258906	**5.31**

*Prevalence %: Number of gastro-intestinal medication patients divided by the corresponding number of patients for the total database, multiplied by 100

Note that those patients that are not allocated to a specific province, are included in the total number of patients, but will not be further discussed.

In Figure 4.22 the gastro-intestinal disease prevalence in different provinces of South Africa in 2007 and 2008 were represented visually.

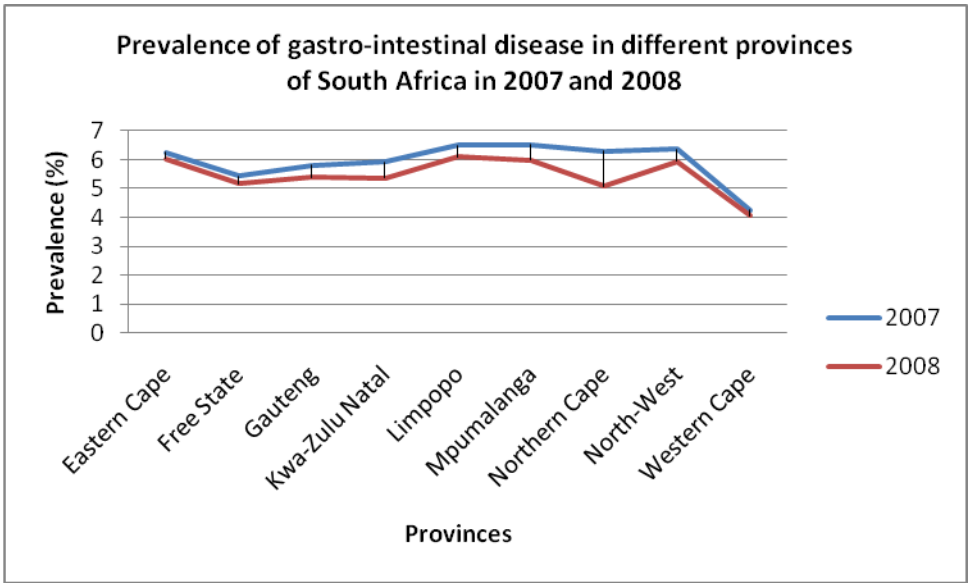

Figure 4.22: The prevalence of gastro-intestinal disease in different provinces of South Africa in 2007 and 2008 according to the number of patients that claimed gastro-intestinal disease medications

4.5.2.1 The prevalence of gastro-intestinal disease in the Eastern Cape in the different months of 2007 and 2008

When observing the data retrieved from dataset B regarding the number of patients and number of gastro-intesttinal disease medication prescriptions in each month of 2007 and 2008, as depicted in Table 4.19, it was observed that the prevalence of gastro-intestinal disease according to the number of patients decreased from 2007 to 2008. In 2007 the prevalence of gastro-intestinal disease according to the number of patients, was 6.24%, whereas the prevalence in 2008 was 6.03%.

The mean prevalence percentage of gastro-intestinal disease patients in 2007 was 6.15% ± 2.08%, while in 2008 it was 5.82% ± 2.34%. The d-value of the gastro-intestinal disease patient prevalence between 2007 and 2008 was 0.14 and therefore considered to be statistically small. January was observed to be the month with the highest patient prevalence percentage in 2007 and 2008 with 11.13% and 11.27% respectavely. The patient prevalence decreased as both years progressed, with the lowest patient prevalences in December of both 2007 and 2008, with values of 4.54% and 3.86% respectively.

The prevalence of gastro-intestinal disease medication prescriptions decreased from 2007 to 2008, being 4.19% and 3.97% respectavely. The prevalence of gastro-intestinal disease medication prescriptions received had a mean value of 4.12% ± 1.40% in 2007 and 3.82% ±

1.49% in 2008. The d-value of 0.21 indicated that the difference in the prevalence of gastro-intestinal disease medication prescriptions processed in 2007 and 2008, was statistically small. January showed the highest prevalence of gasto-intestinal medication prescriptions processed in both 2007 and 2008, being 7.41% and 7.22% respectively. The prevalence values then decreased every month to give values of 3.13% and 2.61% in December of 2007 and 2008 respectively.

The lower prevalence values for the number of gastro-intestinal disease patients as well as the gasro-intestinal disease medication prescriptions processed in 2008 may be due to the fact that there were fewer patients as well as prescriptions claimed in the total database for 2008 than in 2007. Because the difference in d-values for the prevalence of gastro-intestinal disease patients and the prevalence of gastro-intestinal disease medication claims in 2007 and 2008 were small (d = 0.2), no significant difference in the prevalence of gastro-intestinal disease between 2007 and 2008 in the Eastern Cape was observed.

Table 4.19: Prevalence of gastro-intestinal disease in the Eastern Cape in 2007 and 2008

Months	2007			2008			2007			2008		
	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**
January	33664	3748	**11.13**	31324	3531	**11.27**	54932	4070	**7.41**	53239	3843	**7.22**
February	31777	2710	**8.53**	29721	2666	**8.97**	48675	2870	**5.90**	47491	2841	**5.98**
March	33993	2561	**7.53**	29558	2177	**7.37**	54779	2728	**4.98**	48120	2322	**4.83**
April	32007	2145	**6.70**	29317	1802	**6.15**	49607	2284	**4.60**	48219	1902	**3.94**
May	34852	2242	**6.43**	29350	1716	**5.85**	56626	2397	**4.23**	47846	1828	**3.82**
June	32678	1825	**5.58**	27931	1421	**5.09**	52111	1936	**3.72**	44999	1491	**3.31**
July	32514	1683	**5.18**	28347	1402	**4.95**	52103	1788	**3.43**	46483	1513	**3.25**
August	33693	1738	**5.16**	27093	1228	**4.53**	55069	1850	**3.36**	43580	1298	**2.98**
September	29728	1320	**4.44**	24643	1078	**4.37**	45803	1400	**3.06**	39502	1167	**2.95**
October	30100	1345	**4.47**	23943	948	**3.96**	48893	1425	**2.91**	38938	1014	**2.60**
November	27995	1141	**4.08**	21766	744	**3.42**	44029	1209	**2.75**	33665	778	**2.31**
December	24766	1125	**4.54**	21068	814	**3.86**	37472	1172	**3.13**	32987	862	**2.61**
TOTAL	377767	23583	**6.24**	324061	19527	**6.03**	600099	25129	**4.19**	525069	20859	**3.97**

*Prevalence %: Number of gastro-intestinal disease patients divided by the corresponding number of patients in the total database, multiplied by 100

**Prevalence %: Number of gastro-intestinal medication prescriptions divided by the corresponding number of prescriptions for the total database, multiplied by 100

Note that those patients that are not allocated to a specific province, are included in the total number of patients, but will not be further discussed.

4.5.2.2 The prevalence of gastro-intestinal disease in the Free State in the different months of 2007 and 2008

The prevalence of gastro-intestinal disease among patients decreased from 2007 to 2008, from 5.44% to 5.17%. The prevalence of gastro-intestinal disease medication prescriptions decreased from 3.70% in 2007 to 3.50% in 2008. In the Free State it was, however, also observed that the number of patients in the total primary database as well as the number of prescriptions processed in the total database, decreased from 2007 to 2008 (Table 4.20).

In 2007 and 2008 it was observed that the prevalence of gastro-intestinal disease among patients was the highest in January with a prevalence percentage of 9.43% and 9.60% respectively. The prevalence of gastro-intestinal disease among patients decreased toward the end of each year. The lowest prevalence of gastro-intestinal disease among patients on 2007 in the Free State was observed during October and December with a prevalence percentage of 3.68%. The lowest prevalence percentage of gastro-intestinal disease among patients in the Free State during 2008 was during November with a prevalence percentage of 3.39%. The mean patient prevalence of gastro-intestinal disease in 2007 and 2008 was 5.34% ± 1.83% and 5.02% ± 1.89% respectively. The d-value of 0.17 indicated that the difference on patient prevalence of gastro-intestinal disease between 2007 and 2008 was statistically small.

In both 2007 and 2008 the highest prevalence of gastro-intestinal disease medication prescriptions was processed during January with prevalence percentages of 6.21% and 6.26% for 2007 and 2008 respectively. In 2007 the lowest prevalence of gastro-intestinal disease medication prescriptions processed, was during October, with a prevalence of 2.50%. In 2008 the lowest prevalence of gastro-intestinal medication prescriptions was during September, with a prevalence percentage of 2.38%. The mean prevalence precentages of gastro-intestinal disease medication prescriptions received during 2007 and 2008 were 3.62% ± 1.18% and 3.39% ± 1.21% respectvely, with a d-value of 0.19, indicating that the prevalence of prescriptions processed for gastro-intestinal disease between 2007 and 2008 was statistically small.

4.5.2.3 The prevalence of gastro-intestinal disease in Gauteng in the different months of 2007 and 2008

In Gauteng it was observed (Table 4.21) that the prevalence of gastro-intestinal disease among patients decreased from 5.80% to 5.38% from 2007 to 2008. The prevalence of the number of gastro-intestinal disease medication prescriptions decreased from 4.27% in 2007

to 3.92% in 2008. The total number of patients in the primary database, as well as the total number of prescriptions in the primary database decreased from 2007 to 2008.

When considering the prevalence of gastro-intestinal disease among patients, it was observed that the highest prevalence percentage for both 2007 and 2008 was during January, with 10.00% and 9.22% respectively. In 2007 the month with the lowest prevalence percentage was December with 3.68%. November was the month with the lowest prevalence percentage of 3.55% in 2008. In 2007 and 2008 the mean values for prevalence of gastro-intestinal disease among patients, were 5.69% ± 1.87% and 5.24% ± 1.74% respectively. The d-value of 0.24 indicated that the prevalence of gastro-intestinal disease among patients in 2007 and 2008 was statistically small.

In 2007 and 2008 the month with the highest prevalence of gastro-intestinal disease prescriptions processed, was January with 7.17% and 6.53% respectively. December had the lowest prevalence of gastro-intestinal disease medication prescriptions processed (2.84%) in 2007, while the lowest prevalence of 2.62% for Gauteng was observed in November 2008. The mean prevalence percentages of gastro-intestinal disease medication prescriptions processed in 2007 and 2008 were 4.24% ± 1.36% and 3.81% ± 1.22% respectively. The d-value of 0.32 indicated that the difference in the prevalence percentages of 2007 and 2008 was statistically small.

4.5.2.4 The prevalence of gastro-intestinal disease in Kwa-Zulu Natal in the different months of 2007 and 2008

In Kwa-Zulu Natal, it was observed that the prevalence of gastro-intestinal disease among patients decreased from 2007 to 2008 with 5.92% and 5.36% respectively. It was also observed that the total number of patients in the primary database decreased from 2007 to 2008. The prevalence of the gastro-intestinal disease medication prescriptions processed also decreased from 2007 to 2008 with 4.34% to 3.88%. Also with regard to the total number of prescriptions in the primary database, a decrease occurred from 2007 to 2008 (Table 4.22).

January was the month in 2007 as well as 2008 in which the prevalence percentage of gastro-intestinal disease among patients was the highest (11.09% and 10.39% respectively). The prevalence of gastro-intestinal disease among patients decreased from January to December for each year (2007 and 2008) with November being the month with the lowest prevalence in each year with 3.60% and 3.07% respectively. The mean values for the

prevalence of gastro-intestinal disease among patients in 2007 and 2008 were 5.74% ± 2.21% and 5.13% ± 2.11% respectively. The d-value of 0.27 indicated that the difference in prevalence of patients with gastro-intestinal disease was statistically small.

The month with the highest prevalence of gastro-intestinal medication prescriptions processed in Kwa-Zulu Natal in 2007 as well as 2008 was January with 7.85% and 7.26% respectively. The prevalence percentage of the prescriptions for gastro-intestinal medication processed, decreased during the duration of both years with November being the month with the lowest prevalence percentage of 2.70% in 2007 and 2.29% in 2008. The mean values for the prevalence of gastro-intestinal disease medication prescriptions processed for 2007 and 2008 were 4.19% ± 1.54% and 3.70% ±1.45% respectavely. The d-value of 0.33 indicated that the difference in the prevalence persentages for both years was statistically small.

4.5.2.5 The prevalence of gastro-intestinal disease in Limpopo in the different months of 2007 and 2008

In Limpopo it was observed (Table 4.23) that the prevalence of gastro-intestinal disease among patients decreased from 2007 to 2008 with 6.49% to 6.09%. The prevalence of gastro-intestinal disease medication prescriptions processed also decreased from 4.96% in 2007 to 4.61% in 2008. The total number of patients as well as prescriptions in the total primary database decreased from 2007 to 2008 and may therefore contributed to the decrease on the prevalence of gastro-intestinal disease.

In both 2007 as well as 2008 January was the month with the highest prevalence of gastro-intestinal disease among patients, with 11.26% and 11.19% respectively. In 2007 the patient prevalence decreased every month, except for August (5.03%) when a slight increase was observed. December had the lowest patient prevalence of 4.11% in 2007. In 2008 the patient prevalence decreased every month for the duration of the year. December had the lowest patient prevalence with 3.53% in 2008. The mean prevalence percentage values for 2007 and 2008 were 6.27% ± 2.21% and 5.82% ± 2.28% respectively. The d-value obtained (0.20) indicated that the difference in the prevalence of gastro-intestinal disease among patients in 2007 and 2008 was statistically small.

The prevalence of gastro-intestinal disease medication prescriptions processed was the highest in January of 2007 as well as 2008 with 8.38% and 8.27% respectively. In both 2007 as well as 2008 the prevalence percentage of gastro-intestinal medication prescriptions

showed a gradual decrease throughout the year except in 2008 during August where there was a small elevation in the prevalence percentage (3.59%), whereafter the decrease continued. In both 2007 and 2008 the month with the lowest prevalence percentace of gastro-intestinal medication prescriptions processed, was December with 3.31% and 2.77% respectively. The mean values of the prevalence percentages of gastro-intestinal disease medication prescriptions processed were 4.78% ± 1.61% and 4.39% ± 1.67% respectively for 2007 and 2008. The d-value of 0.24 indicated that the difference between the prevalence percentages of 2007 and 2008 was statistically small.

4.5.2.6 The prevalence of gastro-intestinal disease in Mpumalanga in the different months of 2007 and 2008

The prevalence of gastro-intestinal disease among patients as well as the prevalence of prescriptions for gastro-intestinal disease decreased from 2007 to 2008. The patient prevalence decreased from 6.52% to 5.98% as well as the prevalence of gastro-intestinal disease medication prescriptions processed, by decreasing from 4.91% to 4.46%. This may have been due to the fact that the number of patients in the total database and therefore the number of prescriptions processed in the primary database decreased from 2007 to 2008 (Table 4.24).

When the prevalence percentage of gastro-intestinal disease among patients was investigated, it was found that January was the month with the highest patient prevalence percentage of 12.04% and 11.29% in 2007 and 2008 respectively. In both 2007 and 2008 the patient prevalence decreased each month in both 2007 and 2008. In 2007 there was a slight elevation in the patient prevalence in August. The month with the lowest patient prevalence percentage in 2007 was November and then another elevation in December. In 2008 the lowest patient prevalence percentage was December. No elevations were observed during 2008. The mean prevalence percentages for 2007 and 2008 were 6.32% ± 2.49% and 5.77% ± 2.39% respectively. The d-value of 0.22 indicated that the difference in the patient prevalence was statistically small.

The prevalence of gastro-intestinal disease medication prescriptions processed was the highest in January of 2007 and 2008 with 8.85% and 8.12% respectively. The prescription prevalence then decreased each month during 2007 with the lowest prevalence percentage in October, whereafter there was an increase in the prescription prevalence. In 2008 the prescription prevalence decreased each month until there was a slight elevation in November (2.90%), but then a decrease in December was observed, making it the month with the

lowest prescription prevalence. The mean prevalence values observed for 2007 and 2008 were 4.75% ± 1.83% and 4.30% ± 1.71% respectively. The d-value of 0.25 indicated that the difference in prescription prevalence between 2007 and 2008 was statistically small.

Table 4.20: Prevalence of gastro-intestinal disease in the Free State Province in 2007 and 2008

Months	2007			2008			2007			2008		
	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**
January	23098	2179	**9.43**	20928	2009	**9.60**	38096	2367	**6.21**	34333	2150	**6.26**
February	21658	1677	**7.74**	19698	1480	**7.51**	32933	1758	**5.34**	30699	1557	**5.07**
March	22671	1528	**6.74**	18889	1132	**5.99**	36218	1608	**4.44**	29616	1212	**4.09**
April	21777	1254	**5.76**	19867	1026	**5.16**	33213	1325	**3.99**	31563	1079	**3.42**
May	23315	1347	**5.78**	19723	1039	**5.27**	37456	1440	**3.84**	30986	1102	**3.56**
June	21901	1027	**4.69**	18652	825	**4.42**	34329	1080	**3.15**	29144	858	**3.00**
July	21870	971	**4.44**	19403	827	**4.26**	34576	1014	**2.93**	31098	873	**2.81**
August	23404	1050	**4.49**	18350	739	**4.03**	37575	1105	**2.94**	28695	783	**2.73**
September	19849	772	**3.89**	16609	573	**3.45**	29950	826	**2.78**	25766	613	**2.38**
October	19704	726	**3.68**	15936	572	**3.59**	30801	771	**2.50**	24924	615	**2.47**
November	18408	691	**3.75**	14845	503	**3.39**	28303	736	**2.60**	21927	524	**2.39**
December	16048	591	**3.68**	14180	505	**3.56**	23272	639	**2.75**	21135	535	**2.53**
TOTAL	253703	13813	**5.44**	217080	11230	**5.17**	396722	14669	**3.70**	339886	11901	**3.50**

*Prevalence %: Number of gastro-intestinal disease patients divided by the corresponding number of patients in the total database, multiplied by 100

**Prevalence %: Number of gastro-intestinal medication prescriptions divided by the corresponding number of prescriptions for the total database, multiplied by 100

Note that those patients that are not allocated to a specific province, are included in the total number of patients, but will not be further discussed.

Table 4.21: Prevalence of gastro-intestinal disease in Gauteng in 2007 and 2008

Months	2007			2008			2007			2008		
	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**
January	206733	20674	**10.00**	183634	16923	**9.22**	306289	21949	**7.17**	275098	17959	**6.53**
February	193862	15427	**7.96**	178221	13468	**7.56**	269234	16096	**5.98**	255583	14212	**5.56**
March	205724	14508	**7.05**	176084	11110	**6.31**	296778	15208	**5.12**	253611	11656	**4.60**
April	195077	11712	**6.00**	179423	10082	**5.62**	271895	12245	**4.50**	261693	10588	**4.05**
May	214902	13075	**6.08**	176497	9555	**5.41**	310914	13745	**5.06**	253630	9984	**3.94**
June	200040	10516	**5.26**	172549	8532	**4.94**	284406	10962	**3.85**	247766	8918	**3.60**
July	200689	9908	**4.94**	174748	8163	**4.67**	289123	10358	**3.58**	256715	8528	**3.32**
August	206796	10116	**4.89**	167546	7194	**4.29**	300951	10605	**3.52**	241026	7513	**3.12**
September	178371	7654	**4.29**	154332	6095	**3.95**	246083	8019	**3.26**	220398	6388	**2.90**
October	178342	7201	**4.04**	148061	5805	**3.92**	255540	7553	**2.96**	213669	6088	**2.85**
November	168233	6801	**4.04**	136861	4763	**3.48**	236430	7164	**3.03**	189676	4965	**2.62**
December	145055	5339	**3.68**	127491	4524	**3.55**	196383	5581	**2.84**	179630	4728	**2.63**
TOTAL	2293824	132931	**5.80**	1975447	106214	**5.38**	3264026	139485	**4.27**	2848495	111527	**3.92**

*Prevalence %: Number of gastro-intestinal disease patients divided by the corresponding number of patients in the total database, multiplied by 100

**Prevalence %: Number of gastro-intestinal medication prescriptions divided by the corresponding number of prescriptions for the total database, multiplied by 100

Note that those patients that are not allocated to a specific province, are included in the total number of patients, but will not be further discussed.

Table 4.22: Prevalence of gastro-intestinal disease in Kwa-Zulu Natal in 2007 and 2008

Months	2007			2008			2007			2008		
	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**
January	86317	9571	**11.09**	76854	7982	**10.39**	132745	10418	**7.85**	119314	8661	**7.26**
February	78686	6488	**8.25**	72485	5389	**7.43**	111912	6860	**6.13**	105695	5688	**5.38**
March	82110	5770	**7.03**	71081	4582	**6.45**	121371	6147	**5.06**	104309	4826	**4.63**
April	77849	4864	**6.25**	69991	3795	**5.42**	110818	5123	**4.62**	103342	4028	**3.90**
May	83006	5078	**6.12**	70072	3673	**5.24**	123482	5414	**4.38**	102671	3865	**3.76**
June	75928	3965	**5.22**	66413	3068	**4.62**	109794	4223	**3.85**	96807	3239	**3.35**
July	74732	3477	**4.65**	68285	3005	**4.40**	109098	3678	**3.37**	101689	3185	**3.13**
August	77738	3700	**4.76**	63134	2500	**3.96**	115225	3945	**3.42**	91467	2653	**2.90**
September	67669	2845	**4.20**	56914	2165	**3.80**	95108	3013	**3.17**	82440	2297	**2.79**
October	68975	2748	**3.98**	55350	1901	**3.43**	100977	2934	**2.91**	81330	2028	**2.49**
November	62745	2259	**3.60**	51369	1578	**3.07**	89356	2414	**2.70**	72541	1662	**2.29**
December	56557	2095	**3.70**	49407	1669	**3.38**	78041	2220	**2.84**	70583	1759	**2.49**
TOTAL	892312	52860	**5.92**	771355	41307	**5.36**	1297927	56389	**4.34**	1132188	43891	**3.88**

*Prevalence %: Number of gastro-intestinal disease patients divided by the corresponding number of patients in the total database, multiplied by 100

**Prevalence %: Number of gastro-intestinal medication prescriptions divided by the corresponding number of prescriptions for the total database, multiplied by 100

Note that those patients that are not allocated to a specific province, are included in the total number of patients, but will not be further discussed.

Table 4.23: Prevalence of gastro-intestinal disease in Limpopo in 2007 and 2008

Months	2007			2008			2007			2008		
	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**
January	34374	3871	**11.26**	26733	2991	**11.19**	49016	4108	**8.38**	38532	3187	**8.27**
February	29301	2668	**9.11**	24078	2117	**8.79**	39643	2768	**6.98**	33158	2215	**6.68**
March	30920	2483	**8.03**	23424	1692	**7.22**	42711	2582	**6.05**	32453	1773	**5.46**
April	29591	1983	**6.70**	23801	1434	**6.02**	40097	2075	**5.17**	33309	1489	**4.47**
May	32343	2188	**6.76**	24326	1472	**6.05**	45235	2295	**5.07**	33810	1527	**4.52**
June	29331	1654	**5.64**	22732	1218	**5.36**	40145	1717	**4.28**	31268	1285	**4.11**
July	28893	1424	**4.93**	23258	1107	**4.76**	39916	1486	**3.72**	32713	1156	**3.53**
August	31261	1572	**5.03**	22271	1069	**4.80**	43859	1649	**3.76**	30774	1105	**3.59**
September	26488	1207	**4.56**	20003	879	**4.39**	35310	1259	**3.57**	27567	919	**3.33**
October	25455	1172	**4.60**	18575	754	**4.06**	34960	1242	**3.55**	25590	796	**3.11**
November	22316	1015	**4.55**	15921	574	**3.61**	29891	1067	**3.57**	21080	600	**2.85**
December	19025	782	**4.11**	14742	520	**3.53**	24584	813	**3.31**	19443	539	**2.77**
TOTAL	339298	22019	**6.49**	259864	15827	**6.09**	465367	23061	**4.96**	359697	16591	**4.61**

*Prevalence %: Number of gastro-intestinal disease patients divided by the corresponding number of patients in the total database, multiplied by 100

**Prevalence %: Number of gastro-intestinal medication prescriptions divided by the corresponding number of prescriptions for the total database, multiplied by 100

Note that those patients that are not allocated to a specific province, are included in the total number of patients, but will not be further discussed.

Table 4.24: Prevalence of gastro-intestinal disease in Mpumalanga in 2007 and 2008

Months	2007			2008			2007			2008		
	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**
January	29518	3553	**12.04**	24326	2746	**11.29**	42700	3781	**8.85**	35486	2880	**8.12**
February	26567	2529	**9.52**	23299	2118	**9.09**	36105	2641	**7.31**	32406	2225	**6.87**
March	27977	2311	**8.26**	23091	1679	**7.27**	39416	2416	**6.13**	32211	1754	**5.45**
April	25577	1665	**6.51**	23128	1415	**6.12**	34864	1729	**4.96**	32828	1472	**4.48**
May	28752	1929	**6.71**	23416	1357	**5.80**	40695	2014	**4.95**	32961	1408	**4.27**
June	26339	1508	**5.73**	22344	1159	**5.19**	36731	1569	**4.27**	30979	1218	**3.93**
July	26408	1326	**5.02**	23333	1141	**4.89**	37168	1399	**3.76**	33161	1192	**3.59**
August	28034	1415	**5.05**	22467	992	**4.42**	40032	1472	**3.68**	31386	1034	**3.29**
September	23456	1087	**4.63**	20234	820	**4.05**	31699	1138	**3.59**	28061	876	**3.12**
October	23444	971	**4.14**	19137	732	**3.83**	32736	1005	**3.07**	26977	767	**2.84**
November	21221	857	**4.04**	16061	604	**3.76**	28840	901	**3.12**	21722	631	**2.90**
December	17668	730	**4.13**	15009	529	**3.52**	23345	769	**3.29**	20517	552	**2.69**
TOTAL	304961	19881	**6.52**	255845	15292	**5.98**	424331	20834	**4.91**	358965	16009	**4.46**

*Prevalence %: Number of gastro-intestinal disease patients divided by the corresponding number of patients in the total database, multiplied by 100

**Prevalence %: Number of gastro-intestinal medication prescriptions divided by the corresponding number of prescriptions for the total database, multiplied by 100

Note that those patients that are not allocated to a specific province, are included in the total number of patients, but will not be further discussed.

4.5.2.7 The prevalence of gastro-intestinal disease in the Northern Cape in the different months of 2007 and 2008

In the Northern Cape the prevalence of gastro-intestinal disease among patients decreased from 2007 to 2008 from 6.30% to 5.08%. The prevalence of gastro-intestinal disease medication prescription processing decreased from 4.46% to 3.66% in 2007 and 2008. The total number of patients as well as the number of prescriptions processed in the primary database, decreased from 2007 to 2008 (Table 4.25).

In 2007 and 2008 the month with the highest patient prevalence was in January with 11.09% and 8.60% respectively. In 2007 the patient prevalence then decreased every month up to July. In August there was an increase in the patient prevalence, followed by a decrease and then a small increase in November. December was the month with the lowest patient prevalence in 2007. In 2008 there was a decrease in the patient prevalence after January, up till July when there was a slight increase. Increases also occurred in September and December. November (2008) was the month with the lowest prevalence of gastro-intestinal disease among patients. The mean of the prevalence of gastro-intestinal disease among patients between 2007 and 2008, was 6.19% ± 2.13% and 4.96% ± 1.83% respectively. The d-value of 0.58 indicated that there was a medium difference between the prevalence of gastro-intestinal disease among patients in 2007 and 2008.

In 2007 and 2008 the month with the highest prevalence of gastro-intestinal disease medication prescriptions processed, was January. Thereafter the prescription prevalence decreased every month until an elevation was observed in November 2007, with December being the month with the lowest prescription prevalence. In 2008 there were elevations in June, September and December. The month with the lowest prescription prevalence was in November. The mean prescription prevalence values for 2007 and 2008 were 4.39% ± 1.50% and 3.61% ± 1.26% respectively. The d-value of 0.52 indicated that there was a medium difference between the prescription prevalences of 2007 and 2008.

4.5.2.8 The prevalence of gastro-intestinal disease in the North West Province in different months of 2007 and 2008

The prevalence of gastro-intestinal disease among patients decreased from 2007 and 2008 from 6.35% to 5.93%. The prevalence of the gastro-intestinal disease medication prescriptions also decreased from 2007 to 2008 by 4.64% and 4.31% respectively. An explanation for this decrease may be the decrease in the total number of patients as well as the total number of prescriptions processed in the primary database of 2007 and 2008 (Table 4.26).

In 2007 as well as 2008 the month with the highest patient prevalence was January with 11.83% and 11.64% respectively. The patient prevalence then decreased every month until the lowest patient prevalence was observed in December with 3.65% and 3.37% (for both 2007 and 2008) respectively. The mean values for the prevalence percentage of gastro-intestinal disease among patients for 2007 and 2008 respectively were 6.17% ± 2.39% and 5.71% ± 2.36% with a d-value of 0.16 indicating that the patient prevalence percentage between 2007 and 2008 was statistically small.

January of 2007 and 2008 was the month with the highest prevalence of gastro-intestinal disease medication prescriptions processed. The prescription prevalence then decreased every month with a slight increase in November (3.34%) and then further decrease in December with the lowest prescription prevalence of 2.81% in 2007. In 2008 the lowest prescription prevalence was in December with 2.54%. The mean prescription prevalence percentage values for 2007 and 2008 were 4.51% ± 1.71% and 4.13% ± 1.63% respectively. The d-value of 0.22 indicated that the difference in the prescription prevalence values of 2007 and 2008 was statistically small.

4.5.2.9 The prevalence of gastro-intestinal disease in the Western Cape in the different months of 2007 and 2008

In the Western Cape it was observed that the prevalence of gastro-intestinal disease among patients decreased from 2007 to 2008 by 4.27% and 4.05% respectively. The prevalence of gastro-intestinal disease medication prescriptions processed decreased from 3.11% to 2.91% from 2007 to 2008. The number of patients and the number of prescriptions processed in the primary database decreased from 2007 to 2008 (Table 4.27).

January of both 2007 and 2008 was the month with the highest prevalence of gastro-intestinal disease among patients with 7.18% and 6.72% respectively. In 2007 the month with the lowest prevalence of gastro-intestinal disease among patients was October with 2.97% and in 2008 the lowest prevalence of gastro-intestinal disease occurred during September. The mean prevalence values of gastro-intestinal disease in 2007 and 2008 were 4.23% ± 1.36% and 3.96% ± 1.34% respectively. The d-value of 0.20 indicated that the difference in the prevalence of gastro-intestinal disease among patients in 2007 and 2008 was statistically small.

When considering the prevalence of prescriptions processed for gastro-intestinal disease medications processed, it was observed that the month with the highest prescription

prevalence was during January in both 2007 and 2008 with 5.13% and 4.67% respectively. In 2007 the month with the lowest prescription prevalence was October with 2.13%. In 2008 the two months with the lowest prescription prevalence of 2.03% were September and October. The prescription prevalence decreased gradually throughout the duration of 2007 and 2008. The mean prescription prevalence values observed for 2007 and 2008 were 3.08% ± 0.98% and 2.84% ± 0.94% respectively. The d-value of 0.24 indicated that the difference in prescription prevalence between 2007 and 2008 was statistically small.

Table 4.25: Prevalence of gastro-intestinal disease in the Northern Cape in 2007 and 2008

Months	2007			2008			2007			2008		
	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**
January	7076	785	**11.09**	6910	594	**8.60**	10963	844	**7.70**	10577	647	**6.12**
February	6815	596	**8.75**	6653	492	**7.40**	9858	632	**6.41**	9810	516	**5.26**
March	7246	540	**7.45**	6668	455	**6.82**	11032	591	**5.36**	9838	482	**4.90**
April	6834	449	**6.57**	6832	391	**5.72**	9894	476	**4.81**	10250	412	**4.02**
May	7575	505	**6.67**	6723	356	**5.30**	11628	531	**4.57**	9964	374	**3.75**
June	7132	444	**6.23**	6641	270	**4.07**	10832	474	**4.38**	9859	290	**2.94**
July	6958	346	**4.97**	6680	284	**4.25**	10702	366	**3.42**	10052	305	**3.03**
August	7295	377	**5.17**	6432	250	**3.89**	11518	399	**3.46**	9587	263	**2.74**
September	6406	325	**5.07**	5925	236	**3.98**	9523	344	**3.61**	8620	250	**3.54**
October	6326	252	**3.98**	5706	196	**3.43**	9617	275	**2.86**	8413	209	**2.48**
November	6031	274	**4.54**	5164	152	**2.94**	9047	295	**3.26**	7262	159	**2.19**
December	4955	188	**3.79**	4938	151	**3.06**	6951	197	**2.83**	6778	156	**2.30**
TOTAL	80649	5081	**6.30**	75272	3827	**5.08**	121565	5424	**4.46**	111010	4063	**3.66**

*Prevalence %: Number of gastro-intestinal disease patients divided by the corresponding number of patients in the total database, multiplied by 100

**Prevalence %: Number of gastro-intestinal medication prescriptions divided by the corresponding number of prescriptions for the total database, multiplied by 100

Note that those patients that are not allocated to a specific province, are included in the total number of patients, but will not be further discussed.

Table 4.26: Prevalence of gastro-intestinal disease in the North West Province in 2007 and 2008

Months	2007			2008			2007			2008		
	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**
January	32590	3855	**11.83**	27497	3202	**11.64**	48877	4136	**8.46**	41856	3414	**8.16**
February	30176	2733	**9.06**	26461	2225	**8.41**	42549	2885	**6.78**	38236	2334	**6.10**
March	31214	2428	**7.78**	25762	1734	**6.73**	45715	2563	**5.61**	37228	1820	**4.89**
April	29565	1934	**6.54**	26558	1628	**6.13**	41633	2014	**4.84**	38927	1730	**4.44**
May	33068	2187	**6.61**	26410	1532	**5.80**	48427	2287	**4.72**	38569	1606	**4.16**
June	30259	1744	**5.76**	25063	1332	**5.31**	43846	1831	**4.18**	36097	1400	**3.88**
July	30228	1421	**4.70**	25349	1213	**4.79**	44071	1497	**3.40**	37222	1266	**3.40**
August	32353	1614	**4.99**	24401	1083	**4.44**	47970	1691	**3.53**	35086	1126	**3.21**
September	26336	1190	**4.52**	22325	946	**4.24**	36831	1244	**3.38**	31891	992	**3.11**
October	26633	1107	**4.16**	21088	874	**4.14**	38712	1183	**3.06**	30492	923	**3.03**
November	24389	1091	**4.47**	18916	663	**3.50**	34691	1160	**3.34**	25967	697	**2.68**
December	20589	751	**3.65**	17163	579	**3.37**	27949	785	**2.81**	23782	603	**2.54**
TOTAL	347400	22055	**6.35**	286993	17011	**5.93**	501271	23276	**4.64**	415353	17911	**4.31**

*Prevalence %: Number of gastro-intestinal disease patients divided by the corresponding number of patients in the total database, multiplied by 100

**Prevalence %: Number of gastro-intestinal medication prescriptions divided by the corresponding number of prescriptions for the total database, multiplied by 100

Note that those patients that are not allocated to a specific province, are included in the total number of patients, but will not be further discussed.

Table 4.27: Prevalence of gastro-intestinal disease in the Western Cape in 2007 and 2008

Months	2007			2008			2007			2008		
	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of patients in the total database	Total number of patients in the gastro-intestinal disease database	Prevalence %*	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**	Number of prescriptions in the total database	Number of prescriptions in the gastro-intestinal disease medication database	Prevalence %**
January	69207	4967	**7.18**	63858	4289	**6.72**	103612	5320	**5.13**	97460	4556	**4.67**
February	66975	4059	**6.06**	61363	3647	**5.94**	93758	4249	**4.53**	88839	3830	**4.31**
March	73470	4069	**5.54**	63319	3297	**5.21**	107518	4280	**3.98**	92157	3475	**3.77**
April	70065	3165	**4.52**	64095	2749	**4.29**	98602	3299	**3.35**	94326	2893	**3.07**
May	75063	3225	**4.30**	61559	2441	**3.97**	109825	3373	**3.07**	89411	2558	**2.86**
June	70761	2733	**3.86**	59949	2173	**3.62**	101772	2844	**2.79**	87397	2288	**2.62**
July	69601	2448	**3.52**	58283	1959	**3.36**	100921	2566	**2.54**	86413	2050	**2.37**
August	71080	2432	**3.42**	57634	1793	**3.11**	104118	2554	**2.45**	84047	1877	**2.23**
September	63656	1993	**3.13**	53525	1504	**2.81**	89695	2085	**2.32**	77854	1582	**2.03**
October	65106	1933	**2.97**	52928	1519	**2.87**	95428	2037	**2.13**	78775	1596	**2.03**
November	60483	1826	**3.02**	48693	1338	**2.75**	86908	1938	**2.23**	68859	1404	**2.04**
December	56279	1805	**3.21**	48262	1360	**2.82**	78583	1893	**2.41**	69591	1434	**2.06**
TOTAL	811746	34655	**4.27**	693468	28069	**4.05**	1170740	36438	**3.11**	1015129	29543	**2.91**

*Prevalence %: Number of gastro-intestinal disease patients divided by the corresponding number of patients in the total database, multiplied by 100

**Prevalence %: Number of gastro-intestinal medication prescriptions divided by the corresponding number of prescriptions for the total database, multiplied by 100

Note that those patients that are not allocated to a specific province, are included in the total number of patients, but will not be further discussed.

4.6 Gastro-intestinal disease medication prescribing patterns

In order to discuss the prescribing-patterns of gastro-intestinal disease medication, it is of importance to define gastro-intestinal disease medication. Gastro-intestinal disease medication, as redefined by the researcher to fit the scope of this study, is medication used in order to treat symptoms and disease caused by unsafe drinking water and inadequate sanitation. Symptoms of gastro-intestinal disease include diarrhoea, nausea, vomiting and abdominal cramps.

The data obtained, as discussed in section 3.5, had to comply with certain criteria specified by the researcher. Such criteria were based on results of the literature review conducted and discussed in chapter 2. The criteria specified by the researcher included the following:

- The claimed prescriptions had to contain one or more of the following medication groups indicated for the treatment of gastro-intestinal diseases as redefined by the researcher, using the MIMS® (Monthly Index of Medical Specialities)- classification (Snyman, 2008) and NAPPI codes for group 20.4 (minerals and electrolytes):
    - Group 1.8: Antivertigo and anti-emetics
    - Group 12.3: Antispasmodics
    - Group 12.7: Antidiarrhoeals
    - Group 18: Antimicrobials
    - Group 20.4: Minerals and electrolytes:
        - 781444004 Electropak®
        - 722871007 Electropak®
        - 701385001 Gastrolyte®
        - 707419002 Gastrolyte®
        - 779687019 Hydrol®
        - 815187009 Rehidrat®
        - 815195001 Rehidrat®
        - 815209002 Rehidrat®

- 759546010 Rehidrat®
- 762873019 Scripto-Lyte®
- 762873027 Scripto-Lyte®
- 707286001 Sorol Citrate®

Antimicrobials (group18) may only be included in the data when prescribed in combination with antivertigo and anti-emetic agents (group 1.8), antispasmodics (group 12.3), antidiarrhoeals (group 12.7) or minerals and electrolytes (electrolyte replacement) (group 20.4). All medications listed in group 18 and reported in the data are therefore assumed by the researcher to be used in the treatment of gastro-intestinal disease.

The discussion of the prescribing patterns of gastro-intestinal disease medication will first include the discussion of the pharmacological representation of the medicine items prescribed in order to treat gastro-intestinal disease on a national and provincial level, then a discussion of the twenty most prescribed active ingredients used in the treatment of gastro-intestinal disease on both a national and a provincial level and the drug status of the gastro-intestinal disease medication items.

4.6.1 Pharmacological representation of gastro-intestinal disease medication items prescribed

The pharmacological representation of the gastro-intestinal disease medication items prescribed is listed according to the MIMS®-classification (Snyman, 2008). It must be indicated that the individual number of gastro-intestinal disease medication items prescribed for each province may not add up to the total number of gastro-intestinal disease medication items prescribed, as some agents were not plased into specific pharmacological groups or were not correctly indicated in the data obtained. These items were not discussed in this study, although these items were included in the total number of items prescribed. A short summary of the groups of antimicrobial agents used and the gastro-intestinal disease pathogens against which the antimicrobial agents are used, is adapted from Table 2.5 (Nester *et al.,* 2001:598-618, O'Ryan *et al*., 2005:131) and presented in Table 4.28.

Table 4.28: Antimicrobial treatment used against enteric pathogens (Nester *et al.*, 2001:598-618, O'Ryan *et al*., 2005:131)

Anti-microbial treatment	Enteric pathogen
Beta-lactams (18.1)	*Eschericia coli* *Shigella* spp. *Salmonella* spp.
Erythromycin and other macrolides (18.2)	*Shigella* spp. *Campylobacter* spp. *Cryptosporidium parvum*
Aminoglycosides (18.3)	*Eschericia coli* *Campylobacter* spp.
Tetracyclines (18.4)	*Eschericia coli* *Campylobacter* spp. *Vibrio cholerae*
Chloramphenicols (18.5)	*Eschericia coli* *Salmonella* spp. *Vibrio cholerae*
Sulphonamides (18.6)	*Eschericia coli* *Shigella* spp. *Salmonella* spp. *Vibrio cholera* *Cyclospora cyatanensis*
Quinolones (18.7)	*Eschericia coli* *Shigella* spp. *Salmonella* spp. *Campylobacter* spp. *Vibrio cholerae*
Other anti-bacterial agents (18.9)	*Clostridium difficile*
Anti-protozoal agents (18.11)	*Clostridium difficile* *Giardia lamblia* *Entamoeba histolitica*

4.6.1.1 South Africa

In South Africa 428864 gastro-intestinal disease medication items were prescribed in 2007. In 2008 the number of gastro-intestinal disease medication items prescribed decreased to 340921 items. In both 2007 as well as 2008 (Table 4.29) the beta-lactams represented the highest proportion of gastro-intestinal disease medication items prescribed with 22.77% in 2007 and 20.85% in 2008. As beta-lactams (group 18.1) must be prescribed in combination with antivertigo and anti-emetic agents, or antispasmodics, or antidiarrhoeals, or minerals and electrolytes in order to be identified as gastro-intestinal disease medication, it can be assumed that the beta-lactams are used in the treatment of gastro-intestinal disease caused

by bacterial pathogens such as *Eschericia coli, Shigella* spp. and *Salmonella* spp. as stated in Table 2.5 and Table 4.28.

In both 2007 and 2008 antivertigo and anti-emetic agents (group 1.8) showed to be the second highest prescribed gastro-intestinal disease medication in South Africa with proportions of 18.68% and 19.32% respectively. This was followed shortly with the antispasmodics with 18.56% in 2007 and 19.29% in 2008. Antidiarrhoeals represented 11.06% of gastro-intestinal disease medication items prescribed in 2007 and 11.68% in 2008. Quinolones, representing 9.08% of gastro-intestinal disease medication items in 2007 and 9.42% in 2008, presented as the second most prescribed group of antimicrobial agents. Ouinolones (group 18.7) can be used in the treatment of gastro-intestinal diseases caused by *Eschericia coli, Shigella* spp., *Salmonella* spp., *Vibrio cholerae* and *Campylobacter* spp. (Table 2.5 and Table 4.28). It is important to note that minerals and electrolytes (group 20.4) listed as rehydration therapy in later discussions, are the first-line treatment agents in all gastro-intestinal diseases, as discussed in sections 2.4 and 2.8. Minerals and electrolytes represented only 2.99% in 2007 and 2.56% in 2008 of gastro-intestinal disease medication items prescribed. This indicates that gastro-intestinal diseases were not treated according to set standard treatment guidelines as discussed in sections 2.4 and 2.8.

Table 4.29: Pharmacological representation of gastro-intestinal medication items prescribed in South Africa

		2007		2008	
Pharmacological Classification		**Number of items prescribed**	**Proportion***	**Number of items prescribed**	**Proportion***
1.8	Anti-vertigo and anti-emetic agents	80124	18.68	65880	19.32
12.3	Antispasmodics	79586	18.56	65770	19.29
12.7	Antidiarrhoeals	47450	11.06	39814	11.68
18.1	Beta-lactams	97671	22.77	71069	20.85
18.2	Erythromycin and other macrolides	22534	5.25	17208	5.05
18.3	Aminoglycosides	734	0.17	495	0.15
18.4	Tetracyclines	5841	1.36	4775	1.40
18.5	Chloramphenicols	198	0.05	150	0.04
18.6	Sulphonamides and combinations	9056	2.11	6990	2.05
18.7	Quinolones	38942	9.08	32131	9.42
18.8	Mycobacteria	177	0.04	154	0.05
18.9	Other anti-bacterial agents	3148	0.73	2710	0.79
18.10	Anti-fungal agents	10341	2.41	8127	2.38
18.11	Anti-protozoal agents	10371	2.42	8517	2.50
18.12	Anti-viral agents	9880	2.30	8420	2.47
20.4	Minerals and electrolytes	12811	2.99	8711	2.56
Total		**428864**	**99.98**	**340921**	**100.00**

Proportion*: Number of items prescribed in each pharmacological group according to the MIMS®- classification, divided by the total number of gastro-intestinal disease medication items prescribed, multiplied by 100

4.6.1.2 Eastern Cape

As indicated in Table D2 in Appendix D the beta-lactam antibiotics were the gastro-intestinal disease agents most frequently prescribed in both 2007 and 2008 with a proportion of 22.81% and 20.96% respectively. In 2007 the antivertigo and anti-emetic agents were the second most often prescribed gastro-intestinal disease medicines in the Eastern Cape with a proportion of 20.23%, while in 2008 it formed the third most prescribed gastro-intestinal disease medicines with a proportion of 19.41%. With a proportion of 20.14% in 2007 and 20.79% in 2008, the antispasmodics were among on the top five most frequently prescribed gastro-intestinal medication items, with antidiarrhoeals occupying the fourth position in both 2007 and 2008 with a proportion of 12.18% and 12.71% respectively. Quinolones occupied the fith position with a proportion of 6.96% and 20.96% in 2007 and 2008 respectively. In 2007, 30917 (7.21% of the total number of gastro-intestinal disease medication items prescribed in South Africa in 2007) gastro-intestinal disease medication items were prescribed while in 2008 the number of gastro-intestinal disease medication items prescribed, decreased to 25884 items (7.59% of the total number of gastro-intestinal disease medication items prescribed in South Africa in 2008).

4.6.1.3 Free State

With 18061 gastro-intestinal disease medication items prescribed in 2007 and 14745 items in 2008, the Free State represented 4.21% and 4.33% of the total gastro-intestinal disease medication items prescribed in South Africa in 2007 and 2008 respectively (Table D3 in Appendix D). The antivertigo and anti-emetic agents (group 1.8) were the most frequently prescribed gastro-intestinal disease medication items prescribed in both 2007 and 2008 with proportions of 22.22% and 22.46% respectively. The beta-lactams held the second position among the top five gastro-intestinal disease medication items prescribed according to pharmacological classification. The proportion of gastro-intestinal disease medication items prescribed representing the beta-lactams was 21.19% and 19.46% in 2007 and 2008 respectively. Anitispasmodics, representing 18.67% and 19.53% of gastro-intestinal disease medication items prescribed in the Free State in 2007 and 2008 respectively, occupied the third position, followed by anti-diarrhoeals (group 12.7) with 11.74% and 12.81% in 2007 and 2008 respectively. The quinolones (group 18.7) formed the fifth most frequently prescribed gastro-intestinal disease medication items in 2007 with 9.42% and 9.49% in 2008.

4.6.1.4 Gauteng

Gauteng represented 40.61% (174147 items) and 40.71% (138775 items) of the total number of gastro-intestinal disease medication items prescribed in South Africa. As

indicated in Table D4 (Appendix D), the top five gastro-intestinal disease medication groups in 2007 were the beta-lactams (22.46%), antispasmodics (18.48%), antivertigo and anti-emetic agents (18.43%), antidiarroeals (9.76%) and the quinolones with 9.63%. In 2008 the beta-lactams represented 21.01% of gastro-intestinal disease medication items prescribed, the antispasmodics 19.41%, antivertigo and anti-emetic agents 19.12%, antidiarrhoels 10.49% and quinolones with10.26%. In both 2007 and 2008 minerals and electrolytes (rehydration therapy) only represented 2.63% and 2.31% of gastro-intestinal disease medication items prescribed eventhough the number of rehydration therapy items prescribed in Gauteng represented 35.72% and 36.87% of all rehydration therapy items prescribed in South Africa in 2007 and 2008 respectively.

4.6.1.5 Kwa-Zulu Natal

In 2007 (Table D5 in Appendix D), 70357 gastro-intestinal disease medication items were prescribed in Kwa-Zulu Natal and represented 16.41% of all the gastro-intestinal disease medication items prescribed in South Africa. In 2008, 16.21% of all gastro-intestinal disease medication items prescribed in South Africa, were prescribed in Kwa-Zulu Natal (55255 items). The beta-lactams (group 18.1) represented the largest proportion of gastro-intestinal disease medication items prescribed in Kwa-Zulu Natal in both 2007 (24.25%) and 2008 (21.89). The antivertigo and anti-emetic agents represented 16.58% and 17.88% of gastro-intestinal disease medication items prescribed in Kwa-Zulu Natal in 2007 and 2008 respectively. In 2007 and 2008, 16.31% and 16.75% respectively of the gastro-intestinal disease medication items prescribed were antispasmodics (group 12.3), while 12.61% and 12.53% respectively consisted of antidiarrhoeals (group 12.7). Quinolones represented 9.27% and 9.41% of gastro-intestinal disease medication items prescribed in Kwa-Zulu Natal in 2007 and 2008 respectively. The minerals and electrolytes (rehydration therapy items), however, represented higher proportions of the gastro-intestinal disease medication items prescribed in Kwa-Zulu Natal than in the other provinces discussed up to this point, with 4.01% in 2007 and 3.44% in 2008. This is an improvement in the treatment regime in Kwa-Zulu Natal, but it still does not indicate optimal treatment of gastro-intestinal disease.

4.6.1.6 Limpopo

As indicated in Table D6 (Appendix D) 28999 gastro-intestinal disease medication items were prescribed in Limpopo in 2007 and 21039 gastro-intestinal disease medication items in 2008. This represented 6.76% and 6.17% of the total number of gastro-intestinal disease medication items prescribed in South Africa in 2007 and 2008 respectively. In both 2007 and

2008 the highest proportion of gastro-intestinal disease medication items prescribed in Limpopo consisted of the beta-lactams (group 18.1) with 26.07% and 25.36% in 2007 and 2008 respectively. Antispasmodics represented 20.15% of gastro-intestinal disease medication items prescribed in Limpopo in 2007 and 20.37% of the gastro-intestinal disease medication items prescribed in Limpopo in 2008. In 2007 and 2008, 13.53% and 14.43% of gastro-intestinal disease medication items prescribed in Limpopo consisted of antivertigo and anti-emetic agents prescribed. Antidiarrhoeals represented 9.95% and 10.30% of gastro-intestinal disease medication items prescribed in 2007 and 2008 respectively. The quinolones represented 8.39% and 8.52% of gastro-intestinal disease medication items prescribed in 2007 and 2008, while 3.95% and 2.95% of the prescribed gastro-intestinal disease medication items prescribed in 2007 and 2008 respectively, consisted of rehydration therapy items.

4.6.1.7 Mpumalanga

The pharmacological classification of gastro-intestinal disease medication items prescribed in Mpumalanga is indicated in Table D7 in Appendix D. In 2007 a total of 26220 gastro-intestinal disease medication items appeared on prescriptions in Mpumalanga, representing 6.11% of all gastro-intestinal disease medication items prescribed in South Africa. In 2008, 20202 gastro-intestinal disease medication items were prescribed in Mpulalanga. This represented 5.93% of the total number of gastro-intestinal disease medication items prescribed in South Africa. In 2007 and 2008 beta-lactams represented 26.78% and 24.64% respectively of gastro-intestinal disease medication items prescribed in Mpumalanga. The antispasmodics represented 17.10% and 17.43% of the gastro-intestinal disease medication items prescribed in Mpumalanga in 2007 and 2008 respectively. Percentages of 15.57% and 15.55% of the gastro-intestinal disease medication items prescribed in Mpumalanga in 2007 and 2008 respectively, were antivertigo and anti-emetic agents (group 1.8), while the antidiarroeals represented 10.29% and 11.38% of gastro-intestinal disease medication items prescribed in Mpumalanga in 2007 and 2008 respectively. The quinolones (group 18.7) represented one of the top five pharmacological groups used in the treastment of gastro-intestinal disease in Mpumalanga, with a proportion of 9.89% and 10.23% in 2007 and 2008 respectively. Minerals and electrolytes represented 2.74% and 2.44% of the gastro-intestinal disease medication items prescribed in 2007 and 2008 respectively.

4.6.1.8 Northern Cape

In 2007, 6901 gastro-intestinal disease medication items were prescribed in the Northern Cape, representing 1.61% of he total number of gastro-intestinal disease medication items prescribed in South Africa in 2007. In 2008, 5200 gastro-intestinal disease medication items were prescribed in the Northen Cape (1.53% of the total number of gastro-intestinal disease medication items prescribed in South Africa). As indicated in Table D8 in Appendix D, beta-lactams (group 18.1) represented the largest proportion of gastro-intestinal disease medication items prescribed in the Northern Cape in 2007 with 21.72%. The antispasmodics represented 20.69%, antivertigo and anti-emetic agents represented 20.26%, antidiarrhoeals 11.58% and the quinolones represented 8.85% of the gastro-intestinal disease medication items prescribed in the Northen Cape in 2007. In 2008 the highest proportion of gastro-intestinal disease medication items prescribed was represented by the antispasmodics (group 12.3) with 22.15%. The antivertigo and anti-emetic agents represented 21.58%, beta-lactams with 17.67%, antidiarrhoeals with 11.50% and quinolones represented 10.67% of gastro-intestinal disease medication items prescribed in the Northern Cape in 2008.

4.6.1.9 North West

In 2007, 29360 gastro-intestinal disease medication items were prescribed in the North West Province, representing 6.85% of the total number of gastro-intestinal disease medication items prescribed in South Africa. In 2008, 23072 gastro-intestinal disease medication items were prescribed in the North West Province, representing 6.77% of the total number of gastro-intestinal disease medication items prescribed in South Africa. As indicated in Table D9 (Appendix D) the beta-lactams (group 18.1) represented the highest proportion of gastro-intestinal disease medication items prescribed in North West with 25.13% and 20.94% in 2007 and 2008 respectively. The antivertigo and anti-emetic agents represented 19.29% and 18.83% of the gastro-intestinal disease medication items prescribed in 2007 and 2008 in North West. In 2007, 16.93% of the prescribed gastro-intestinal disease medication items in North West consisted of antispasmodics, 9.42% were antidiarrhoeals and 9.39% were Quinolones. In 2008 the antispasmodics represented 17.22%, antidiarrhoeals 10.09% and the quinolones 8.95% of prescribed gastro-intestinal disease medication items in North West.

4.6.1.10 Western Cape

In 2007, the Western Cape represented 10.24% (43902 items) of all gastro-intestinal disease medication items prescribed in South Africa. This representation percentage increased in

2008 to 10.56% even though the number of gastro-intestinal medication items prescribed in the Western Cape decreased to 35995. This increase may be due to the decrease in the total number of gastro-intestinal disease medication items prescribed in South Africa. As indicated in Table D10 (Appendix D), the antivertigo and anti-emetic agents represented 25.11% and 25.94% (the highest proportion of gastro-intestinal disease medication items indicated according to the pharmacological classification in the Western Cape) of the number of gastro-intestinal disease medication items prescribed in the Western Cape in 2007 and 2008 respectively. The antispasmodics represented 21.88% and 22.73% of the prescribed gastro-intestinal disease medication items in 2007 and 2008 respectively. In 2007 the antidiarrhoeals represented 14.91%, the beta-lactams 16.30% and the quinolones 7.74% of the prescribed number of gastro-intestinal disease medication items in the Western Cape. In 2008 the antidiarrhoeals represented 15.79%, the beta-lactams 14.72% and the quinolones 7.77% of the total number of gastro-intestinal disease medication items prescribed in the Western Cape. In both 2007 and 2008 the proportion of minerals and electrolytes prescribed, remained low as only 2.92% and 2.62% of gastro-intestinal disease medication items prescribed in the Western Cape included agents used for rehydration therapy in 2007 and 2008 respectively.

4.6.2 The active ingredients used in the treatment of gastro-intestinal disease in South Africa

In order to determine the prescribing patterns in the treatment of gastro-intestinal disease in South Africa on both a national and a provincial level, the active ingredients prescribed (according to the MIMS®-classification specified as agents used in the treatment of gastro-intestinal disease) were counted on an item level and listed according to the twenty most frequently prescribed active ingredients used in the treatment of gastro-intestinal disease for both 2007 and 2008. The proportion percentage of each active ingredient was calculated by taking the number of items prescribed in the specified active ingredient group, divided by the total number of gastro-intestinal disease items prescribed (according to the geographical region), multiplied by 100. The restuls were presented in Table 4.30 and Appendix E.

Table 4.30: The twenty most frequently prescribed active ingredients redefined as gastro-intestinal medication in South Africa in 2007 and 2008

2007			2008		
Active ingredient	**Number of items prescribed**	**Proportion (%)**	**Active ingredient**	**Number of items prescribed**	**Proportion (%)**
South Africa					
Amoxycillin/Clavulanic acid	41487	9.67	Amoxycillin/Clavulanic acid	31351	9.20
Metoclopramide	27433	6.40	Metoclopramide	23035	6.76
Ciprofloxacin	24941	5.82	Ciprofloxacin	20619	6.05
Amoxycillin	22723	5.30	Loperamide	18107	5.31
Loperamide	20551	4.79	Amoxycillin	15932	4.67
Cyclizine	17636	4.11	Cyclizine	14029	4.12
Hyoscine/Dipyrone	16249	3.79	Hyoscine/Dipyrone	13725	4.03
Hyoscine Butylbromide	13990	3.26	Mebeverine	11594	3.40
Mebeverine	13204	3.08	Hyoscine Butylbromide	11530	3.38
Cinnarazine	11078	2.58	Cinnarazine	9738	2.86
Electrolyte replacement	10943	2.55	Hyoscine	8525	2.50
Hyoscine-N-Butylbromide	10604	2.48	Hyoscine-N-Butylbromide	8130	2.38
Hyoscine	10433	2.43	Electrolyte replacement	8047	2.36
Clarithromycin	9744	2.27	Kanamycin/Aminopentamide	8022	2.35
Prochlorperazine	9119	2.13	Prochlorperazine	7620	2.24
Kanamycin/Aminopentamide	9068	2.11	Clarithromycin	7138	2.09
Metronidazole	8825	2.06	Metronidazole	7119	2.09
Trimethoprom/Sulphamethoxazole	8639	2.01	Trimethoprim/Sulphamethoxazole	6835	2.00
Cefuroxime	8407	1.96	Cefuroxime	6120	1.80
Cefpodixime	8102	1.89	Domperidone	5737	1.68
Total	**428864**	**70.69**	**Total**	**340921**	**71.27**

Proportion (%): Number of items prescribed in the specified active ingredient group, divided by the total number of gastro-intestinal disease items prescribed (according to the specified geographical region), multiplied by 100

In 2007 the top twenty prescribed active ingredients represented 70.69% of the total number of gastro-intestinal disease medication items prescribed. In 2008 the top twenty active ingredients prescribed represented 71.27% of the total number of gastro-intestinal disease medication items.

In both 2007 and 2008 amoxycillin/clavulanic acid showed to be the most frequently prescribed active ingredient representing 9.67% (41487 items) and 9.20% (31351 items) of the total number of active ingredients (428864 items in 2007 and 340921 items in 2008 respectively) prescribed. This complies with the data obtained and discussed in section 4.6.1 as amoxycillin/clavulanic acid is a beta-lactam antibiotic (group 18.1) which rated in the group of gastro-intestinal disease medications most commonly prescribed in South Africa (Table 4.29). Beta-lactam antibiotics can be used in the treatment of gastro-intestinal

disease caused by *Eschericia coli, Shigella* spp. and *Salmonella* spp. as indicated in Table 4.28. Although amoxycillin/clavulanic acid can be used in the treatment of gastro-intestinal disease, it is not indicated in the standard treatment guidelines of gastro-intestinal diseases (Table 2.2) and therefore the "excessive" if not incorrect usage of this antibiotic in all provinces should be questioned and further investigated. As antimicrobial agents were only included in the data if prescribed together with either antivertigo and anti-emetic agents (group 1.8), antispasmodics (12.3), antidiarrhoeals (group 12.3) or minerals and electrolytes (group 20.4), it is assumed that the antimicrobial agents were used in the treatment of gastro-intestinal disease. This assumption had to be made in order to identify possible cases of gastro-intestinal disease as ICD-10 codes were incomplete on the data obtained.

The second most frequently prescribed active ingredient in both 2007 and 2008 was metoclopramide with 27433 items prescribed and a proportion percentage of 6.40% in 2007. In 2008 a total of 23035 items showed on prescriptions, representing 6.76% of the total number of gastro-intestinal disease medication items prescribed in South Africa. Metoclopramide is a substituted benzamide used to treat nausea and vomiting, except in cases of Miniere's disease, labarinthine disorders or motion sickness (Rossiter *et al.*, 2010:47). Metoclopramide, discussed in section 2.8.4 (anti-emetic agents) forms part of group 1.8 (antivertigo and anti-emetic agents) and forms part of the second most frequently prescribed group of gastro-intestinal disease medications in South Africa (Table 4.29). As metoclopramide forms part of the standard treatment guidelines of nonspecific nausea and vomiting in adults (DOH, 2008:13), the presense of metoclopramide among the top twenty most frequently prescribed active ingredients in the treatment of gastro-intestinal disease in South Africa was reasonable.

Ciprofloxacin, a flouroquinolone, discussed in section 2.8.5.1.1, was the third most frequently prescribed gastro-intestinal disease medication listed according to active ingredient in South Africa in 2007 and 2008. In 2007, 24941 ciprofloxacin items were prescribed, covering 5.82% of the total number of gastro-intestinal disease medication items prescribed in South Africa. In 2008, 23035 items (6.05%) were prescribed. Other than the beta-lactam antimicrobials, ciprofloxacin forms a very important part in the standard treatment guidelines of gastro-intestinal diseases in South Africa (DOH, 2008:10-34). Ciprofloxacin forms part of the treatment regimen of bacillary dysentery caused by *Salmonella* spp., *Shigella* spp., *Campylobacter* and *E. coli*, typhoid fever (*Salmonella typhi*) and cholera caused by *Vibrio cholerae* (Tables 2.2 and 4.29). The use of ciprofloxacin in the treatment of gastro-intestinal disease is therefore justified, but for an absolute conclusion to be made based on the

prescribing patterns, ICD-10 codes need to be available. ICD-10 codes will also be of value to determine the pathogen against which ciprofloxacin is used.

Loperamide, an antidiarrhoeal agent (group 12.7) was the fourth most frequently prescribed active ingredient used in the treatment of gastro-intestinal disease in South Africa in 2008. In 2007 loperamide was the fith most frequently prescribed actice ingredient used in the treatment of gastro-intestinal disease (Table E1 in Appendix E). Loperamide items representing a proportion of 4.79% (20551 items) of the total number of gastro-intestinal disease medication items prescribed, were prescribed in 2007. In 2008 the number of items decreased to 18107 (5.31%), but the ranking of the active ingredient improved by one position. Loperamide forms part of the standard treatment guidelines of acute diarroea without the presence of blood in the stool, as indicated in Table 2.2 and discussed in section 2.8.2 (antidiarrhoeal agents). It is important to note that loperamide is contra-indicated in the treatment of bacillary dysentery as well as amoebic dysentery (DOH, 2006:16-17). The use of loperamide and its position among the top twenty most frequently prescribed active ingredients used in the treatment of gastro-intestinal disease in South Africa is therefore justified.

In 2007 amoxycillin was the fourth most frequently prescribed gastro-intestinal disease medication item prescribed and in 2008 the fifth most prescribed gastro-intestinal disease medication item. This is a beta-lactam antimicrobial with 22723 items prescribed in 2007 (5.30%) and 15932 items prescribed in 2008 (4.67%). The use of this antimicrobial is the same as that of the amoxycillin/clavulanic acid combination, discussed earlier in this section, in gastro-intestinal disease (Table 4.28) but the use of this active ingredient in the treatment of gastro-intestinal disease may not be justified as amoxycillin does not form part of the standard treatment guidelines of gastro-intestinal disease (Table 2.2).

Cyclizine, an antivertigo and anti-emetic agent (group 1.8) formed part of the top twenty gastro-intestinal disease medication active ingredients prescribed in South Africa. In 2007, 17636 items representing 4.11% of the total number of gastro-intestinal disease medication items, listed according to active ingredient, prescribed in South Africa. Fourteen thousand and twenty-nine cyclizine items were prescribed in South Africa in 2008. This represented 4.12% of the total number of gastro-intestinal disease medication items prescribed in 2008. Cyclizine, discussed in section 2.8.4 (anti-emetic agents) is mainly used in the treatment of nausea and vomiting caused by labarinthine disorders and motion sickness (Rossiter *et al.*, 2010:48).

Hyoscine and its various derivatives (Hyoscine butylbromide and Hyoscine-N-butylbromide) together represent 8.17% and 8.27% of the total number of gastro-intestinal disease medication items prescribed in 2007 and 2008. Although the derivatives were indicated separately in Table E1 (Appendix E) it was discussed as one active ingredient namely hyoscine butylbromide. Hyoscine butylbromide (section 2.8.3), a belladonna alcaloid and semisynthetic, quaternary ammonium compound is mainly used for its antispasmodic effects on the gastro-intestinal and genito-urinary tracts (Rossiter *et al.,* 2010:44) and is also indicated as part of the standard treatment guidelines of abdominal pain (DOH, 2008:12). Hyoscine in combination with dipyrone, a pyrazalone derivative non-steroidal anti-inflammatory drug with analgesic, antipyretic as well as anti-inflammatory effects (Rossiter *et al.,* 2010:44) also form part of the top twenty gastro-intestinal disease medication items prescribed in South Africa. In 2007, 16249 (3.79%) hyoscine/dipyrone items were prescribed and in 2008 , 13725 items representing 4.03% of the gastro-intestinal disease medication items were prescribed. As hyoscine butylbromide forms part of the standard treatment guidelines of abdominal pain, its presence among the top twenty gastro-intestinal disease medication items prescribed is valid, although the ICD-10 codes were needed in order to rule out genito-urinary tract infections.

Mebeverine, as discussed in section 2.8.3 (antispasmodic agents), a synthetic anticholinergic ester with a tertiary amino group is selectively spasmolytic on the smooth muscle of the gastro-intestinal tract (Rossiter *et al*., 2010:43). In 2007, 13204 mebeverine items were prescribed, representing 3.08% of the total number of gastro-intestinal disease medication items prescribed in South Africa. In 2008 the number of mebeverine items prescribed was 11594, with a proportion percentage of 3.40% of the total number of gastro-intestinal disease medication items prescribed.

Cinnarazine, a piperazine derivative with antihistaminic effects used in the treatment of nausea and vomiting caused by motion sickness as well as nausea and vertigo associated with vestubilar disorders and Miniere's disease (Rossiter *et al.,* 2010:47) is listed in group 1.8 (antivertigo and anti-emetic agents). In 2007, 11078 cinnarazine items were prescribed and represented 2.58% of all redefined gastro-intestinal disease medication items prescribed. In 2008 the number of cinnarazine items prescribed was 9738, with a proportion percentage of 2.86%. Although cinnarazine is not indicated in the treatment of gastro-intestinal disease, it was included in the data on the basis that it was used to treat nausea and ICD-10 codes were incomplete and could therefore not exclude nausea and vomiting caused by motion sickness, vertigo or labarinthine disorders.

In 2007, 10943 electrolyte replacement items were prescribed, representing 2.55% of all gastro-intestinal disease medication items prescribed in South Africa. In 2008 the number of electrolyte replacement items prescribed was 8047, 2.36% of the total number of gastro-intestinal disease medication items prescribed. The electrolyte replacement items, listed in group 20.4 (minerals and electrolytes) and specified according to NAPPI-codes mainly consist of over-the-counter rehydration therapy items. Although electrolyte therapy forms the first line treatment of gastro-intestinal disease (Table 2.2), these items were not among the top three or the top ten gastro-intestinal disease medication items prescribed, but were only listed among the top twenty gastro-intestinal disease medication items prescribed, listed according to active ingredient. As these products can be obtained without a prescription and may therefore not be included in the data if not claimed, the true number of rehydration therapy items used cannot be indicated. The number of rehydration therapy items indicated in the data is the number if items claimed and this indicates that improvement is required in future with regard to rehydration therapy items used in the treatment of gastro-intestinal disease.

Clarithromycin with 9744 items prescribed in 2007 and 7138 items in 2008, represented 2.27% and 2.09% in 2007 and 2008 respectively of the total number of gastro-intestinal disease medication items prescribed in South Africa (Table E1 in Appendix E). Clarithromycin is a macrolide antimicrobial agent and can be used in the treatment of duodenal ulcers in combination with proton pump inhibitors caused by *Helicobacter pylori* and is also usead in the treatment of *Mycobacterium avium* infections (Rossiter *et al.,* 2010:289). As indicated in Tables 2.5 and 4.28, erythromycin and other macrolides can be used in the treatment of *Shigella* spp., *Campylobacter* spp. and *Cryptosporidium parvum* infections. The occurrence of clarithromycin among the top twenty active ingredients used in the treatment of gastro-intestinal disease in South Africa is not truly acceptable as clarithomycin was not indicated in the standard treatment guidelines of gastro-intestinal disease in South Africa. ICD-10 codes therefore need to be available to make true conclusions about the use of this medication.

Prochlorperazine, a phenothiazine derivative, blocks dopamine at the CETZ and therefore has anti-emetic activity (Rossiter *et al.,* 2010:49). This drug forms part of group 1.8 (antivertigo and anti-emetic agents) and was discussed in section 2.8.4 (anti-emetic agents). In 2007, 9119 items were prescribed, representing 2.13% of the total number of gastro-intestinal disease medication items prescribed. In 2008, 7620 items were prescribed. This

represented 2.24% of the total number of gastro-intestinal disease medication items prescribed in 2008 (Table E1 in Appendix E).

Kanamycin/aminopentamide is an antidiarrhoeal included in group 12.7 and is used in the treatment of specific and non-specific gastro-enteritis (Snyman, *ed.*, 2008:201). Kanamycin, an aminoglycoside (Rossiter *et al.,* 2010:295) and according to Tables 2.2 and 4.28, aminiglycosides can be used in the treatment of gastro-intestinal disease caused by *Eschericia coli* and *Campylobacter* spp. In 2007 and 2008, 9068 and 8022 kanamycin/aminopentamide items respectively, were prescribed, representing 2.11% and 2.35% of the total number of gastro-intestinal disease medication prescribed in South Africa (Table E1 in Appendix E).

In 2007, 8825 metronidazole items were prescribed. This represented 2.06% of the total number of gastro-intestinal disease medication items prescribed in South Africa. In 2008 the number of metronidazole items prescribed was 7119 (2.09%) (Table E1 in Appendix E). Metronidazole, discussed in section 2.8.5.4.1, was indicated in the treatment of amoebic dysentery caused by *Entamoeba histolytica* (DOH, 2008:28) as well as gastro-intestinal disease caused by *Giardia lamblia* and *Clostriduim difficile* (Tables 2.5 and 4.28). The ranking of metronidazole among the top twenty most frequently prescribed active ingredients used in the treatment of gastro-intestinal disease is therefore of importance as it indicates the occurrence of gastro-intestinal disease caused by protozoal agents.

Trimethoprim/sulphamethoxazole, also known as co-trimoxazole, is an antifolate drug and was discussed in sections 2.8.5.2 and 2.8.5.2.1. This sulphonamide was used in the treatment of gastro-intestinal diseases caused by *Eschericia coli, Shigella* spp., *Salmonella* spp., *Vibrio cholerae* and *Cyclospora cyatanensis* (Tables 2.5 and 4.28). As indicated in Table 2.2, Co-trimoxazole was included in the standard treatment guidelines of shigellosis in Lesotho. In 2007 and 2008, 8639 and 6835 trimethoprim/sulphamethoxazole items respectively were prescribed. This represented 2.01% and 2.00% of all gastro-intestinal disease medication items prescribed in South Africa in 2007 and 2008 respectively (Table E1 in Appendix E).

Cefuroxime, a second generation cephalosporin and cefpodoxime a third generation cephalosporin (Rossiter *et al.,* 2010:285) were listed in group 18.1 under the beta-lactam antibiotics and can therefore be used in the treatment of gastro-intestinal disease caused by *Eschericia coli, Shigella* spp. and *Salmonella* spp. (Tables 2.5 and 4.28). In 2007 and 2008 respectively, 8407 and 6120 cefuroxime items were presribed in South Africa, representing

1.96% and 1.80% of the total number of gastro-intestinal disease medication items prescribed in 2007 and 2008 respectively. In 2007, 8102 cefpodixime items were prescribed, representing 1.89% of the total number of gastro-intestinal disease medication items prescribed (Table E1 in Appendix E). In order to make truly accurate conclusions on the use of these cephalosporins in the treatment of gastro-intestinal disease, the availability of correct and complete ICD-10 codes is required.

Domperidone, a peripheral dopamine blocking agent, is used in the treatment of nausea and vomiting due to peripheral or central causes (Rossiter *et al.,* 2010:45) as discussed in section 2.8.4. In 2008, 5737 domperidone items were prescribed, representing 1.68% of the total number of gastro-intestinal disease medication items prescribed in South Africa in 2008 (Table E1 in Appendix E).

As indicated in Tables 4.31 and 4.32, the top twenty active ingredients used in the treatment of gastro-intestinal disease in the different provinces in 2007 and 2008 were indicated. A number (one to twenty) was allocated to the ranking positions of the different active ingredients in which order, from most to least,the medication acive ingredient was prescribed. In cases where the active ingredient was not listed in the top twenty gastro-intestinal disease medication items prescribed, the ranking was indidated as “NA” or not applicable. It is clear from both Tables 4.31 and 4.32 that the prescribing patterns of gastro-intestinal disease medication in the Western Cape, as well as the Northern Cape (2008) differ from the rest of the provinces. In the Western Cape, the most frequently prescribed gastro-intestinal disease medication active ingredient in both 2007 and 2008 was loperamide, an anti-diarrhoeal and not amoxycillin/clavulanic acid as in the rest of the provinces in 2007 and most provinces in 2008. This may indicate a different approach in the treatment of gastro-intestinal disease in the Western Cape, but the use of antimicrobials was still highly ranked. A more comprehensive Table with the different active ingredients prescribed, the number of items prescribed and the proportion percentage of the gastro-intestinal disease medications prescribed in all provinces in 2007 and 2008, is contained in Appendix E.

Table 4.31: The ranking of the top twenty most frequently prescribed gastro-intestinal disease medication active ingredients in each province in 2007

Active ingredient	SA	EC	FS	GP	KZN	LP	MP	NC	NW	WC
Amoxycillin/Clavulanic acid	1	1	1	1	1	1	1	1	1	3
Metoclopramide	2	3	2	2	4	4	4	2	2	2
Ciprofloxacin	3	6	3	3	2	3	2	3	3	5
Amoxycillin	4	2	5	4	3	2	3	4	4	7
Loperamide	5	4	4	7	5	5	6	5	5	1
Cyclizine	6	5	6	6	8	8	7	6	6	4
Hyoscine/Dipyrone	7	11	9	5	7	14	9	7	7	9
Hyoscine Butylbromide	8	7	15	13	6	6	5	13	8	11
Mebeverine	9	9	8	8	16	16	13	8	9	6
Cinnarazine	10	10	7	12	17	19	18	11	11	8
Electrolyte replacement	11	16	13	14	9	9	16	NA	14	14
Hyoscine-N-Butylbromide	12	12	NA	11	13	11	15	15	17	15
Hyoscine	13	8	12	NA	15	7	8	10	13	12
Clarithromycin	14	17	14	10	18	13	12	NA	10	20
Prochlorperazine	15	13	11	19	14	NA	NA	14	19	10
Kanamycin/Aminopentamide	16	NA	10	9	NA	NA	19	17	18	16
Metronidazole	17	15	NA	20	12	10	14	12	12	NA
Trimethoprom/Sulphamethoxazole	18	14	17	18	20	12	10	9	16	NA
Cefuroxime	19	19	19	15	NA	18	17	19	15	17
Cefpodixime	20	NA	20	16	11	NA	11	NA	20	NA
Chlorodyne/Kaolin/Pectin	NA	18	18	NA	10	20	20	NA	NA	19
Diphenoxylate/Atropine	NA	20	NA	NA	NA	NA	NA	NA	NA	NA
Domperidone	NA	NA	16	NA	19	NA	NA	NA	NA	18
Chlordiazepoxide/Clidinium Bromide	NA	NA	NA	17	NA	NA	NA	18	NA	13
Erythromycin estolate	NA	NA	NA	NA	NA	15	NA	NA	NA	NA

Table 4.31 (continued): The ranking of the top twenty most frequently prescribed gastro-intestinal disease medication active ingredients in each province in 2007

Active ingredient	SA	EC	FS	GP	KZN	LP	MP	NC	NW	WC
Hyoscine HBr/Hyocyam	NA	NA	NA	NA	NA	17	NA	16	NA	NA
Doxycycline	NA	NA	NA	NA	NA	NA	NA	20	NA	NA

NA: Not applicable

Table 4.32: The ranking of the top twenty most frequently prescribed gastro-intestinal disease medication active ingredients in each province in 2008

Active ingredient	SA	EC	FS	GP	KZN	LP	MP	NC	NW	WC
Amoxycillin/Clavulanic acid	1	1	1	1	1	1	1	3	1	3
Metoclopramide	2	4	2	2	2	4	3	2	2	2
Ciprofloxacin	3	5	4	3	3	2	2	1	3	5
Loperamide	4	3	3	6	4	5	5	4	5	1
Amoxycillin	5	2	9	5	5	3	4	8	4	10
Cyclizine	6	7	6	7	8	7	7	5	6	4
Hyoscine/Dipyrone	7	10	8	4	7	11	8	7	7	8
Mebeverine	8	8	5	8	17	16	11	6	11	6
Hyoscine Butylbromide	9	6	10	13	6	6	6	18	8	11
Cinnarazine	10	11	7	10	16	19	14	10	10	7
Hyoscine	11	9	13	18	11	8	10	9	12	13
Hyoscine-N-Butylbromide	12	13	NA	12	12	13	18	17	18	12
Electrolyte replacement	13	16	15	15	9	10	16	NA	17	14
Kanamycin/Aminopentamide	14	NA	12	9	NA	NA	17	19	14	15
Prochlorperazine	15	12	11	17	10	NA	NA	11	NA	9
Clarithromycin	16	16	19	11	20	17	13	20	13	20
Metronidazole	17	14	NA	16	13	12	12	13	15	NA
Trimethoprim/Sulphamethoxazole	18	15	16	NA	19	9	9	12	9	NA
Cefuroxime	19	NA	20	14	NA	18	19	NA	20	18
Domperidone	20	20	14	NA	14	NA	NA	NA	NA	17
Erythromycin Estolate	NA	18	NA	NA	NA	15	NA	NA	NA	NA
Diphenoxylate/Atropine	NA	19	NA	NA	NA	NA	NA	NA	NA	NA
Levofloxacin	NA	NA	NA	19	NA	NA	NA	NA	NA	NA

Table 4.32 (continued): The ranking of the top twenty most frequently prescribed gastro-intestinal disease medication active ingredients in each province in 2008

Active ingredient	SA	EC	FS	GP	KZN	LP	MP	NC	NW	WC
Chlorodyne/Kaolin/Pectin	NA	NA	18	NA	18	20	20	NA	NA	19
Chlordiazepoxide/Clidinium Bromide	NA	NA	NA	20	NA	NA	NA	NA	NA	16
Cefpodoxime	NA	NA	NA	NA	15	NA	15	NA	NA	NA
Hyoscine HBr/Hyoscyamide	NA	NA	NA	NA	NA	14	NA	14	NA	NA
Efavirenz	NA	NA	NA	NA	NA	NA	NA	NA	16	NA
Amoxycillin/Clavulanic acid	NA	NA	NA	NA	NA	NA	NA	NA	19	NA
Methixene/Pancreatin/Pepsin	NA	NA	NA	NA	NA	NA	NA	15	NA	NA
Doxycycline	NA	NA	NA	NA	NA	NA	NA	16	NA	NA

NA: Not applicable

4.6.3 Drug status of the gastro-intestinal disease medication items claimed in South Africa in 2007 and 2008

In South Africa, gastro-intestinal disease medication items are claimed and recorded on the medicine claims database under different drug status categories, namely acute, chronic, OTC (over-the-counter), oncology, PMB (Prescribed Minimum Benefits) and other not specified groups. According to Pugh *et al.* (2000:22) acute refers to a health condition that has a rapid onset and is not a condition of a prolonged effect. Pugh *et al.* (2000:348) defines chronic as a health condition that has a prolonged duration. Gastro-intestinal disease that has a sudden onset, such as diarrhoea and bacillary diarrhoea, can be considered as acute conditions. Diarrhoea lasting longer than two weeks is considered as being chronic and giardiasis may be considered as a common cause, it must be emphasised that chronic diarrhoea may be related to HIV (DOH, 2008:23-25). According to the Council for Medical Schemes (2010), PMB can be defined as a set of benefits to which all members belonging to a medical scheme have access. Medical schemes therefore cover any claims made (diagnosis, treatment and management) for emergency conditions, 270 predetermined medical conditions and 25 predetermined chronic conditions. OTC medications are those medications for which a prescription is not needed and claims for the medication can be made to the medical scheme of the patient. Gastro-intestinal disease medications can be claimed from the medical aid and are paid for from funds allocated to different drug statuses.

Tables 4.33 and 4.34 provide information regarding the different drug statuses of the different gastro-intestinal disease medication items claimed in the different provinces of South Africa in 2007 and 2008 respectively. In 2007 (Table 4.33) a total number of 428864 gastro-intestinal disease medication items were claimed. Acute gastro-intestinal disease medication items covered 89.52% (383898 items) of the total number of gastro-intestinal disease medication items claimed. Chronic claims represented 0.29%, OTC claims 7.58% and oncology 0.31%, PMB 1.59% and other not specified claims presented 0.72%. According to the data obtained, the high percentage of acute gastro-intestinal disease medication items claimed, complied with the epidemiology of different gastro-intestinal diseases discussed in sections 2.5 to 2.7.

In 2008 a total number of 340921 gastro-intestinal disease medication items were claimed in South Africa. Of the total number of gastro-intestinal disease medication items claimed, 88.99% were for acute gastro-intestinal medication items, 0.21% were chronic items, 7.59% were for OTC items, 0.49% were oncology items, PMB items covered 1.87% and not indicated items represented 0.86% (Table 4.34). The drug status of the claimed gastro-

intestinal disease medication items claimed in the different provinces of South Africa in 2008 is included in Table 4.34.

Table 4.33: Drug status of the claimed gastro-intestinal medication items in the different provinces in 2007

	Total	Acute		Chronic		OTC		Oncology		PMB		Other	
Province		**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
South Africa	428864	383898	89.52	1247	0.29	32514	7.58	1309	0.31	6819	1.59	3077	0.72
Eastern Cape	30917	26450	85.55	111	0.36	4139	13.39	7	0.02	88	0.28	122	0.39
Free State	18061	16417	90.90	148	0.08	1134	6.28	98	0.54	54	0.30	210	1.16
Gauteng	174147	157263	90.30	474	0.27	9199	5.28	385	0.22	5649	3.24	1177	0.68
KwaZulu-Natal	70357	62902	89.40	119	0.17	5879	8.36	591	0.84	671	0.95	195	0.28
Limpopo	28999	25867	89.20	37	0.13	2808	9.68	7	0.02	69	0.24	211	0.73
Mpumalanga	26220	24061	91.77	55	0.21	1658	6.32	17	0.06	100	0.38	329	1.25
North West	29360	27262	92.85	61	0.21	1581	5.38	7	0.02	114	0.39	335	1.14
Northern Cape	6901	6213	90.03	4	0.06	484	7.01	87	1.26	10	0.14	103	1.49
Western Cape	43902	37463	85.33	238	0.54	5632	12.83	110	0.25	64	0.15	395	0.90

%: Number of gastro-intestinal medication items claimed in the specific category (N), divided by the total number of gastro-intestinal disease items claimed in each province, multiplied by 100

Table 4.34: Drug status of the claimed gastro-intestinal medication items in the different provinces in 2008

	Total	Acute		Chronic		OTC		Oncology		PMB		Other	
Province		**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**	**N**	**%**
South Africa	340921	303371	88.99	729	0.21	25859	7.59	1661	0.49	6380	1.87	2921	0.86
Eastern Cape	25884	22199	85.76	120	0.46	3009	11.62	4	0.02	206	0.80	346	1.34
Free State	14745	13445	91.18	48	0.33	766	5.19	79	0.54	202	1.37	205	1.39
Gauteng	138775	126469	91.13	291	0.21	8042	5.79	538	0.39	2463	1.77	972	0.70
KwaZulu-Natal	55255	48334	87.47	48	0.09	4421	8.00	699	1.27	1509	2.73	244	0.44
Limpopo	21039	19099	90.78	60	0.29	1545	7.34	10	0.05	124	0.59	201	0.96
Mpumalanga	20202	18480	91.48	22	0.11	1206	5.97	41	0.20	195	0.97	258	1.28
North West	23072	19870	86.12	31	0.13	1298	5.63	14	0.06	1566	6.79	293	1.27
Northern Cape	5200	4663	89.67	8	0.15	354	6.81	77	1.48	23	0.44	75	1.44
Western Cape	35995	30098	83.62	101	0.28	5197	14.44	183	0.51	91	0.25	325	0.90

%: Number of gastro-intestinal medication items claimed in the specific category (N), divided by the total number of gastro-intestinal disease items claimed in each province, multiplied by 100

4.7 Application of the *Medicine Usage Standard* model in the North West Province

As referred to in sections 3.4.2 and 3.6.4, Serfontein proposed a model (2009) according to which the impact of water supply systems and sanitation facilities on medicine usage can be determined. The model, though not absolute, might be used in future to determine the impact that socio-economic factors have on the use of medication in South Africa. The model, known as the Medicine Usage Standard, is outlined in section 3.6.4 and all abbreviations were listed in the List of Abbreviations. The Community Survey 2007 data were essential in the calculation of the Medicine Usage Standard. The Medicine Usage Standard identifies the calculated factor by which medicine usage may increase by making use of a particular source of water and sanitation facility.

First the geographical household ratio (*gR*) was determined. This gave the average size of each household in a particular geographical area. The geographical prevalence descriptor source (*gPds*) provided the proportion (prevalence) of households with access to a particular water supply system or sanitation system. As described in section 3.6.4 an impact factor was provided to a particular water supply source and sanitation system. This determined the possible impact that each water supply source and sanitation system may possibly have on the medicine usage in a particular geographical area. These three factors were used to determine the Georaphical Additional Medicine Source (*gAds*), a value indicating the fraction by wich the geographical household ratio will “increase” in size. The *gAds* was used to determine the source medicine usage unit for a geographical area (*gUds*), a value giving the newly determined average household ratio based on the water source and sanitation facility. The *gUds* could also be described as the increase in medicine usage of each household in a geographical area based on the water source and sanitation facility. The estimated increase percentage in medicine usage calculated for each municipality in the North West Province, indicated the increase in gastro-intestinal medication usage for the households in the North West Province due to the use of a particular water source or sanitation facility.

As an example the medicine usage standard in Kgetlengrivier Local Municipality based on the water supply source was calculated (Table F1, Appendix F). By taking the use of water in daily lives into account, not depending on the source of the water, it was considered that the use of water may cause disease and in turn increase medicine usage, therefore a baseline impact factor of one was awarded. The water source used had an impact factor allocated to the source, with the smallest impact factor allocated to the best water source and the highest impact factor allocated to the worst water source. Piped water inside the dwelling

Medicine Usage Standard:

$$\textbf{Geographical Additional Medicine Source} = \left(\begin{array}{c}\text{Geographical}\\ \text{Household Ratio}\end{array}\right) \times \left(\frac{\text{Impact Descriptor Factor}}{10}\right) \times \left(\begin{array}{c}\text{Geographical Prevalence}\\ \text{Descriptor Source}\end{array}\right)$$

$$\boldsymbol{gAds} = \frac{\text{g Number of persons}}{\text{g Number of households}} \times \frac{Ids}{10} \times \frac{\text{Geographical number of households ds}}{\text{Geographical number of households}}$$

$$\boldsymbol{gAds} = gR \times \frac{Ids}{10} \times gPds$$

Source Medicine Usage Unit for GA = g Household Ratio + g Additional Medicine Usage Standard

$$\boldsymbol{gUds} = \frac{\text{g Number of persons}}{\text{g Number of households}} + \left(\frac{\text{g Number of persons}}{\text{g Number of households}} \times \frac{Ids}{10} \times \frac{\text{Geographical number of households ds}}{\text{Geographical number of households}}\right)$$

$$\boldsymbol{gUds} = gR + \left(gR \times \frac{Ids}{10} \times gPds\right) = gR + gR\left(\frac{Ids}{10} \times gPds\right) = gR\left(1 + \left(\frac{Ids}{10} \times gPds\right)\right)$$

$$\boldsymbol{gUds = gR\left(1 + \left(\frac{Ids}{10} \times gPds\right)\right)}$$

was considered to be a good water source and had an impact factor of two. To calculate the increase in medicine usage based on the water source, the resultant impact factor (*Ids*) had to be calculated. For piped water inside the dwelling, the resultant impact factor was one (impact factor minus the baseline impact factor). In Kgetlengrivier Local Municipality 4587 households had access to piped water inside their houses (dwellings), giving the proportion of households in a geographical area with access to a particular water supply system (*gPds*) to be 0.44. The average size of each household (*gR*) in the Kgetlengrivier Local Municipality was 3.59 persons. The *gAds* was calculated and indicated that due to the water source being piped water inside the dwelling, the household ratio would "increase" with 0.16 persons. This could also be interpreted by using the *gUds* where the medicine usage of each household would represent the medicine usage of a household consisting out of 3.75 persons and not 3.59 persons as calculated in the *gR*. This was an estimated increase of 4.46% in gastro-intestinal medication usage in the Kgetlengrivier Local Municipality due to piped water inside the dwelling. The Medicine usage standard model as calculated for the North West Province will be discussed shortly in the section below. Refer to Appendices F and G for the Medicine usage standard as determined for water source and sanitation facilities respectively.

When ranking the different municipalities of North West according to the estimated increase in medicine usage (%) for the differrent water supply systems, it was found that the top five municipalities with the highest estimated increases in medicine usage were Ratlou Local Municipality (40.14%), Kagisano Local Municipality (36.92%), Greater Taung Local Municipality (35.93%), Mafikeng Local Municipality (32.18%) and Moretele Local Municipality (30.09%). When considering the different water supply systems in these five municipalities, it was found that not only in these municipalities but in ten other municipalities in North West the main water source, having an increasing factor in the medicine usage, was piped water with an access point within 200 metres of the dwelling. Although the resultant impact factor of this water source was relatively low (two), the number of households relying on this water source increased the estimated gastro-intestinal medication usage in those particular municipalities more than any other water source. Refer to section 2.2.2 for a discussion of the possible negative impact that water from a communal tap might have on health and the importance of other socio-economic factors on that matter. However, it must be emphasised that the households making use of these water sources and sanitation facilities that may have a relatively high impact on medicine usage, are mostly in the lower income sector of the population and these households may therefore not be represented in the medicine claims data received.

These findings therefore emphasised that although piped water with an access point within 200 metres of the dwelling may be considered a good water source (refer to section 3.6.4), other socio-economic factors must be further investigated to fully determine the impact thereof on the prevalence of gastro-intestinal disease and in turn on gastro-intestinal medication usage.

When the impact of different sanitation facilities on the estimated increase in gastro-intestinal disease medication usage was investigated, the municipalities of the North West Province were ranked from the largest to the smallest estimated increase (%) in gastro-intestinal medication usage. The top five municipalities with the highest estimated increase (%) in gastro-intestinal medicine usage were Ramotshere Local Municipality (51.05%), Kagisano Local Municipality (49.47%), Moretele Local Municipality (48.05%), Greater Taung Local Municipality (47.19%) and Moses Kotane Local Municipality (44.15%). The sanitation facility that had the highest impact on the estimated increase (%) in gastro-intestinal medicine usage in these five municipalities as well as well as eight other North West municipalities was a pit toilet without ventilation. Both the relatively high impact factor (seven) allocated to this facility as well as the estimated high number of households relying on this type of sanitation facility make this facility, also considered not to be an optimal sanitation facility (refer to section 3.6.4), one that needs improvement in future.

This model by Serfontein (2009) is not absolute and the impact factors allocated to water supply systems and sanitation facilities may change according to the situation investigated. It is then recommended that the model be further refined and other socio-economic factors taken into account when investigating the possible impact that a water supply system and sanitation facility may have on medicine usage. However, the refinement of this model falls outside the scope of this study.

4.8 Correlation between geographical area, water quality, the prevalence of gastro-intestinal disease and gastro-intestinal medication usage

In order to summarise some of the key findings of this study Table 4.35 was constructed. Note that these results are only reported up to provincial level and to identify whether there may be a correlation between the geographical area, water quality, the prevalence of gastro-intestinal disease and gastro-intestinal medication usage, sections 4.2 and 4.6 provide a more extensive discussion of this matter up to district and municipality level.

Table 4.35: Summary of the Blue Drop Scores (DWA, 2010:5), prevalence of gastro-intestinal disease and proportion of gastro-intestinal medication usage in the different provinces of South Africa

		Prevalence of gastro-intestinal disease (%)		Proportion of medicine items used (%)*	
Province	**Blue Drop Score (%)**	**2007**	**2008**	**2007**	**2008**
Eastern Cape	79.40	21.30	20.98	7.21	7.59
Free State	48.50	18.00	17.62	4.21	4.33
Gauteng	85.54	17.54	16.79	40.61	40.71
Kwa-Zulu Natal	65.91	17.43	16.47	16.41	16.21
Limpopo	54.95	16.17	15.38	6.76	6.17
Mpumalanga	65.42	17.86	17.14	6.11	5.93
North West	66.01	18.32	17.72	6.85	6.77
Northern Cape	46.87	19.79	16.97	1.61	1.53
Western Cape	92.45	12.54	12.10	10.24	10.56

Prevalence of gastro-intestinal disease (%): The number of patients that claimed gastro-intestinal disease medication, divided by the total number of patients in that province, multiplied by 100.

Proportion of medicine items used (%)*: The number of gastro-intestinal disease medication items prescribed in that province, divided by the total number of gastro-intestinal medication items prescribed in South Africa, multiplied by 100.

From Table 4.35 it can be observed that the province with the best water quality based on the Blue Drop Report (DWA, 2010:5) was the Western Cape. In both 2007 as well as 2008 the Western Cape had the lowest prevalence in gastro-intestinal disease in South Africa. According to the proportion of gastro-intestinal disease medication items prescribed, the Western Cape, however, had the third highest proportion percentage, which may indicate that more gastro-intestinal disease items were prescribed per patient. The Northern Cape had the lowest Blue Drop Score (46.87%) of all the provinces and the second highest prevalence in gastro-intestinal disease in 2007. It should be noted that the proportion percentage of gastro-intestinal medication items prescribed in the Northern Cape is the lowest and may indicate that fewer gastro-intestinal disease medication items may have been prescribed per patient. In both 2007 and 2008 the Eastern Cape had the highest

prevalence in gastro-intestinal disease even though the Blue Drop Score was 79.40%. These findings indicate that future research need to be conducted in order to determine whether there is a correlation between geographical area, water quality, gastro-intestinal disease prevalence and medicine usage as time restrictions attached to this study limited an extensive investigation.

4.9 Chapter summary

The results obtained from the empirical investigation were reported and discussed. The geographical distribution of gastro-intestinal disease in South Africa as well as the different provinces, districts and municipalities were determined. Prevalence of gastro-intestinal disease in different age groups and genders were investigated, as well as the seasonal prescribing patterns of gastro-intestinal disease medication in the different provinces of South Africa. The gastro-intestinal disease medication prescribing patterns were investigated with special reference to the pharmacological representation of gastro-intestinal medication items prescribed, the active ingredients used in the treatment of gastro-intestinal disease and the drug status of the gastro-intestinal medication items claimed. Lastly the Medicine Usage Standard model (Serfontein, 2009) was applied in the North West Province to determine the possible impact that a water source and sanitation facility might have on medicine usage. In chapter five conclusions and recommendations will be made based on the research objectives of this study.

CHAPTER 5

Conclusions and recommendations

In this chapter the conclusions attached to this study will be presented. The discussions will refer to the objectives investigated by the literature review and the empirical investigation. The limitations of this study will be stated and finally recommendations regarding this study as well as future investigations will be discussed.

5.1 Introduction

The general objective of this study was to determine the prescribing patterns of gastro-intestinal medication in different geographical areas in the private health care sector of South Africa. A retrospective drug utilisation review was conducted and a pharmacoepidemiological approach followed. Special emphasis was placed on the epidemiology of gastro-intestinal diseases.

5.2 Conclusions

The Specific objectives of this study were divided into a literature review and an empirical investigation. The conclusions based on the different specific objectives will be discussed briefly.

5.2.1 Conclusions based on the literature review

The literature review, as discussed in chapter two, will be referred to in the following section. The objectives will be stated in order to formulate the relevant conclusions.

- ***The first specific objective of the literature review was to determine from the literature which gastro-intestinal diseases may be caused by poor quality of drinking water and of sanitation in South Africa, compared to the international environment.***

As indicated in section 2.2.2 only water-borne diseases such as cholera, dysentery, typhoid, giardiasis and gastroenteritis that spread via polluted water and water-washed diseases caused by the lack of water for sanitary purposes, such as salmonellosis and amoebic dysentery (Ashbolt, 2004:232; Mintz *et al.*, 2001:1565; White *et al*., 2002:64-66), that affect the gastro-intestinal tract by causing symptoms such as diarrhoea, nausea, vomiting and

abdominal cramps were considered by the researcher as gastro-intestinal disease. The impact of water quality on human health in South Africa was discussed in section 2.3. In section 2.4.1 Theron and Cloete (2002:4-7) stated that newly recognised water-borne pathogens that need to be investigated are *Eschericia coli* O157, *Campylobacter, Helicobacter* and *Cyclospora*. Peters *et al*. (1995:43) reported the presence of atypical mycobacteria in tapwater in Berlin. Although the pathogens that cause gastro-intestinal disease in South Africa are not clearly different from those pathogens causing gastro-intestinal disease in other countries, it must be emphasised that all the pathogens discussed in sections 2.5, 2.7 and 2.6 do pose threats in causing gastro-intestinal disease in South Africa as well as other countries and those pathogens are therefore considered to be of clinical importance. More investigation on an empirical level is required in order to investigate currently known as well as not yet identified pathogens that may cause gastro-intestinal disease in South Africa.

- ***The second specific objective of the literature review was to determine which gastro-intestinal medications are prescribed in South Africa.***

In order to identify the gastro-intestinal disease treatment regimes in South Africa, the Standard Treatment Guidelines as determined by the Department of Health (2008) were consulted and a tabulated version of the treatment guidelines was provided in Table 2.2 (section 2.4.1). Sections 2.5, 2.6 and 2.7 provided information regarding the treatment of gastro-intestinal disease caused by the discussed pathogen in that section. Section 2.8 provided pharmacological information regarding the treatment of gastro-intestinal disease on an international as well as South African level.

In order to truly determine which gastro-intestinal disease medication was prescribed in South Africa, an empirical investigation was performed on a national as well as a provincial level. In section 4.6 the gastro-intestinal disease medication prescribing patterns were discussed. Refer to sections 4.6.1 (pharmacological representation of the gastro-intestinal disease medication items prescribed), 4.6.2 (the active ingredients used in the treatment of gastro-intestinal disease in South Africa) and section 4.6.3 (drug status of the gastro-intestinal disease medication items claimed).

In 2007 and 2008 the most frequently prescribed gastro-intestinal medication pharmacological groups were beta-lactam anti-microbials, antivertigo and anti-emetic agents, antispasmodics, antidiarrhoeals and quinolone antimicrobials. Minerals and electrolytes represented only a small proportion of the prescribed gastro-intestinal medication in South

Africa. In the Free State and Western Cape antivertigo and anti-emetic agents were the most frequently prescribed gastro-intestinal medication items according to pharmacological groups, while in other provinces beta-lactam antimicrobials ranked highest. In all provinces except the Western Cape and the Northern Cape, amoxicillin/clavulanic acid was the most frequently prescribed gastro-intestinal medication active ingredient. In the Western Cape loperamide was the most frequently prescribed active ingredient, while ciprofloxacin was the most frequently prescribed active ingredient in the Northern Cape in 2008.

5.2.2 Conclusions based on the empirical investigation

The empirical investigation was reported and discussed in chapter four. In order to provide more insight with regard to the different objectives stated it is necessary to refer to chapter four as well as the appendices specified in the referred sections.

- ***The first specific objective of the empirical investigation was to determine the geographical distribution of gastro-intestinal diseases based on prescribing patterns of gastro-intestinal medication in specific geographical areas of South Africa such as provinces, districts and municipalities.***

In order to conclude on the first specific objective of the empirical investigation, it is necessary to refer to section 4.2.1 where the prevalence of gastro-intestinal disease in the different provinces of South Africa was discussed. In 2007 it was found that the prevalence of gastro-intestinal disease in South Africa was 17.04%. The Eastern Cape had the highest prevalence of gastro-intestinal disease in 2007 with 21.30% while the Western Cape had the lowest prevalence (12.54%). In 2008 the prevalence of gastro-intestinal disease in South Africa was 16.27%, with the Eastern Cape having the highest prevalence of 20.98% and the Western Cape the lowest prevalence (12.10%). The prevalence of gastro-intestinal disease in the different districts of South Africa in 2007 and 2008 was calculated and discussed in section 4.2.2. The top twenty districts with the highest gastro-intestinal disease prevalence in 2007 and 2008 were listed in Table 4.5 and visually represented in Figures 4.4 and 4.5. The prevalence of gastro-intestinal disease in the different municipalities of South Africa was calculated and discussed in section 4.2.3. The top twenty municipalities with the highest prevalence percentages were listed in Table 4.9 and visually represented in Figures 4.10 and 4.11.

The estimated gastro-intestinal disease prevalence index (%) was determined in order to estimate whether gastro-intestinal medication claims constitute a significant proportion of the

medicine claims made by the higher income sector of South Africa (households earning R 76801-00 per annum and more) as discussed in section 3.7.4. The gastro-intestinal disease prevalence index was calculated for the different provinces, districts and municipalities and the application discussed in sections 4.2.1, 4.2.2 and 4.2.3.

- ***The second specific objective of the empirical investigation was to determine the influence of age and gender on gastro-intestinal medication prescribing patterns in the different geographical areas of South Africa.***

In section 4.3 the prevalence of gastro-intestinal disease in different age groups was investigated up to provincial level. In 2007 the prevalence of gastro-intestinal disease was the highest in the age group 0 - ≤ 5 years (9.07%), while the smallest prevalence was observed in the age group of > 60 years (2.52%). In 2008 the age group with the highest prevalence in gastro-intestinal disease was the 0 - ≤ 5 years group with 8.49%, while the lowest prevalence was observed in the age group > 60 years with 2.45%.

In section 4.4 the prevalence of gastro-intestinal disease according to gender was calculated up to provincial level and discussed. The relative risk being slightly higher than one indicated that the risk for females to develop gastro-intestinal diseases was higher than that for males, though not significantly higher. The calculated odds ratio smaller than 1.50 indicated that the odds for females to develop such diseases compared to males, was small (Steyn, 2009:40).

- ***The third specific objective of the empirical investigation was to determine whether seasonal gastro-intestinal medication patterns could be identified from the database.***

As discussed in section 4.5 the data as well as prevalence percentages obtained regarding the prevalence of gasto-intestinal disease in the different months of 2007 and 2008, rendered certain findings and it can be concluded that the prevalence of gastro-intestinal disease in South Africa decreased from January to December in both the study periods of 2007 and 2008. This did not comply with the findings in the literature that some gastro-intestinal diseases have a higher prevalence during certain months of the year (refer to sections 2.5, 2.6 and 2.7). The general observation does, however, comply with the data obtained from the PBM, as indicated in Figure 4.19 (section 4.5.1) and it may then be stated that the data were not sufficient in order to indicate seasonal trends in the prevalence of gastro-intestinal disease. This is a limitation of the study as the depletion of funds of beneficiaries may influence the way in which patients claim gastro-intestinal disease medication, e.g. towards

the end of the year. The prevalence of gastro-intestinal disease in different months of 2007 and 2008 in the different provinces of South Africa was discussed in section 4.5.2.

- ***The fourth specific objective of the empirical investigation was to investigate whether water quality is an indicator of gastro-intestinal disease by making use of a medicine claims database, the Blue Drop Report (DWA, 2010), the Green Drop Report (DWA, 2009) and the proposed model by Serfontein (2009).***

In order to investigate whether there was a correlation between the prevalence of gastro-intestinal disease and the Blue Drop Scores and Green Drop Scores for the top twenty districts with the highest gastro-intestinal disease prevalences Tables 4.7 and 4.8 as well as Figures 4.8 and 4.9 were compiled. It can be concluded that the prevalence of gastro-intestinal disease among patients cannot be attributed to the Blue Drop Score or the Green Drop Score in an absolute manner. One example for substantiating this statement is that Nelson Mandela Bay Metro had a Blue Drop Score of 95.10%, indicating that water quality is managed with excellence (DWA, 2010:10) and a Green Drop Score of 70.00%, indicating that waste water quality performance was adequate (DWA, 2009:17), yet this district had the second highest gastro-intestinal disease prevalence in South Africa in 2007. In the case of O.R. Tambo, the gastro-intestinal disease prevalence (22.82% in 2007 and 20.66% in 2008) may be attributed to the quality of drinking water and poor waste water management, as the Blue Drop Score was 22.20% and the Green Drop Score was 0.00%.

In order to determine whether there was a correlation between the prevalence of gastro-intestinal disease and the corresponding Green Drop Scores (2009) as well as the Blue Drop Scores (2010) of the top twenty municipalities with the highest gastro-intestinal disease prevalence in 2007 and 2008, Tables 4.11 and 4.12 as well as Figures 4.14 and 4.15 were compiled. It can be concluded that the prevalence of gastro-intestinal disease cannot absolutely be attributed to the drinking water quality or the waste water management in each municipality, but that either one or both may lead to a high prevalence of gastro-intestinal disease. As the Blue Drop Report and the Green Drop Report are not conclusive and cannot be absolutely linked to gasto-intestinal disease, further research in this sector is required as well, as on the influence of other socio-economic factors on gastro-intestinal disease.

- ***The fifth specific objective of the empirical investigation was to investigate whether there is a correlation between water quality, geographical area and the prevalence of gastro-intestinal disease and gastro-intestinal medication usage in the private health care sector of South Africa.***

In order to conclude on this specific objective, reference is made to section 4.2.1 in which the prevalence of gastro-intestinal disease in different provinces was discussed and section 4.6.1 in which the proportion of gastro-intestinal disease medication items prescribed in different provinces were discussed. Information regarding the water quality according to the Blue Drop Scores assigned was obtained from DWA (2010:5). To fully illustrate the results of this study Table 4.35 was constructed to report on the summarised findings. Note that these results are only reported up to provincial level and to identify whether there may be a correlation between water quality, the geographical area, the prevalence of gastro-intestinal disease and gastro-intestinal medication usage, sections 4.2 and 4.6 provide a more extensive discussion of this matter up to district and municipality level. Further investigation into this matter is required.

From Table 4.35 it can be observed that the province with the best water quality based on the Blue Drop Report (DWA, 2010:5) was the Western Cape. In both 2007 as well as 2008 the Western Cape had the lowest prevalence in gastro-intestinal disease in South Africa. According to the proportion of gastro-intestinal disease medication items prescribed, the Western Cape however had the third highest proportion percentage, which may indicate that more gastro-intestinal disease items were prescribed per patient. The Northern Cape had the lowest Blue Drop Score (46.87%) of all the provinces and the second highest prevalence in gastro-intestinal disease in 2007. It should be noted that the proportion percentage of gastro-intestinal medication items prescribed in the Northern Cape is the lowest and may indicate that fewer gastro-intestinal disease medication items may have been prescribed per patient. In both 2007 and 2008 the Eastern Cape had the highest prevalence in gastro-intestinal disease even though the Blue Drop Score was 79.40%. These findings indicate that future research need to be conducted in order to determine whether there is a correlation between water quality, gastro-intestinal disease prevalence and medicine usage as time restrictions attached to this study limited an extensive investigation.

- ***The sixth specific objective of the empirical investigation was to determine the value of the impact factors (model of Serfontein, 2009) to be allocated to the different water sources and toilet facilities.***

As indicated in section 3.6.4 the values of the different impact factors to be allocated to different water sources and sanitation facilities, are not absolute and may be changed by the researcher based on the situation in which the study was performed. In order to determine the different values of the impact factors used in this study, the World Health Organization (WHO) (2010) provided information regarding the quality of different water sources and

sanitation facilities. No detailed impact factors were specified by the WHO water sources and sanitation facilities, apart from these being either an optimal source or an inadequate source. The impact factors allocated to the different water sources and sanitation facilities by the researcher and study supervisors were indicated in section 3.6.4. The model proposed by Serfontein (2009) in order to determine the medicine usage standard, was applied to the different municipalities of the North West Province and discussed in section 4.7. It was found that the different impact factors allocated did not pose significant questionable results, but sources that may cause an increase in medicine usage were piped water with an access point within 200 metres of the dwelling as well as pit toilets without ventilation. Although this model had not been used before, it may be used in investigating the impact that other socio-economic factors may pose on medicine usage. Further investigation with regard to the refinement of the different impact values need to be investigated, but for the purposes of this study the impact values were applicable.

5.3 Study limitations

For the purpose of this study the following limitations were identified:

- It was assumed that all data obtained were correct.
- Only the private health care sector was investigated in this study as data were obtained from a medicine claims database of a Pharmacy Benefit Management company. By implication the data would represent the higher income sector of the population only and would exclude therefore the public health care sector as well as the less wealthy communities of South Africa.
- The Community Survey 2007 data, although considered to be correct for the purpose of this study, may not be as sufficient as Census information. As the next national Census would only be performed in 2011, the Community Survey 2007 data were considered to be more sufficient in this study than the Census 2001 data.
- The patient representation in the database on a district and municipality level was too small in order to make significant conclusions.
- ICD-10 codes were incomplete on the database used. Conclusions regarding the definition, diagnosis and treatment of gastro-intestinal disease (redefined by the researcher) could therefore not be based on ICD-10 codes.

- Gastro-intestinal disease and gastro-intestinal medication had to be redefined by the researcher in order to compensate for the inavailability of accurate ICD-10 codes.

- Medications, such as non-scheduled substances and schedule one and schedule two medications may not be claimed from the medical aid, as a prescription is not required, or may not be covered by the medical aid. These medications may therefore not be included in the data obtained and conclusions made on medicine usage may therefore be incorrect.

- Medical aid fund depletions may cause patients not to claim from their medical aid although disease may be present. Those patients will therefore not be included in data obtained on a monthly basis (dataset B) and seasonal trend identification on medicine usage would therefore not be possible.

- Only the study years 2007 and 2008 were included in this study as those years coincided with the Community Survey of 2007 as well as the midway mark of the Millennium Development Goals. Due to the time limitation more study years could not be included in this study.

- Due to time limitations not all investigations could be performed up to municipality level and therefore a more refined conclusion on matters such as water quality could not be made.

5.4 Recommendations for future research

The following recommendations were made:

- As the next national Census will be conducted in 2011, future research regarding the access to water sources, sanitation facilities as well as other socio-economic factors is needed to give an accurate representation of the population dynamics in South Africa. The year 2015 is of great importance as the Millennium Development Goals must be completed. The impact of the completed Millennium Development Goals need to be investigated, especially the impact on medicine usage.

- The Medicine usage standard model of Serfontein (2009) needs to be refined and applied to other socio-economic variables in order to predict medicine usage.

- More empirical investigations need to be performed in order to identify pathogens that spread via water that may pose a risk to the population of South Africa, especially with regard to newly emerging pathogens.

- The Blue Drop Scores (DWA, 2010) and Green Drop Scores (DWA, 2009) may not be conclusive in the determination of the cause of gastro-intestinal disease. Further research in order to investigate other socio-economic factors that may cause disease is required.

- The prevalence of gastro-intestinal disease as well a the usage of gastro-intestinal disease medication needs to be investigated in both the private as well as the public health care sector of South Africa.

- The impact of water quality on health and medicine usage needs to be investigated not only with regard to gastro-intestinal disease, but other possible diseases as well.

- The cost implications that poor water quality and inadequate sanitation may have on health care need to be investigated.

- The treatment guidelines of gastro-intestinal disease must be clearly indicated and the importance of electrolyte replacement therapy must be emphasised. The use of antimicrobial therapy in the treatment of gastro-intestinal disease must be validated and the importance of ICD-10 coding emphasised.

5.5 Chapter summary

In this chapter the specific objectives stated in chapters one and three were discussed and conclusions on those objectives were made based on the reported results in chapter four. The limitations of this study were listed and recommendations were made regarding future investigations. The general as well as specific objectives of this study were therefore met and the importance of future research emphasised.

GLOSSARY

Bacterium: a unicellular, prokaryotic microorganism. These organisms have a cell wall that gives them structure (Pugh *et al.,* 2000:183).

Dataset A: dataset A was compiled by defining a patient as any person that submitted a claim that was processed and paid for by the PBM once, or more times, a year in a specific geographical area.

Dataset B: dataset B was compiled by defining a patient as any person that submitted a claim that was processed and paid for by the PBM once, or more times, a month in a particular geographical area.

Diarrhea/Diarrhoea: the frequent and abnormal discharge of fluid or semisolid matter from the bowel (Pugh *et al.,* 2000:494).

Disease: disorder or interruption of an organ, system, or body function (Pugh *et al.,* 2000:509).

Effect size: used in order to calculate the magnitude of difference between two sample means (Samuels & Witmer, 1999:272).

Environment: the sanitary quality of the community environment and the household (Trevett, 2005:262).

Epidemiology: the study of the distribution of health-related events in a specified population. Such a study may be used in future to manage problems related to health (Pugh *et al.,* 2000:604).

Gastro-, gastr-: referring to the stomach or abdomen (Pugh *et al.,* 2000:729).

Gastroenteritis: inflammation of the mucus membrane of the intestines and stomach (Pugh *et al.,* 2000:732).

Gastro-intestinal: all that is related to the intestines and the stomach (Pugh *et al.,* 2000:732).

Gastro-intestinal disease: those diseases of the gastro-intestinal tract that are caused by pathogens that spread via contaminated water, the lack of, or improper sanitation and insufficient hygiene.

Gastro-intestinal disease medication: those medications used to treat gastro-intestinal disease.

Gastro-intestinal disease medication dataset: the dataset that included the patients and claims processed and paid for by the involved PBM with regard to the selection criteria for gastro-intestinal disease medication only.

Health: the state of the organism in which there is no evidence of disease. A state that is characterised by anatomical, physiological, and psychological well-being that enables people to deal with all their responsibilities and stressors (Pugh *et al.,* 2000:789).

Household ratio: the average size of households in a selected geographical area (Serfontein, 2009).

Hygiene: cleanliness, especially personal cleanliness that promotes health (Pugh *et al.,* 2000:845).

Immunocompromised: a person is considered to be immunocompromised if the person has a positive test for the human immunodeficiency virus (HIV), or if the person is being treated with an immunosuppressive drug, chemotherapy, radiation, or renal dialysis (Mac Kenzie *et al.,* 1994:164).

Impact factor: the value of impact (numerical value out of ten) that a specific source or service provided has on the medicine usage of a household in a specific geographical area (Serfontein, 2009).

Improved sanitation: sanitation facilities that separate human excreta from human contact in a safe and hygienic fashion (WHO, 2010).

Improved water source: water source where water is protected from contamination by the environment, especially fecal contamination (WHO, 2010).

Incidence: the number of new cases of a disease that occur during a specified time period in a specified population that are at risk for developing a disease (Soruki & Chan, 2008:220).

Median: the value that lies in the middle of the sample (Samuels & Witmer, 1999:32).

Medicine usage standard: calculated factor by which medicine usage will increase by making use of a particular drinking water source or sanitation facility (Serfontein, 2009).

Nausea: an urge to vomit (Pugh *et al.,* 2000:1183).

Pathogen: a microorganism, virus, or substance that causes disease (Pugh *et al.,* 2000:1332).

Pathogenesis: the mechanism, be it pathological, physiological, or biochemical, that results in the development of disease (Pugh *et al.,* 2000:1332).

Patient: a patient, according to the method being applied in data retrieval, is defined as any individual that received one or more prescriptions per month, had been claimed from and paid for by a medical aid.

Pharmacoepidemiology: the study of the distribution of, and medicine-related events in a population. This study is then applied to ensure efficient medicine treatment (Pugh *et al.,* 2000:1360).

Pharmacology: the science concerning the source, chemistry, action, and use of medicine (Pugh *et al*., 2000:1360).

Prevalence: the total number of cases of a disease in a population in a specified period of time (Soruki & Chan, 2008:220).

Protozoa: a subkingdom of the animal kingdom that includes all acellular and unicellular forms of life. These life forms consist of a single functional cellular unit, or are the aggregation of non-differentiated cells that are loosely held together without the formation of tissue structures (Pugh *et al.,* 2000:1467).

Range: difference between the largest and smallest observations in a sample (Samuels & Witmer, 1999:48).

Sample mean: the average of a sample calculated by dividing the sum of the observations by the number of the observations (Samuels & Witmer, 1999:32).

Sample standard deviation: the difference between an observation and the sample mean (Samuels & Witmer, 1999:104).

Sanitation: the use of procedures developed to prevent disease and therefore promote health (Pugh *et al.,* 2000:1591).

Shared sanitation facilities: sanitation facilities that are used between two or more households (WHO, 2010).

Source prevalence: the fraction of the households with access to a particular water source or sanitation facility (Serfontein, 2009).

Symptom: any phenomenon that indicates a deviation from the normal structure, function, or sensation that indicates disease (Pugh *et al.,* 2000:1742).

Total database: this refers to all the data that can be obtained from the medicine claims database. The total number of patients in the total database therefore refers to all the patients that submitted one or more claims that were processed and paid for by the involved PBM.

Traveller's diarrhoea: diarrhoea that has a sudden onset and usually occurs during the first week of travel. Abdominal cramps, fever and vomiting are additional symptoms. The most common causative agents are unfamiliar stains of enterotoxigenic *Escherichia coli* (Pugh *et al.,* 2000:494).

Treatment: management, be it medical or of surgical nature, of a patient (Pugh *et al.,* 2000:1866).

Unimproved sanitation facilities: sanitation facilities that do not separate human excreta from human contact in a hygienic fashion (WHO, 2010).

Virus: a term used to refer to a group of infectious agents that usually have the ability to pass through filters that retain bacteria, are usually not visible through the light microscope, do not have the ability to undergo independent metabolism, and do not have the ability to undergo growth or reproduction away from living cells. The complete viral structure contains either RNA or DNA, and is covered by a protein capsid. The viral genetic apparatus is the same as those of prokaryotes (Pugh *et al.,* 2000:1963).

Vomiting: the clearance of the stomach content through the esophagus and mouth in a retrograde manner (Pugh *et al.,* 2000:1979).

Water-based diseases: those diseases caused by pathogens that spend part of their life cycle in water. An example is schistosomiasis (Steiner *et al.,* 1997:330).

Waterborne diseases: diseases such as cholera, cryptosporidiosis, and typhoid fever that are transmitted via drinking water that is contaminated (Steiner *et al*., 1997:330).

Water-carried diseases: diseases caused by the ingestion or exposure to contaminated water used for recreational purposes, such as giardiasis and cryptosporidiosis (Steiner *et al.,* 1997:330).

Water quality: "physical, chemical, and biological characteristics of water necessary to sustain desired water uses" (UN/ECE, 1995; UN Water, 2010).

Water-vectored diseases: those diseases transmitted by insects that breed in or near water, such as malaria, dengue fever and yellow fever (Steiner *et al.,* 1997:330).

Water-washed diseases: those diseases transmitted from one person to another due to inadequate sanitation and insufficient water available for hygienic purposes. Examples are cryptosporidiosis, shigellosis, and hepatitis A (Steiner *et al.,* 1997:330).

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