QATAR UNIVERSITY

COLLEGE OF HEALTH SCIENCE

TITLE: INVESTIGATING THE UTILIZATION OF HEALTHCARE SERVICES TO MANAGE RESPIRATORY TRACT INFECTIONS (RTIs) AMONG QATARI PATIENTS ATTENDED SELECTED PRIMARY HEALTHCARE CENTERS IN QATAR.

BY

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ABSTRACT

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Title:_Investigating the utilization of healthcare services to manage respiratory tract infections (RTIs) among Qatari patients attended selected primary healthcare centers in Qatar.

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Background: Respiratory-Tract-Infections (RTIs) are a common cause for most of the GP consultations and antibiotic use at primary care. The study aims to investigate the pattern, distribution, and determinants of several healthcare services use (RTI-related GP visits, antibiotic use, other medication uses and tests and investigations) to manage RTIs among local Qatari patients presented at the selected Primary Health Care Centers (PHCCs) in Qatar.

Methods: A retrospective cross-sectional study was conducted in the selected seven (7) Primary Health Care Centers in Qatar for which a complete primary healthcare services data is available on the CERNER system from July 2015 to December 2017. We analyzed electronic data on RTIs-related GP consultations, antibiotic use, other medication uses, and tests and investigations recorded by the PHCC. Trends were investigated by employing linear regression analysis, including months and seasonal dummies as independent-variables. The rates of services use (per 1000 total cause visits) were presented

by age-categories, gender, and comorbidity-status. We also analyzed individual patient-level count data on RTI-related 4 selected healthcare services use. A separate negative binomial regression model was used to identify determinants of healthcare services use.

Results: A total of 171,447 RTI visits made by 58,786 patients during July-2015 to December-2017. The Mean age ±SD of participants is 24.80±18.5 years, among them 38.79% falls to age group 5-19 and 33.53% belongs to 20-44. Of the total patients, 48.91% are male and the rest are female. Highest number of patients with a comorbidity of Diabetes (12.85%), followed by Hypertension (10.54%). We have found no difference in the month-to-month rates of RTI-related GP visits (per 1000 total visits) over the study period (non-significant decreasing trend). However, there was a significant decreasing trend in the monthly rates of antibiotics consumption and an increasing trend in the tests/investigations done but there was no clear increasing or decreasing trend in the monthly rates of other medications use. As expected, we found lower number of RTI related healthcare services use during the summer months. After the bi-variate analysis of individual patient-level data of selected 4 health care services across age-categories, gender and various comorbidity status, we found healthcare services varied significantly across age-categories (younger patients relatively used more healthcare services compared to older patients) and whether patients had one of the five comorbidities. We have also found that age and comorbidity status (whether patients had a comorbidity or not) were important predictors for determining individual patient-level healthcare services use.

Conclusion: In this study, antibiotic consumption for RTIs significantly decreased, as did consultation rates but investigations use rate significantly increased. The large seasonal variation indicates additional likelihoods to decrease healthcare service use. After the bi-variate analysis of individual patient-level data of selected 4 healthcare services across age-categories, gender and various comorbidity status, healthcare services varied significantly across age-categories and whether patients had one of the five comorbidities. We have also found that age and comorbidity status (whether patients had a comorbidity or not) were important predictors for determining individual patient-level healthcare services use. So, the first ever study investigating the utilization of healthcare services use by RTI patients presented at the 7 PHCC healthcare centers in Qatar, which may help policymakers to comprehend the scale of the utilization and to plan a better management of RTIs at primary care setting in Qatar.

خلفية: عدوى الجهاز التنفسي تعد سببا شائعا لمعظم استشارات أطباء العموم ولاستخدام المضادات الحيوية في الرعاية الصحية الأولية. تستهدف هذه الدراسة استقصاء نمط وتوزيع ومحددات الاستخدام لخدمات الرعاية الصحية المتنوعة (زيارات أطباء العموم ذات الصلة بعدوى الجهاز التنفسي، استخدام المضادات الحيوية، استخدامات الأدوية الأخرى، والاختبارات والفحوص) لمعالجة عدوى الجهاز التنفسي لدى المرضى القطريين المحليين في مراكز الرعاية الصحية الأولية*(PHCCs)* المختارة بقطر.

طرق البحث: تم إجراء دراسة مقطعية مرجعية في سبعة مراكز للرعاية الصحية الأولية في قطر لديها بيانات مكتملة عن خدمات الرعاية الصحية الأولية متوفرة على **نظام** السجلات الطبية الإلكترونية (سيرنر) من يوليو 2015 إلى ديسمبر 2017. قمنا بتحليل البيانات الإلكترونية عن استشارات الأطباء المتعلقة بعدوى الجهاز التنفسي، واستخدام المضادات الحيوية واستخدامات الأدوية الأخرى، والاختبارات والفحوص المسجلة من قبل مراكز الرعاية الصحية الأولية. تم اختبار الاتجاهات باستخدام تحليل الانحدار الخطي باعتبار المتغيرات الشكلية للشهور والمواسم كمتغيرات مستقلة. تم عرض معدلات استخدام الخدمات (لكل ألف من إجمالي أسباب الزيارات) من خلال الفئات العمرية، الجنس، والحالة المرضية. قمنا أيضا بتحليل بيانات عددية فردية على مستوى المريض عن استخدام أربع خدمات رعاية مختارة متعلقة بعدوى الجهاز التنفسي. استخدم نموذج انحدار ثنائي سلبي منفصل لتحديد محددات استخدام خدمات الرعاية الصحية.

النتائج: إجمالا هناك 171447 زيارة بسبب الإصابة بعدوى الجهاز التنفسي قام بها 58786 مريضا خلال يوليو 2015 إلى ديسمبر 2017. متوسط العمر ± الانحراف المعياري للمشاركين هو 24.80 ± 18.5 سنة، من بينهم 38.79 %ينتمون للفئة العمرية 5-19 عاما و33.53 % ينتمون إلى الفئة العمرية 20-44 عاما. 48.91 % من إجمالي المرضى ذكور والباقي إناث. أعلى عدد من المرضى كانوا من الذين لديهم السكري كمرض مصاحب (12.85 %)، يليه ارتفاع ضغط الدم (10.54 %). لم نجد فرقا في المعدلات الشهرية لزيارات أطباء العموم المتعلقة بعدوى الجهاز التنفسي (لكل ألف زيارة إجمالية) على مدار فترة الدراسة (اتجاه تناقصي غير مهم إحصائيا).

غير أنه كان هناك اتجاه تناقصي ملحوظ في المعدلات الشهرية لاستهلاك المضادات الحيوية واتجاه تزايدي في الاختبارات / الفحوص التي أجريت، لكن لم يكن هناك اتجاه تزايدي أو تناقصي واضح في المعدلات الشهرية لاستخدام الأدوية الأخرى. وكما هو متوقع، وجدنا استخداما أقل للموارد ذات الصلة بعدوى الجهاز التنفسي أثناء أشهر الصيف.

بعد التحليل ثنائي المتغير للبيانات الفردية على مستوى المريض عن أربع خدمات رعاية صحية مختارة عبر الفئات العمرية والجنس وحالة الأمراض المصاحبة، وجدنا أن خدمات الرعاية الصحية تختلف بشكل ملحوظ في الفئات العمرية (استخدم المرضى الأصغر سنا خدمات صحية أكثر نسبيا مقارنة بالمرضى كبار السن) وتختلف فيما إذا كان المرضى يشكون من واحد من الأمراض المصاحبة الخمسة. وجدنا أيضا أن العمر وحالة الأمراض المصاحبة (إذا كان المرضى لديهم مرض مصاحب أم لا) كانت منبئات مهمة لتحديد استخدام خدمات الرعاية الصحية الفردية على مستوى المريض.

الاستنتاج: في هذه الدراسة، انخفض استهلاك المضادات الحيوية لعدوى الجهاز التنفسي بشكل ملحوظ إحصائيا، وبالمثل معدلات الاستشارات لكن معدل استخدام الفحوص ازداد بشكل ملحوظ. ويدل التغير الموسمي الكبير على وجود احتمالات إضافية لتقليل استخدام موارد الرعاية الصحية. بعد إجراء التحليل ثنائي المتغير للبيانات الفردية على مستوى المريض عن أربع خدمات رعاية صحية مختارة عبر الفئات العمرية والجنس وحالة الأمراض المصاحبة المختلفة، تفاوتت خدمات الرعاية الصحية بصورة ملحوظة في الفئات العمرية وفيما إذا كان المرضى لديهم واحدا من الأمراض المصاحبة الخمسة. وجدنا كذلك أن العمر وحالة المرض المصاحب (فيما إذا كان المرضى لديهم أمراض مصاحبة أم لا) كانا منبئين مهمين لتحديد استخدام خدمات الرعاية الصحية الفردية على مستوى المريض.هذه الدراسة هي الدراسة الأولى على الإطلاق التي تستقصي عبء استخدام موارد الرعاية الصحية من قبل مرضى عدوى الجهاز التنفسي في سبعة مراكز للرعاية الصحية الأولية تابعة لمؤسسة الرعاية الصحية الأولية في قطر، ما قد يساعد واضعي السياسات على فهم حجم العبء والتخطيط لمعالجة أفضل لعدوى الجهاز التنفسي في بيئة الرعاية الأولية بدولة قطر.

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CHAPTER 1: INTRODUCTION

World-wide population structure has gone through the transition to massive changes i.e. increased life expectancy, reduced mortality due to infectious diseases, increased mortality due to chronic non-communicable diseases, accidents and violence (1). Similarly, to the rest of the world, Qatar, also has a significant reduction in the proportion of deaths due to infectious diseases but the number of some common infectious diseases like Respiratory Tract Infections (RTIs), Otitis media, Intestinal Infection and Skin & Soft tissue infection still remained high in the last decades, with a substantial impact on morbidity and mortality (2).

Antibiotic medications abuse has prompt an expanding rate of antimicrobial medication resistance. As there are currently less new antimicrobial drugs being created, it is vital to safeguard the viability and accessibility of antimicrobial drugs for future generations (3).The Chief Medical Officer's yearly report of UK for 2011 (3) advanced the idea of antimicrobial stewardship, which implies that pointless or improper utilization of antimicrobial agents ought to maintain a strategic distance in order to limit the choice of antimicrobial safe strains on living beings. In context of expanding antimicrobial medication protection, the abuse of anti-infection drugs can prompt superfluous symptoms and increment in the number of future consultations for RTIs (4) (5).

According to the Global Burden of the Disease (GBD) study in 2015, Infectious Diseases causes 5.7 million deaths worldwide (6). Among them RTIs (mainly lower) alone causes

3.2 million deaths and has the fourth highest incidence in the world, with more than 290 million cases, accounting for 4.9% of all deaths in the world (7). Even in primary care, RTIs are a common cause for consultation and antibiotics are commonly prescribed for it (8). Globally, RTIs account for around 60% of antibiotic prescribing in primary care (8) (9).

The State of Qatar took its first steps in establishing a primary healthcare system and started to provide healthcare services through a range of clinics as early as 1954. In 1978 the Ministry of Health developed a comprehensive scheme for building a primary healthcare system which was submitted to the Council of Ministers and the scheme included the launching of primary healthcare services through 9 health centres, covering different parts of the country, and capable of providing basic and essential health and medical services (preventive and curative). Since then, all effort has been spent to enhance healthcare standards. Overtime, services were planned with the objective of being the first health defence line, and it continued to improve both in terms of quantity and quality.

Currently, the Primary Health Care Corporation is operating through 23 primary healthcare centres distributed into three regions, namely Central, Western, and Northern. Thirteen of these centres are located in Doha city, while the rest of centres are located in populated areas in all parts of the country in order to provide a wide variety of different types of healthcare services that depend on the location and needs of each area throughout a set of objectives which focuses on keeping the health of population, and prevention from diseases, in addition to patient diagnose and treatment, and the provision of a long-term

and constant support to patients and their families from infants to elderly, children, adults, married couples, and mothers. Many health centres provide specialty services to the community aiming to enhance self-care model as well as healthy life style manner (10).

In Qatar, various recent studies and statistics show that annual mortality by the Infectious diseases for all age is around 3.5% which is 84 per 100,000 people and Annual years of Healthy Life lost is 7,252 per 100,000 people (11) (12) (13). These common infections are Upper Respiratory Tract Infection, Lower Respiratory Tract Infection, Otitis media, Intestinal Infection and Skin and Soft Tissue Infections (14). These infectious diseases are not only common in Qatar but can also be seen in other middle east countries (15).

Despite enormous burden with infectious diseases, there is limited data on the extent of healthcare services which are used for treating and managing respiratory tract infections (RTIs) in primary care setting in the middle-eastern countries. However, a few studies on disease burden have done in some other countries, but in Qatar this kind of study has never been done before. Therefore, the present study has been undertaken to investigate the utilization and distribution of healthcare services used to manage one of the common infections, Respiratory Tract Infections (RTIs) among Qatari patients who presented at the selected Primary Health Care Centres (PHCCs) in Qatar. This study also explored the trend and determinants of health care services used by Qatari patients attending PHCCs for RTI during July 2015 to December 2017. The study results may help policy makers to understand the scale of the problem, will provide evidence on the pattern of healthcare services used for treating RTI patients at primary healthcare setting and ultimately will help

to guide a better dealing of the issue at PHCC-level. It may also help the Government to prioritize a more efficient health intervention to decrease the economic and disease burden.

CHAPTER 2: LITERATURE REVIEW

According to Bosch et al., Respiratory Tract Infection is mainly divided into Upper Respiratory Tract Infection and Lower Respiratory Tract Infections (16). Regular features of RTIs are nasal obstruction, sore throat, tonsillitis, pharyngitis, laryngitis, sinusitis, otitis media, common cold and pneumonia (17). Most of the RTIs are viral in nature i.e. rhino virus, Adenovirus, Influenza A virus, Influenza B virus, Human parainfluenza viruses, Human respiratory syncytial virus and in other instances the cause is bacterial (18). Most basic microbes' are Streptococcus pyogenes (19).Other bacterial causes are Streptococcus pneumoniae, Haemophilus influenzae, Corynebacterium diphtheriae, Bordetella pertussis, and Bacillus anthracis. RTIs can also be fungal or helminth in origin, but these are far less common (19).

Management of Respiratory Tract Infections in Primary Care:

The UK national guidance on the self-limiting infection control claimed that most patients presenting with acute RTIs in primary care can be managed by either no or a delayed antibiotic prescribing, with prescriptions only being used if symptoms do not improve (9).

A systematic review by Reveiz et al. indicated that prescribing antibiotics for URTIs is not a suggested exercise especially antibiotics like penicillin V and erythromycin are not effective for acute laryngitis (20). The authors found that Erythromycin may improve voice

disturbances following one week and cough following two weeks, yet any uncertain subjective advantage isn't superior to anything the opposite impacts, cost, and the risk of microbes creating protection from the anti-infection agents. The study concluded with a proposal that, health specialists ought to firmly urge the doctors to discourage antimicrobials to treat normal RTIs because anti-microbial practice does not genuinely diminish recovery time for these viral illnesses.

Some non-Scandinavian countries suggests penicillin V as the primary line option and the European Society for Clinical Microbiology and Infectious Disease prescribed amoxicillin or an antibiotic medication to bring down RTIs (21). No solid proposal has indicated a particular antimicrobial as best exact anti-infection treatment (22). As most genuine intense respiratory infections are identified with pneumococci, penicillin V may without movement against gram-positive cocci (minimal inhibitory concentration 0.06 μg/ml) and few symptoms (23).

A Canadian study with the aim of examining the general practitioners' (GPs') prescribing patterns for acute respiratory tract infections (ARTIs) as compared with national guidelines also recommends penicillin V as a first line antibiotic for RTI (24).

Young population who are generally given syrup or other fluid formulations of antimicrobials, the high utilization of amoxicillin is additionally announced in studies from Norway(24) and this is most likely due to better taste of amoxicillin compared to the primary line option penicillin V. Similarly, it may be sensible to prescribe amoxicillin to secure compliance with treatment (25), also a recent study has suggested that resistance

selection by amoxicillin is mostly short-lived (less than 1 month) (26). Yet, the long-term use of antibiotics and increased risk of resistance due to prolonged use of antibiotics (27) needs attention, and antibiotic prescribing should be targeted only to the patients with a high chance of receiving benefit (28), (29).

Factors Associated with Managing Respiratory Tract Infections in Primary Care:

A Danish study based on routine registry data from the out-of-hours (OOH) registration system on patient contacts and ATC-coded prescriptions, described the frequency and characteristics of antibiotic prescribing for different types of contacts found a much higher prescription rate of 26.1% (30).

A Dutch cohort study on febrile children, recommends that GPs advise more antimicrobial drugs in the OOH service than in regular GP exercise (31).

A Canadian study by Gjelstad et al,. explored probable determinants of antibiotic practice patterns (24). After analysis they found that high number of practice was linked to inappropriate antibiotic counselling and GPs' practice rate recognised as a determinant of antimicrobial counselling for ARTIs in a Norwegian study. The study also found that GPs with a high volume of over-all yearly encounters had higher prescription rates for ARTIs and GPs with fewer yearly patient meetings used additional non-penicillin V antimicrobials. GPs of maximum quintile with respect to the total yearly encounter

percentage had 1.6 times the odds of advising antibiotics compared with GPs in the lowest quintile.

A Swedish study investigated, how prescription patterns for RTIs differed among medical student, residents, younger GPs, older GPs and locums (32). The study concluded that elder GPs pick broad-spectrum antibiotics to a higher mark than younger GPs and medical student.

According to Gjelsted et al. female clinicians had overall higher prescription rate than their male colleagues, but the authors couldn't find any significant difference in the rate of broad-spectrum antibiotics prescription (24).

But according to B. Lindberg et al. female clinicians consult fewer broad-spectrum antibiotics than male clinicians (33). They also found a high broad-spectrum consultation rate in the aging population with acute bronchitis and pneumonia but found no relation between median duration of consultations per session nor median days between duty hours and broad-spectrum antibiotics.

Similar studies also identified some other factors that have been shown to be related with consulting drugs for RTIs in primary care and these factors are age (higher for elder patients) and lengthy list of patients (34, 35). An American study based on National Ambulatory Medical Care Survey identifies some factor are related to Antibiotic Prescribing for ARTIs in Adult Primary Care (36). They found that Physicians specialist filed, and terrestrial province is the most strongly associated factor for a high prescribing rate. They also found that black race, absence of health coverage, and health keeper group

membership is related with lesser rates of consultation, but patient's age, sex, and municipal vs countryside setting were not significantly associated with consulting choice.

Burden of Managing Respiratory Tract Infections in Primary Care:

In Norway (Lindberg et al., 2017) (33), the antibiotic prescription frequency increased significantly along with increasing activity level, measured as shorter median duration of consultations per session, from 28.7% (reference) in the least busy quintile of meetings to 36.6% in the busiest quintile of meetings.

In a recent study by (Aabenhus et al. 2017) (37) based on Danish general practice, ARTIs accounted for a high number (456,532) of antimicrobial consultations delivered between July 2012 and June 2013. Likewise, the practise of second-line agents increased with oldness for all indications and encompassed additional 40% of the prescriptions in patients more than 75 years. Females were more frequently given antibiotics irrespective of clinical need.In Germany (Hueber et al. 2017) (38), the average practice rate of antibiotics was 24.9% and prescription rate in high practitioners was 43.5% compared to 8.5% in low practitioners.

In Columbia (Lara-Oliveros et al. 2016) (39), the children were the significant users of health care services. They also found that main use of services was attributed to hospitalizations, diagnostic tests and pharmaceutical costs.

Most of the UK general practices consult antibiotics to young and middle-aged adults with RTIs at rates that are prominently more than what is clinically proved (Gulliford et al., 2014) (40).

In the regions of Arctic Canada (Mustafa et al. 2017) (41), the healthcare services use in Nunavut and Nunavik are much higher than that in Northwest Territories and remain among the highest worldwide. The study also concluded that, the services of these admissions are remarkably high due to the mixture of very high rates of admission, very expensive medical evacuations and lengthy hospitalizations.

A recent study by (Li et al. 2016) (42) found that, the burden and use of hospital healthcare services of RTIs increases with age in these countries, with hospitalizations driving the costs of RTI upwards in the aging populace.

In Australia (Dallas et al. 2014) (43), The authors found significant ($p<0.001$) result related to antibiotic prescription, for URTI it was 21.6% and 73.1% for acute bronchitis/bronchiolitis. They also found significant ($p<0.001$) result for the use of services like Pathology tests (32%) and Imaging tests (31%).

In Netherlands (Jansen et al., 2006) (44), Yearly more than 10% of the children's were prescribed at least one antibiotic following an RTI and antibiotics were prescribed in more than half of events of LRTI. Compared with elder children, under two years of age were more frequently treated with antibiotics and the result was significant.

Burden of Antimicrobial Resistance (AMR):

Different studies strongly suggest that a reduction in antibiotic prescriptions can prevent drug resistant bacteria. (45) (46).

Spellberg et al. have identified antimicrobial resistance as a great threat in the modern world (47). The authors also suggested that, global collective actions need to be taken to address the danger, including a proposal for a world-wide agreement on antimicrobial resistance. They also stated that additional element and consideration is still required to identify and measure tendencies in resistance on the intercontinental level.

According to the systematic review by G Spurling et al. found no variation in the change of signs among those treated with antibiotics immediately and those with postponed medications. Additionally, different studies demonstrated no difference in patient satisfaction, patient complications, side effects between late and no antimicrobials. The authors concluded with the suggestion of the reduction in the use of inappropriate antimicrobials. (48).

Lee et al. suggested few policies that are needed for reducing the AMR i.e. Antibiotic stewardship to sustain the worth of current and upcoming antibiotics, the use of timing of prescription of effective antibiotics sooner rather than later, to develop at least ten new antibiotics by the year 2020 (42).

Several studies suggested that Antibiotic stewardship programmes is most convenient for reducing rates of AMR (49) (50). The studies also highlighted that unnecessary antibiotic

usage has become one of the highest contributors to the growth of AMR. Since the start of the antimicrobial time, antimicrobial agents have been utilized to treat an extensive variety of disease. Misuse of antimicrobials has become the key reason for increasing levels of AMR. The principle issue is that specialists will endorse anti-microbials to uneducated people who trust that anti-infection agents can cure almost all diseases, including viral diseases like the common cold.

According to Llor et al. antimicrobial resistance is a world-wide public health challenge, which has enhanced by the misuse and abuse of antibiotics (51). Authors also said that, AMR can lead to severe infections, complications, extended hospital stays and high mortality because over use of antibiotics is linked with high risk of contrary effects, recurrent re-admission and increased medicalization of self-managing illnesses. Antibiotic over prescription is a problem in primary care, where virus is the most common cause of infections. Authors concluded the study with the suggestion of importance of need to multi-layered interventions to reduce misuse of antimicrobials. They also suggested that, interferences should involve the implementation of the strategy of omitting the over-the-counter sale of antimicrobials, the use of antimicrobial stewardship programmes, the active contribution of physicians in assessments, the use of effective fast point-of-care tests, the promotion of delayed antibiotic prescribing approaches, the development of counselling skills with patients with the support of information leaflets and the act upon more realistic studies in primary care with the results that are of clinicians' interest, such as complications and clinical outcomes.

Significance and Implications

The focus of the research is to investigate the healthcare services use of managing RTIs in Qatar, which is one of the leading causes of morbidity and mortality in the world. Exploration on the epidemiology and management of RTIs has provided significant understandings into predictive factors for these conditions. Yet, there is little data on the healthcare services use in managing RTIs. So, this research will provide a wider, broader assessment of the healthcare services use associated with the managing Respiratory tract infections in Qatar. The study result may help the policymakers to comprehend the size of the issue and how to better arrangement the issue at PHCC-level. If patients are better managed at primary care, it may reduce some healthcare services at hospital-level, e.g. hospitalizations. It may also assist the Government to organize and ensure efficient wellbeing for its RTI patients with limited resources.

Aim

To investigate the pattern, distribution, and determinants of a number of healthcare services use (RTI-related GP visits, antibiotic use, other medication uses and tests and investigations) to manage RTIs among local Qatari patients presented at the selected Primary Health Care Centers (PHCCs) in Qatar.

Objectives

1. To investigate the utilization of the Primary healthcare services to manage Respiratory tract infections among Qatari patients presented at the selected PHCCs in Qatar.
2. To examine the trends of selected Primary healthcare services used by Qatari patients attending selected Primary Health Care Centers for RTIs during the period July 2015 to December 2017.
3. To investigate the determinants of individual patient level healthcare services during July 2015 to December 2017.

CHAPTER 3: METHODS

Study Design: A retrospective cross-sectional study.

Study Setting:

This study conducted in the selected seven (7) primary health care centers in Qatar for which a complete primary healthcare services data is available on the CERNER system from July 2015 to December 2017. Although there are in total 23 PHCCs in Qatar, the CERNER electronic database has complete patient-level information for only 7 primary healthcare centers over the study period. The availability of primary care electronic database in Qatar has also restricted the study duration for only being 2 and half years.

Name of the seven Primary Health Care Centers:

1- Al Daayen Health Centre.

2- Gharrafat Al Rayyan Health Centre

3- Leghwairiya Health Centre

4- Omar Bin Al Khattab Health Center

5- Al Sheehaniya Health Center

6- Al Wakra Health Center

7- West Bay Health Center

Study Population:

- Qatari patients attended PHCC healthcare centers for respiratory tract infections (RTIs) are selected for this study.
- This study included only Qatari Patients attending selected seven PHCC for the respiratory tract infections between July 2015 to December 2017 of all ages.

Source of the Data:

This study used the secondary data from the CERNER electronic database system of the Primary Health Care Corporation, Qatar on the RTIs among Qatari patients. The recorded diagnosis in the database were considered final and not verified externally. The database does not include hospital-level information for patients, and there is no data linkage currently available to track healthcare services used at hospital by the RTI patients presented at primary healthcare centers. The study does not include non-Qatari people because RTI profile is not complete in the CERNER for non-Qatari population.

Data was validated by the PHCC validation team by taking random sample from each month one encounter from each healthcare center.

Missing data:

As trained physicians enter data into the CERNER and CERNER itself programed in a way that there is less chance of error. For the variables of interests, there was no missing data in the CERNER database provided by the PHCC.

Primary Healthcare services includes:

Number of GP visits, number of antibiotics use, other medications taken by the patient except antibiotic, number of tests and investigations prescribed by clinicians, etc. Other medication includes number antipyretics, bronchodilator and oxygen therapy prescribed.

The following information were collected from electronic records-

Variables:

Demographic Variables

1. Age
2. Sex / gender
3. Co-morbidity status

Individual patient level variables- monthly

1. *International Classification of Diseases,* 10th Revision (ICD-10) for the Respiratory tract infections.
2. Number of GP/clinicians visits for the Respiratory tract infections
3. Were antibiotics prescribed? - (Y/N)
4. If yes, number of antibiotics (item) prescribed for the Respiratory tract infection.
5. Number of other medications (item) prescribed for the Respiratory tract infection.
6. If any lab tests and investigations (e.g. X-ray, blood tests, etc.) - Name/type of tests, number of tests, etc.

Outcome:

Utilization of healthcare services related to RTI i.e. GP visits, antibiotic use, medications use, tests and investigations.

Sampling Method-

All health centers for which data were complete on the CERNER during 2015 to 2017.

Instrument/Tool for data collection-

This study was conducted in the selected seven Primary Health Care Centers of Qatar for which a complete data is available on the CERNER system from July 2015 to December 2017. This study analyzed the secondary data from the electronic data base system of PHCC, Qatar on the RTIs with ICD code-10 of the infection. The recorded diagnosis in the database were considered final and not verified externally.

Inclusion criteria-

1. Qatari Patients attended selected seven PHCC for RTIs between July 2015 to December 2017 of all ages.

2. Diagnosis done by either clinical assessment or by using diagnostic test.

Exclusion criteria:

1. Qatari Patients attended selected seven PHCCs not for the RTIs between July 2015 to December 2017of all ages.

2. Non-Qatari Patients attended selected seven PHCCs for the RTIs between July 2015 to December 2017of all ages.

Statistical Analysis:

Overview of Analysis Plan-

Descriptive statistics included frequency with percentages for categorical variables, mean and standard deviation for continuous variables. The rate of use of each PHCC

healthcare services were calculated in terms of per 1000 total GP visits. These rates were presented according to age category, gender, and co-morbid status.

The mean differences of outcome variables between categories of patient's characteristics were compared according to nature of the variables. Two samples non-parametric Mann-Whitney test for non-normally distributed outcomes between categories of binary variables and non-parametric Kruskal Wallis test for categorical independent variables with more than two categories.

Trends were investigated in monthly rates of 4 selected healthcare services use by RTI patients. We converted each of the 4 healthcare services use into monthly rate and reported in per 1000 total visits. For example, monthly rate of RTI-related visit is calculated by

$$\frac{Total\ number\ of\ RTI-related\ visits\ from\ all\ 7\ healthcare\ centers\ in\ a\ month}{Total\ number\ of\ all-cause\ visits\ from\ all\ 7\ healthcare\ ceneters\ in\ that\ month}\ \text{x}\ 1000.$$

Following the above formula, we calculated monthly rate of RTI-related visit, antibiotic and other medication use, and tests/investigations use for 30 months during July 2015 and December 2017. The trends in the monthly rate of each of the 4 selected healthcare services use over 30 months study period were presented in a graph. Since there is a possible seasonal influence on the occurrence of RTIs, hence an effect on the RTI-related healthcare services use, this was accounted for in the estimated regression model of trend analysis. Since most of the dependent variables follow an approximate normal distribution, we estimated the following simple linear regression to investigate the trend in monthly rate of

various RTI-related healthcare services used by patients:

$Y = a + b_1$ Months + b_2 Q2 + b_3 Q3 + b_4 Q4 + e ---------- (1)

where 'Y' is the dependent variable (monthly utilization rate for one of the 4 healthcare services use), 'Months' represents time-trend of 30 months of the study period (1-30, where 1 for July 2015, 2 for August 2015, ……., 30 for December 2017). Quarters 'Q1' – 'Q4' are seasonal dummies, where 'Q1' refers to January to March, Q2 refers April to June, Q3 refers July to September and Q4 refers to October to December of a year, Q1 is a reference category and e represent the random error. From the regression model, b_1 estimates the monthly trend in the dependent variable ('Y') after adjusting for seasonal effects, b_2, b_3 and b_4 are the regression coefficients for respective seasonal dummies. β –coefficients and their p-value with 95% Confidence Intervals were reported. All statistical analyses were two-sided, and a p-value less than 0.05 considered to be significant.

Negative binomial regression model was used to identify determinants of healthcare services use because of over-dispersed count outcome variables. At first, univariate analysis was used to identify important covariates and explore unadjusted association (IRR) between variables and the outcomes, the significance was assessed by Wald statistic p-value or Likelihood ratio test if the categorical variable had more than two levels. All variables whose p-value <0.25 along with the variables of known clinical importance were selected and the multivariable model is fitted (the initial full model). Then the significance of variable was assessed using its Wald statistic p-value, and variables that did not make contribution to the model (with p-value >0.05) were eliminated and a new smaller model fitted. These two models were then compared by using likelihood ratio test (LRT) for

model comparison to make sure that the new smaller model fits as well as the initial full model.

Analysis were done by using Microsoft Excel and STATA statistical software package 15.0.

Storage Plan-

Electronic data were kept in password protected folder in a computer with the access only to investigators and team members. Papers and other printed materials were locked in a cabinet.

Ethical Considerations-

1. Formal approval obtained from QU-IRB (Ref No: QU-IRB 875-E/18)
2. Formal approval obtained from PHCC-IRB of Qatar. (Ref No: PHCC/RS/17/10/013).

CHAPTER 4: RESULTS

A total of 171,447 RTI-related visits made by 58,786 patients during July-2015 to December-2017. The Mean age ±SD of patients is 24.80±18.5 years, among them 38.79% falls to age group 5-19 and 33.53% belongs to 20-44. Of the total patients, 48.91% are male and the rest are female. Highest number of patients with a comorbidity of Diabetes (12.85%), followed by Hypertension (10.54%). Table-1.

Table-1: Descriptive of all RTI patients (N=58,786) attended primary healthcare centres in Qatar during July 2015 to December 2017.

Variables		Continuous data (Mean ±SD), Categorical data (Number & %)
Age	(Mean ±SD)	(24.80±18.5)
Age-category	< 5 years N (%)	6,163 (10.48)
	5 -19 years N (%)	22,803 (38.79)
	20 -44 years N (%)	19,709 (33.53)
	45+ years N (%)	10,111 (17.20)
Gender		
	Male N (%)	28,753 (48.91)
	Female N (%)	30,033 (51.09)
Diabetes		
	Yes N (%)	7,555 (12.85)
	No N (%)	51,231 (87.15)
Hypertension		
	Yes N (%)	6,195 (10.54)
	No N (%)	52,591 (89.46)
Asthma		
	Yes N (%)	4,293 (7.30)
	No N (%)	54,493 (92.70)
Dyslipidaemia		
	Yes N (%)	3,481 (5.92)
	No N (%)	55,305 (94.08)
Obesity		
	Yes N (%)	2,743 (4.67)
	No N (%)	56,043 (95.33)

The most common infections were unspecified acute upper respiratory infection, unspecified acute pharyngitis and acute nasopharyngitis (common cold).

Trend analysis of rates (per 1000 total all-cause visits) of healthcare services use:

Total 30 months (July 2015 to December 2017) rates of four selected healthcare services were used to observe the monthly trend.

Table: 2 Descriptive of monthly rates of four (4) selected health care services during July 2015 to December 2017.

Variables	Mean	Std. Dev.
RTI-related GP visits	186.4	46.52
Antibiotics	59.9	14.48
Other medication	507.2	127.91
Investigations	8.7	5.43

The Mean rate of RTI-related GP visits (±SD) is 186.4 (±46.52), Mean Antibiotic-use rate (±SD) is 59.9 (±14.48), Mean Medication use rate (±SD) is 507.2 (±127.91) and Mean Investigations use rate (±SD) is 8.7 (±5.43) (Table-2).

Table-3 produces results from the estimated regression model (1) for the trend analyses in monthly rates of 4 selected healthcare services use. We observed that monthly rates of RTI-related GP visits during July 2015 and December 2016 decreased by 0.5 visit (per 1000 total visits) which was not statistically significant (p=0.441). However, the rate of RTI-related antibiotic use decreased significantly by about 0.8 (per 1000 total visits) over the study period (p <0.001). Although for both other medications use and tests and investigations there was a slightly increasing trend in the monthly rates, it was statistically significant for tests/investigations ((p <0.001) whereas for other medications use the trend was not significant (p=0.797). As expected, RTI-related GP visits were significantly lower in quarters 2 and 3 (Q2, Q3) compare to Q1 of winter months (Jan.-Mar.)

Table-3: Estimated regression model (1) showing the trend analysis of monthly rates of 4 selected healthcare services use by RTI patients during July 2015 to December 2017.

RTI-related GP visits	Estimates	*P*-value	95% Confidence Interval		R^2
Months	-0.47	0.441	-1.70	0.76	0.69
Q1	Reference				
Q2	-47.87	0.007	-81.30	-14.45	
Q3	-63.14	<0.001	-93.47	-32.81	
Q4	26.76	0.083	-3.79	57.31	
RTI-related Antibiotic use	Estimates	*P*-value	95% Confidence Interval		R^2
Months	-0.84	<0.001	-1.26	-0.43	0.64
Q1	Reference				
Q2	-5.77	0.298	-16.97	5.42	
Q3	-15.64	0.004	-25.79	-5.48	
Q4	8.66	0.093	-1.57	18.89	
Other Medications use	Estimates	*P*-value	95% Confidence Interval		R^2
Months	0.50	0.797	-3.50	4.51	0.57
Q1	Reference				
Q2	-103.62	0.060	-212.15	4.91	
Q3	-127.71	0.013	-226.17	-29.24	
Q4	95.72	0.058	-3.48	194.91	
Tests/Investigations	Estimates	*P*-value	95% Confidence Interval		R^2
Months	0.49	<0.001	0.33	0.64	0.65
Q1	Reference				
Q2	-1.69	0.410	-5.83	2.46	
Q3	-0.37	0.843	-4.12	3.39	
Q4	0.71	0.703	-3.08	4.50	

Figures 1-4 present the trend in the monthly rate of 4 selected healthcare services use by RTI patients from July 2015 to December 2017. It is clear from these figures that, although there is no difference in the month-to-month rates of RTI-related GP visits over the study period, there is a decreasing trend in the monthly rate of RTI-related antibiotics consumption and an increasing trend in the tests/investigations done (Figures 2 and 4). Figure 3 does not show a clear trend in the monthly rates of other medications use.

Figure 1: Monthly rate of RTI-related GP visits (per 1000 total all-cause visits) during July 2015 to December 2017.

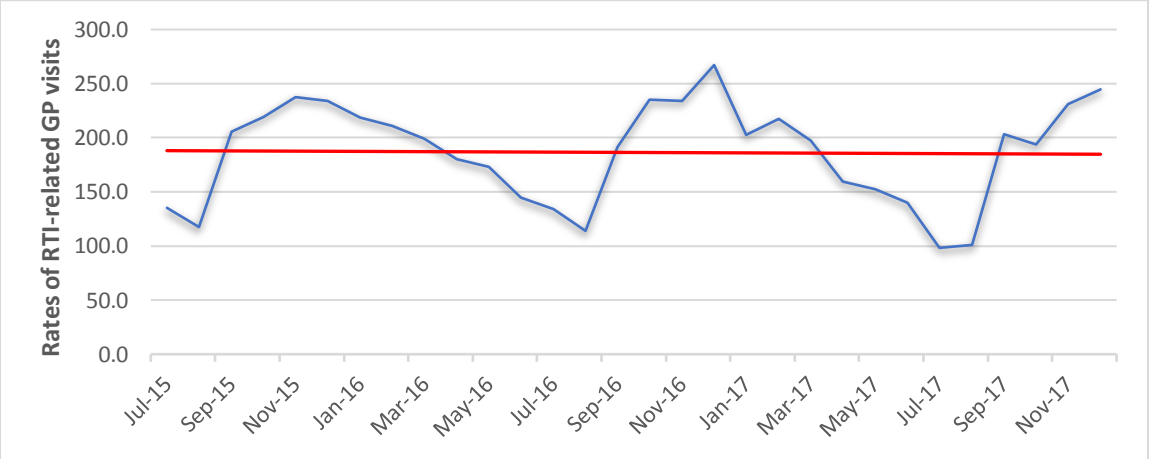


Figure 2: Monthly rate of RTI-related antibiotics use (per 1000 total all-cause visits) during July 2015 to December 2017.

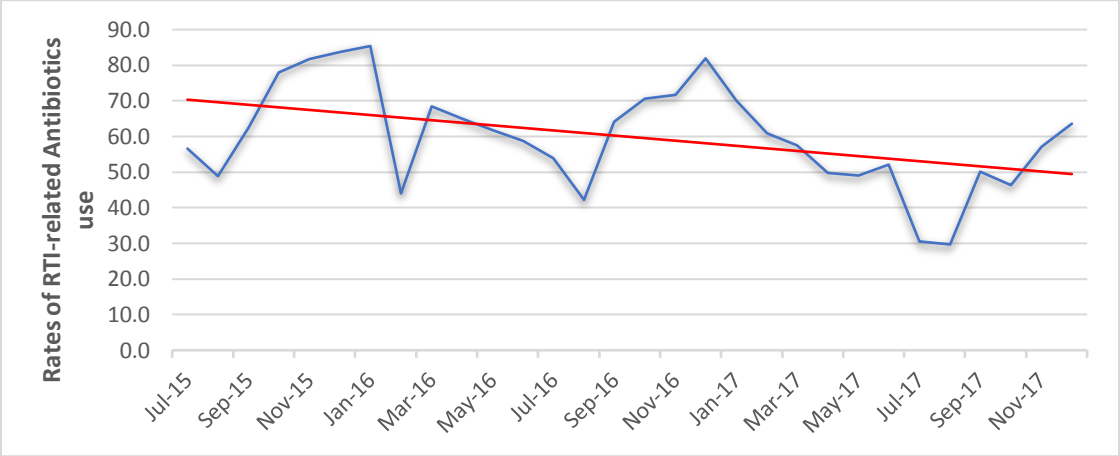


Figure 3: Monthly rate of RTI-related other medication use (per 1000 total all-cause visits) during July 2015 to December 2017.

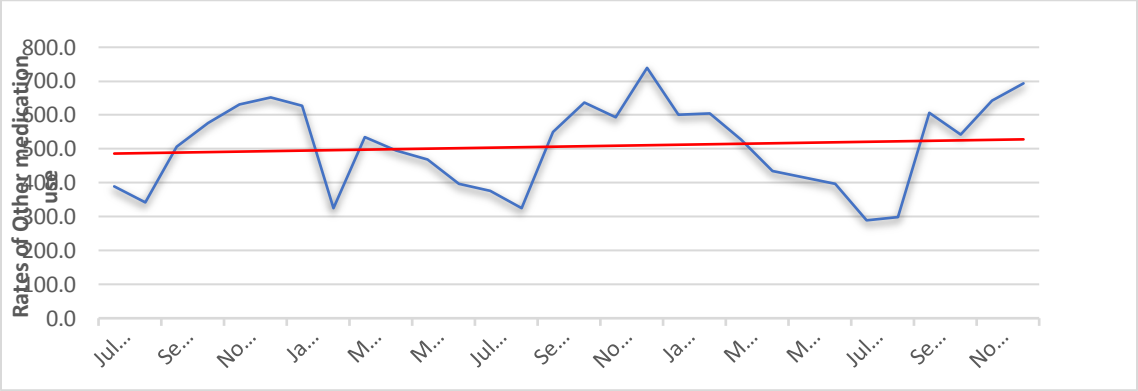
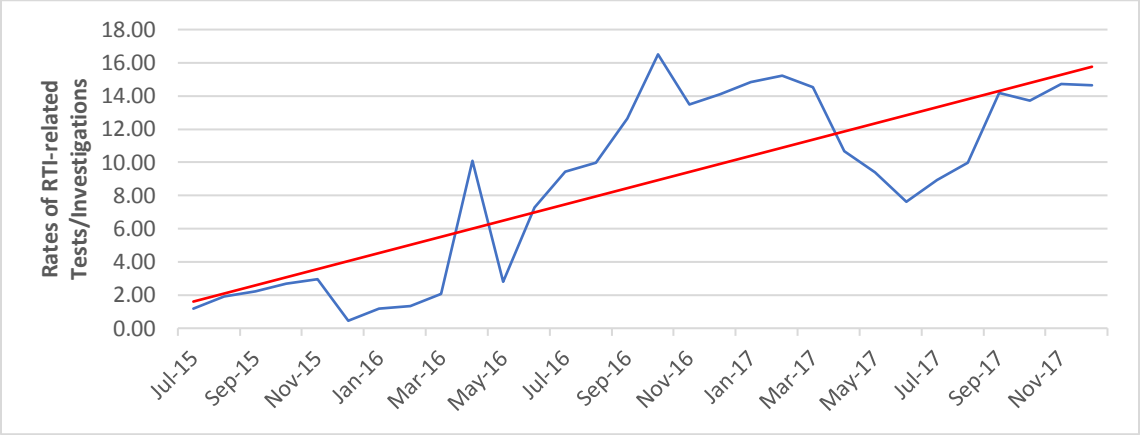


Figure 4: Monthly rate of RTI-related tests/investigations use (per 1000 total all-cause visits) during July 2015 to December 2017



Although we have data only for calendar 3 years, we presented yearly rates of 4 selected primary health care services use by age-categories, gender and co-morbidity status.

Table-4 shows the rates of RTI-related GP visits (per 1000 total all-cause visits) during 2015 to 2017. The rate of RTI-related visits in the three years (2015 to 2017) is showing decreasing trend in age groups. Age group 5 to 19 years had the highest rate of RTI-related visits among all age groups and it is decreased from 86.50 in 2015 to 75.50 per 1000 total-cause visits in 2017. Rate of RTI is same between males and females. For co-morbidities like Diabetes, Hypertension, Asthma and Dyslipidaemia RTI-related GP visit is showing an increasing trend but for obesity it is showing a decreasing trend. RTI patients with Diabetes has the highest and those with Obesity has the lowest rate of RTI-related GP visits

during the study period among all co-morbidities groups. For the Diabetes rate was increased from 22.86 to 27.64 per 1000 total-cause visits and for obesity is decreased from 10.03 to 9.95 per 1000 total-cause visits.

Table-4: Rate of RTI-related GP visits (per 1000 total all-cause visits) during 2015 to 2017 across age categories, gender and Co-morbidities.

RTI Visits/1000 visit		2015	2016	2017
Age Groups				
	< 5 years	25.55	22.50	20.00
	5 -19 years	86.50	83.44	75.50
	20 -44 years	62.90	59.86	53.68
	45+ years	27.45	31.18	33.83
Gender				
	Male	100.61	97.10	90.91
	Female	101.79	99.88	92.10
Co-morbidities				
Diabetes		22.86	25.67	27.64
Hypertension		18.31	21.23	24.06
Asthma		17.85	18.58	18.95
Dyslipidaemia		10.29	12.15	13.97
Obesity		10.03	9.90	9.95

Table-5 provides rate of RTI-related antibiotics use (per 1000 total all-cause visits) during 2015 to 2017 by age categories, gender and Co-morbidities. Antibiotic use rate in the three years is showing overall decreasing trend among age categories. Overall, the rate of antibiotic use was decreasing for all age groups except older populations, 45+ years. For those aged 5 to 19 years, the rate of antibiotic use decreased from 31.62 to 21.76 per 1000 total all-cause visits, which highest among all age groups. For both male and female RTI patients, antibiotic use was decreasing during 2015 to 2017. For patients with various comorbidities the rate was also either decreasing or stable, except for hypertension for which the rate was showing a small increasing trend. The rate of antibiotic use was highest for patients with diabetes (22.86 to 27.64 per 1000 total all-cause visits) but remained almost stable (7.36 to 7.31 per 1000 total-cause visits) and lowest for patients with obesity with decreasing trend (3.49 to 2.75 per 1000 total-cause visits).

Table-5: Rate of RTI-related antibiotics use (per 1000 total all-cause visits) during 2015 to 2017 among age category, gender and Co-morbidities.

Antibiotics		2015	2016	2017
Age Groups				
	< 5 years	9.73	8.30	6.59
	5 -19 years	31.62	28.63	21.76
	20 -44 years	21.24	18.67	14.32
	45+ years	9.02	9.25	9.10
Gender				
	Male	35.62	32.35	25.78
	Female	36.00	32.51	25.99
Co-morbidities				
Diabetes		7.36	7.69	7.31
Hypertension		5.98	6.28	6.34
Asthma		5.93	5.86	4.96
Dyslipidaemia		3.19	3.58	3.76
Obesity		3.49	3.09	2.75

Table-6 gives the rates other medication use (per 1000 total all-cause visits) during 2015 to 2017 among age categories, gender and Co-morbidities. Age group 5 to 19 years had the

highest rate of other medication use in the three years among all age groups (234.38 to 213.98 per 1000 total-cause visits) and age group 45+ years has the lowest rate of medication use (69.63 per 1000 total-cause visits) for the year 2015 and age group <5 years has the lowest rate of medication use (64.67 to 61.31 per 1000 total-cause visits) for the year 2016 and 2017. All the co-morbidities are showing increasing trend, in the diabetes rate was increased from 58.16 to 75.06 per 1000 total-cause visits, highest among all co-morbidities group and in the obesity, rate was increased from 25.87 to 27.07 per 1000 total-cause visits.

Table-6: Rate of other medication use (per 1000 total all-cause visits) during 2015 to 2017 among age category, gender and Co-morbidities.

Other Medications		2015	2016	2017
Age Groups				
	< 5 years	76.46	64.67	61.31
	5 -19 years	234.38	222.59	213.98
	20 -44 years	162.88	152.69	149.38
	45+ years	69.63	78.07	90.63
Gender				
	Male	269.67	256.71	255.89
	Female	273.67	261.31	259.41
Co-morbidities				
Diabetes		58.16	64.65	75.06
Hypertension		46.49	53.10	64.88
Asthma		46.19	47.84	51.77
Dyslipidaemia		25.98	30.12	37.77
Obesity		25.87	25.19	27.07

Table-7 provides rates of RTI related investigations use (per 1000 total all-cause visits) during 2015 to 2017 among age category, gender and Co-morbidities. The rate of

tests/investigations uses over three years study period from 2015 to 2017 is showing an overall increasing trend. For those aged 5 to 19 years, the Investigations rate of use increased from 0.84 to 5.61 per 1000 total-cause visits, highest among all age groups and those aged 45+ years the rate was increased from 0.22 to 1.52 per 1000 total-cause visits, lowest among all age groups. Among the co-morbidities diabetes has the highest rate (0.16 to 1.43 per 1000 total-cause visits) and obesity has the lowest rate (0.07 to 0.56 per 1000 total-cause visits) of using investigations.

Table-7: Rate of RTI related investigations use (per 1000 total all-cause visits) during 2015 to 2017 among age category, gender and Co-morbidities.

Investigations		2015	2016	2017
Age Groups	< 5 years	0.45	1.35	1.94
	5 -19 years	0.84	3.9	5.61
	20 -44 years	0.49	2.37	3.6
	45+ years	0.22	0.94	1.52
Gender	Male	0.9	4.35	6.2
	Female	1.09	4.22	6.47
Co-morbidities				
	Diabetes	0.16	0.81	1.43
	Hypertension	0.14	0.62	1.08
	Asthma	0.19	0.66	1
	Dyslipidaemia	0.04	0.32	0.62
	Obesity	0.07	0.34	0.56

Analysis of individual patient-level healthcare services use:

Table-8 Delivers the distribution and bi-variate analysis of individual patient-level number of RTI-related GP visits across age-categories, gender and various comorbidity status. The mean ±SD number of the RTI related visits differs significantly (p-value <0.001) among the levels of age groups. Age group less than 5 years (3.18±3.56), 5 to 19 years (3.16±3.10) had the highest and age group 20 to 44 years (2.62±2.69) had the lowest mean number of RTI related visits. The Mean ±SD number RTI related visits between male and female was statistically not significant but there was statistically significant difference between the mean use of RTI related visits for Diabetes (3.08±3.22, p-value <0.001), Hypertension (3.17±3.34, p-value <0.001), Asthma (3.87±3.94, p-value <0.001), Dyslipidaemia (3.24±3.38, p-value<0.001) and Obesity (3.24±3.27, p-value <0.001).

Table-8: Bi-variate analysis of individual patient-level number of RTI related GP visits during July 2015 to December 2017 (N=58,786).

Variables		RTI-related GP visits Mean ±SD	p-value
Age Groups	<5 years	3.18±3.56	<0.001
	5 to 19 years	3.16±3.10	
	20 to 44 years	2.62± 2.69	
	45+ years	2.80±2.83	
Gender	Male	2.95±3.11	0.159
	Female	2.88±2.87	
Diabetes	Yes	3.08±3.22	<0.001
	No	2.89±2.95	
Hypertension	Yes	3.17±3.34	<0.001
	No	2.89±2.94	
Asthma	Yes	3.87±3.94	<0.001
	No	2.84±2.89	
Dyslipidaemia	Yes	3.24±3.38	<0.001
	No	2.89±2.96	
Obesity	Yes	3.24±3.27	<0.001
	No	2.90±2.98	

Table-9 Provides the distribution and bi-variate analysis of individual patient-level number of Antibiotic use across age-categories, gender and various comorbidity status. The mean ±SD number of Antibiotic use varies significantly (p-value <0.001) between the levels of age groups. Age group less than 5 years (1.13±1.63),

5 to 19 years (1.03±1.42) had the highest and age group 20 to 44 years (0.78±1.19) had the lowest mean number of Antibiotic use. There was statistically significant difference between the mean use of antibiotics for Diabetes (0.88±1.32, p-value=0.005), Hypertension (0.90±1.37, p-value=0.01), Asthma (1.14±1.63, p-value <0.001) and Obesity (0.98±1.39, p-value=0.01).

Table-9: Bi-variate analysis of individual patient-level number of Antibiotic use during July 2015 to December 2017 (N=58,786).

Variables		Number of Antibiotic use Mean ±SD	p-value
Age Groups	<5 years	1.13±1.63	<0.001
	5 to 19 years	1.03±1.42	
	20 to 44 years	0.78±1.19	
	45+ years	0.81±1.22	
Gender	Male	0.93±1.38	0.129
	Female	0.90±1.31	
Diabetes	Yes	0.88 ±1.32	0.005
	No	0.90±1.31	
Hypertension	Yes	0.90 ±1.37	0.011
	No	0.92±1.34	
Asthma	Yes	1.14±1.63	<0.001
	No	0.90±1.32	
Dyslipidaemia	Yes	0.92±1.36	0.557
	No	0.92±1.34	
Obesity	Yes	0.98±1.39	0.010
	No	0.91±1.34	

*p-value <0.05 significant, based on non-parametric Mann-Whitney and Kruskal-Wallis test.

Table-10 Delivers the distribution and bi-variate analysis of individual patient-level number of other medications use across age-categories, gender and various comorbidity status. Age group less than 5 years (9.45±11.27) had the highest and 20 to 44 years (6.93±7.73) had the lowest mean number of other medication use and the mean use of medication was statistically significantly different (p-value<0.001). Also, statistically significant difference was present between the mean use of other medication for Diabetes (8.04±8.87, p-value <0.019), Hypertension (8.22±9.18, p-value <0.001), Asthma (10.25±11.06, p-value <0.001), Dyslipidaemia (8.39±9.20, p-value<0.001) and Obesity (8.50±8.92, p-value <0.001).

Table-10: Bi-variate analysis of individual patient-level number of other medications use during July 2015 to December 2017 (N=58,786).

Variables		Number of Other Medications use Mean ±SD	p-value
Age Groups	<5 years	9.45±11.27	<0.001
	5 to 19 years	8.65±9.23	
	20 to 44 years	6.93±7.73	
	45+ years	7.24±7.81	
Gender	Male	8.03±9.11	0.655
	Female	7.81±8.53	
Diabetes	Yes	8.04± 8.87	0.019
	No	7.90± 8.81	
Hypertension	Yes	8.22±9.18	<0.001
	No	7.88± 8.77	
Asthma	Yes	10.25±11.06	<0.001
	No	7.73± 8.59	
Dyslipidaemia	Yes	8.39±9.20	<0.001
	No	7.89± 8.79	
Obesity	Yes	8.50±8.92	<0.001
	No	7.89±8.81	

*p-value <0.05 significant, based on non-parametric Mann-Whitney and Kruskal-Wallis test.

Table-11 shows the distribution and bi-variate analysis of individual patient-level number of RTI related investigations use across age-categories, gender and various comorbidity status. The mean ±SD number of the Investigations use varies significantly (p-value <0.001) among the different age groups. Age group less than 5 years (0.21±3.56) had the highest and 45+ years (2.62±2.69) had the lowest mean number of investigations use. The mean ±SD use of investigations use in Diabetes (0.11±0.38, p-value <0.001), Hypertension (0.11±0.36, p-value <0.001), Dyslipidaemia (0.10±0.35, p-value<0.001) and Obesity (0.13±0.41, p-value <0.001) was showing statistically significant result.

Table-11: Bi-variate analysis of individual patient-level number of investigations use during July 2015 to December 2017 (N=58,786).

Variables		Number of Investigations use Mean ±SD	p-value
Age Groups	<5 years	0.21±0.54	<0.001
	5 to 19 years	0.16 ± 0.45	
	20 to 44 years	0.12±0.38	
	45+ years	0.10±0.34	
Gender	Male	0.14±0.43	0.306
	Female	0.14±0.42	
Diabetes	Yes	0.11±0.38	<0.001
	No	0.14±0.43	
Hypertension	Yes	0.11±0.36	<0.001
	No	0.14±0.43	
Asthma	Yes	0.15±0.45	0.078
	No	0.14±0.42	
Dyslipidaemia	Yes	0.10±0.35	<0.001
	No	0.14±0.43	
Obesity	Yes	0.13±0.41	0.019
	No	0.14±0.42	

*p-value <0.05 significant, based on non-parametric Mann-Whitney and Kruskal-Wallis test.

Determinants by Negative Binomial regression analysis:

Negative Binomial regression analysis of factors associated with RTI related GP visits:

After univariate analysis, all variables had p value <0.25, so they were all included in the initial full model. In the next step all the variables were statistically significant (p <0.05). The significant predictors identified by our analysis (the final model) consisted of seven variables: Age category, Gender, Diabetes Mellitus, Hypertension, Asthma, Dyslipidaemia and Obesity which were found to be the significant predictors for RTI related GP visits in the context of our study and available data.

Table-12 is showing results of Negative Binomial Regression analysis of significant predictors of RTI related GP visits. Incidence Rate Ratio (IRR) for age category 5 to 19 years (IRR=0.98, 95% CI= 0.95 to 1.02, p-value =0.031) indicates that the incident rate for 5 to 19 years is 0.98 times the incident rate for the reference group (<5 years), holding the other variables constant and the result is not significant. For age category 20 to 44 years (IRR=0.76, 95% CI= 0.74 to 0.79, p-value <0.001) indicates that the incident rate for 20 to 44 years is 0.76 times the incident rate for the reference group (<5 years), holding the other variables constant and the result is significant. For age category 45+ years (IRR=0.71, 95% CI= 0.68 to 0.74, p-value <0.001) indicates that the incident rate for 45+years is 0.71 times the incident rate for the reference group (<5 years), holding the other variables constant and the result is significant. The IRR for the Gender- male (IRR=1.02, 95% CI= 1.00 to 1.04, p-value=0.01) demonstrated that the incident rate for gender-male is 2% significantly

higher when compared to the reference group (female), holding the other variables constant.

The IRR for the Diabetes Mellitus (IRR=1.08, 95% CI= 1.04 to 1.12, p-value <0.001) indicates that the incident rate for Diabetes Mellitus patient is 8% significantly higher when compared to the reference group (no diabetes), holding the other variables constant. For the variable Hypertension (IRR=1.14, 95% CI= 1.10 to 1.19, p-value <0.001) indicates that the incident rate for Hypertensive patient is 14% significantly higher when compared to the reference group (no hypertension), holding the other variables constant. For the variable Asthma (IRR=1.46, 95% CI= 1.41 to 1.51, p-value <0.001) indicates that the incident rate for Asthma patient is 46% significantly higher when compared to the reference group (no asthma), holding the other variables constant. The IRR for the Dyslipidaemia (IRR=1.11, 95% CI= 1.06 to 1.16, p-value <0.001) indicates that the incident rate for Dyslipidaemia patient is 11% significantly higher when compared to the reference group (no dyslipidaemia), holding the other variables constant. For the variable Obesity (IRR=1.09, 95% CI= 1.04 to 1.13, p-value <0.001) indicates that the incident rate for obese patient is 9% significantly higher when compared to the reference group (no obesity), holding the other variables constant.

Table-12: Negative Binomial Regression analysis of significant predictors of RTI related GP visits (N=58,786).

Variables	IRR	P value	95% C. I.	
Age category			Lower	Upper
<5 years	1 (Reference)			
5 to 19 years	0.98	0.31	0.95	1.02
20 to 44 years	0.76	<0.001	0.74	0.79
45+ years	0.71	<0.001	0.68	0.74
Gender				
Female	1 (Reference)			
Male	1.02	0.01	1.00	1.04
Diabetes Mellitus				
No	1 (Reference)			
yes	1.08	<0.001	1.04	1.12
Hypertension				
No	1 (Reference)			
Yes	1.14	<0.001	1.10	1.19
Asthma				
No	1 (Reference)			
yes	1.46	<0.001	1.41	1.51
Dyslipidaemia				
No	1 (Reference)			
yes	1.11	<0.001	1.06	1.16
Obesity				
No	1 (Reference)			
yes	1.09	<0.001	1.04	1.13

*RTI= Respiratory Tract Infection *p-value <0.05 significant *IRR= Incidence Rate Ratio

Negative Binomial regression analysis of factors associated with Antibiotic use:

After univariate analysis, four variables: age category, gender, diabetes, asthma and obesity had p value <0.25, so they were included in the initial full model. In the next step variables age category, diabetes, asthma and obesity were statistically significant ($p < 0.05$) and variable gender were not and removed from the model ($p > 0.05$). Comparing the initial full model with the smaller one by using Likelihood-ratio test (LRT) was in favour of the smaller model (p-value= 0.105). The significant predictors identified by our analysis (the final model) consisted of four variables: Age category, Diabetes Mellitus, Asthma and Obesity which were found to be the significant predictors for Antibiotic use in the background of our study and available data.

Table-13 provides the result of Negative Binomial Regression analysis of significant predictors of RTI related Antibiotics use. IRR for age category 5 to 19 years (IRR=0.90, 95% CI= 0.86 to 0.94, p-value <0.001) indicates that the incident rate for 5 to 19 years is 0.90 times the incident rate for the reference group (<5 years), holding the other variables constant and the result is significant. For age category 20 to 44 years (IRR=0.64, 95% CI= 0.61 to 0.67, p-value <0.001) indicates that the incident rate for 20 to 44 years is 0.64 times the incident rate for the reference group (<5 years), holding the other variables constant and the result is significant. For age category 45+ years (IRR=0.62, 95% CI= 0.58 to 0.64, p-value <0.001) indicates that the incident rate for 45+years is 0.62 times the incident rate for the reference group (<5 years), holding the other variables constant and the result is significant.

The IRR for the Diabetes Mellitus (IRR=1.09, 95% CI= 1.04 to 1.13, p-value=0.02) indicates that the incident rate for Diabetes Mellitus patient is 9% significantly higher when compared to the reference group (no diabetes), holding the other variables constant. For the variable Asthma (IRR=1.46, 95% CI= 1.39 to 1.53, p-value <0.001) indicates that the incident rate for Asthma patient is 46% significantly higher when compared to the reference group (no asthma), holding the other variables constant. For the variable Obesity (IRR=1.16, 95% CI= 1.09 to 1.23, p-value <0.001) indicates that the incident rate for obese patient is 16% significantly higher when compared to the reference group (no obesity), holding the other variables constant.

Table-13: Negative Binomial Regression analysis of significant predictors of RTI related Antibiotics use (N=58,786).

Variables	IRR	P value	95% C. I.	
Age category			Lower	Upper
<5 years	1(Reference)			
5 to 19 years	0.90	<0.001	0.86	0.94
20 to 44 years	0.64	<0.001	0.61	0.67
45+ years	0.59	<0.001	0.58	0.64
Diabetes Mellitus				
No	1 (Reference)			
yes	1.09	0.017	1.04	1.13
Asthma				
No	1 (Reference)			
yes	1.46	<0.001	1.39	1.53
Obesity				
No	1 (Reference)			
yes	1.16	<0.001	1.09	1.23

*RTI= Respiratory Tract Infection *p-value <0.05 significant *IRR= Incidence Rate Ratio

Negative Binomial regression analysis of factors associated with other medication use:

After univariate analysis, all the seven variables: age category, gender, diabetes, hypertension, asthma, dyslipidaemia and obesity had p value <0.25, so they were included in the initial full model. In the next step variables age category, diabetes, hypertension, asthma, dyslipidaemia and obesity were statistically significant (p <0.05) and variable gender were not and removed from the model (p>0.05). Comparing the initial full model with the smaller one by using Likelihood-ratio test (LRT) was in favour of the smaller model (p-value= 0.067). The significant predictors identified by our analysis (the final model) consisted of four variables: Age category, diabetes, hypertension, asthma, dyslipidaemia and obesity which were found to be the significant predictors for medications use in the context of our study and available data.

Table-14 gives the result of Negative Binomial Regression analysis of significant predictors of RTI related other medications use. IRR for age category 5 to 19 years (IRR=0.91, 95% CI= 0.88 to 0.94, p-value <0.001) indicates that the incident rate for 5 to 19 years is 0.91 times the incident rate for the reference group (<5 years), holding the other variables constant and the result is significant. For age category 20 to 44 years (IRR=0.68, 95% CI= 0.66 to 0.70, p-value <0.001) indicates that the incident rate for 20 to 44 years is 0.68 times the incident rate for the reference group (<5 years), holding the other variables constant and the result is significant. For age category 45+ years (IRR=0.62, 95% CI= 0.59 to 0.65, p-value <0.001) indicates that the incident rate for 45+years is 0.62 times the

incident rate for the reference group (<5 years), holding the other variables constant and the result is significant.

The IRR for the Diabetes Mellitus (IRR=1.08, 95% CI= 1.04 to 1.12, p-value <0.001) indicates that the incident rate for Diabetes Mellitus patient is 8% significantly higher when compared to the reference group (no diabetes), holding the other variables constant. For the variable Hypertension (IRR=1.14, 95% CI= 1.09 to 1.19, p-value <0.001) indicates that the incident rate for Hypertensive patient is 14% significantly higher when compared to the reference group (no hypertension), holding the other variables constant. For the variable Asthma (IRR=1.47, 95% CI= 1.42 to 1.52, p-value <0.001) indicates that the incident rate for Asthma patient is 47% significantly higher when compared to the reference group (no asthma), holding the other variables constant. The IRR for the Dyslipidaemia (IRR=1.10, 95% CI= 1.05 to 1.16, p-value <0.001) indicates that the incident rate for Dyslipidaemia patient is 10% significantly higher when compared to the reference group (no dyslipidaemia), holding the other variables constant. For the variable Obesity (IRR=1.11, 95% CI= 1.04 to 1.16, p-value <0.001) indicates that the incident rate for obese patient is 11% significantly higher when compared to the reference group (no obesity), holding the other variables constant.

Table-14: Negative Binomial Regression analysis of significant predictors of RTI related other medications use (N=58,786).

Variables	IRR	P value	95% C. I.	
Age category			Lower	Upper
<5 years	1(Reference)			
5 to 19 years	0.91	<0.001	0.88	0.94
20 to 44 years	0.68	<0.001	0.66	0.70
45+ years	0.62	<0.001	0.59	0.65
Diabetes Mellitus				
No	1 (Reference)			
yes	1.08	<0.001	1.04	1.12
Hypertension				
No	1 (Reference)			
yes	1.14	<0.001	1.09	1.19
Asthma				
No	1 (Reference)			
yes	1.47	<0.001	1.42	1.52
Dyslipidaemia				
No	1 (Reference)			
yes	1.10	<0.001	1.05	1.16
Obesity				
No	1 (Reference)			
yes	1.11	<0.001	1.04	1.16

*RTI= Respiratory Tract Infection *p-value <0.05 significant *IRR= Incidence Rate Ratio

Negative Binomial regression analysis of factors associated with RTI related investigations use:

After univariate analysis, six variables: age category, diabetes, hypertension, asthma, dyslipidaemia and obesity had p value <0.25, so they were included in the initial full model. In the next step variables age category and asthma were statistically significant (p <0.05) and variable gender, diabetes, hypertension, dyslipidaemia and obesity were not and removed from the model (p>0.05). Comparing the initial full model with the smaller one by using Likelihood-ratio test (LRT) was in favour of the smaller model (p-value= 0.099). The significant predictors identified by our analysis (the final model) consisted of two variables: Age category and asthma which were found to be the significant predictors for medications use in the context of our study and available data.

Table-15 is demonstrating the result of Negative Binomial Regression analysis of significant predictors of RTI related Investigations use IRR for age category 5 to 19 years (IRR=0.76, 95% CI= 0.71 to 0.82, p-value <0.001) indicates that the incident rate for 5 to 19 years is 0.71 times the incident rate for the reference group (<5 years), holding the other variables constant and the result is significant. For age category 20 to 44 years (IRR=0.52, 95% CI= 0.48 to 0.56, p-value <0.001) indicates that the incident rate for 20 to 44 years is 0.52 times the incident rate for the reference group (<5 years), holding the other variables constant and the result is significant. For age category 45+ years (IRR=0.40, 95% CI= 0.35 to 0.44, p-value <0.001) indicates that the incident rate for 45+years is 0.40 times the

incident rate for the reference group (<5 years), holding the other variables constant and the result is significant.

For the variable Asthma (IRR=1.44, 95% CI= 1.32 to 1.57, p-value <0.001) indicates that the incident rate for Asthma patient is 44% significantly higher when compared to the reference group (no asthma), holding the other variables constant.

Table-15: Negative Binomial Regression analysis of significant predictors of RTI related Investigations use (N=58,786).

Variables	IRR	P value	95% C. I.	
Age category				
<5 years	1(Reference)			
5 to 19 years	0.76	<0.001	0.71	0.82
20 to 44 years	0.52	<0.001	0.48	0.56
45+ years	0.39	<0.001	0.35	0.44
Asthma				
No	1 (Reference)			
yes	1.42	<0.001	1.32	1.57

*RTI= Respiratory Tract Infection *p-value <0.05 significant *IRR= Incidence Rate Ratio

CHAPTER 5: DISCUSSIONS AND CONCLUSIONS

We have analysed selected healthcare services use data for RTI patients who attended 7 primary healthcare centres in Qatar during July 2015 to December 2017. We have selected these four healthcare services because we wanted to investigate the clinical burden or utilization related to RTIs. We have observed the highest rate of RTI-related GP visits, antibiotics and other medications use, tests & investigations among young Qatari patients, and patients with diabetes, hypertension and asthma. The findings were also in accordance with studies from the UK (40), USA (52), Australia (43) and Netherlands (44).

Our study showed that RTI-related GP visits monthly rates and antibiotics use monthly rates overall decreased from 2015 to 2017, but for the antibiotic rates the result was significant. Monthly rates of other medications use didn't show a clear trend, but tests and investigations were showing significant increasing trend. Similar studies also showed decreasing trend, they explained this decreasing trend because of implementation of antimicrobial stewardship program. No clear explanation was found related to increasing trend of tests and investigation, although they suspect this might be due to cultural impact and patients' demand for healthcare services use because in Qatar, patients doesn't have to pay for the services (52) (53). Also, there is a general tendency observed among clinicians in Qatar to advise excessive tests and investigations for patients which might not be needed.

It is evident that RTI related antibiotic use has declined during 1990s, however, has remained unchanged since then (54). In the UK, there has been a long-term decrease in the

rate of General Practitioner (GP) consultations sought and antibiotic prescribing for managing respiratory infections (55). From a study conducted in Southern Sweden (56), revealed that there has been a reduction of 12% and 10% in yearly primary care consultation rates for acute tonsillitis and AOM between 1999 and 2005.

Several studies (57) (58) have stated the importance of antimicrobial stewardship program in relation to the reduction of use of healthcare services because the reduction in antimicrobial consumption in relation with the attainments of clinical outcomes and prevention of other harmful effects, including death and new events of RTI, have a definitive effect on the utilization of funds and resources.

According to (Al-Niemat & Gunn et al.,2014) observing infection related practitioners visits and antimicrobial utilization has been viewed as a fundamental part of antimicrobial stewardship programs, nevertheless inspecting the nature of solutions for curative or prophylactic use in the diverse settings amid understanding consideration, including the emergency department, inpatient, or outpatient facilities (59) (60)

As expected, the finding of our study producing lower number of RTI related resource use during the summer months. In general, the new event of RTIs is higher in the winter months. Yet, the populace movement patterns in the GCC states are such that a huge section of migrant workforces return to their home states during the summer break, and the Qatari nationals travel overseas for leisure. A smaller Qatari population would lead to a smaller denominator of persons looking for treatment, and a smaller overall population may be related with lower transmission rates. Whether the lower figures in Qatar during the

summer months are due to the usual epidemiological patterns seen everywhere the world, or to a much lesser populace base in those months, warrants additional study (61).

After the bi-variate analysis of individual patient-level data of selected 4 healthcare services across age-categories, gender and various comorbidity status, we found health care services varied significantly across age-categories, younger patients relatively used more healthcare services compared to older patients. Different studies also showed similar result, for the reason they explained that younger patients are more susceptible to RTI because for several reasons, nasal or respiratory discharges from children and young with viral RTIs comprise more viruses than those from infected adults. This increased output of viruses, along with typically lesser attention to hygiene, makes children and young more likely to spread their infection to others. The likelihood of spread is further boosted when several children and young are gathered together, such as in child care centres, schools and playing grounds (62). Also, patients with co-morbidities used on average more compared to patients without co-morbidities.

We have found that age and comorbidity status (whether patients had a comorbidity or not) were important predictors for determining individual patient-level healthcare services use. For the RTI related GP visits and other medications use the predictors were almost same i.e. age-categories, diabetes mellitus, hypertension, asthma, dyslipidemia, and obesity. For the RTI related antibiotic use age-categories, diabetes mellitus, asthma, obesity was identified as a significant predictor but for RTI related investigations only age-category and asthma were identified as significant predictors. The findings were similar with other

studies. In a recent systematic review, McKay et al. (2016) investigated a wide range of factors associated with antibiotic prescribing for RTIs. The authors found ten studies that explored Gender as a possible factor, and just one study (Kozyrskyj et al., 2004) showed a statistically significant association between male sex and higher odds of antibiotic prescriptions. Nineteen studies explored age as a factor, 10 suggested older people had higher odds/risk of prescription than younger and 3 suggested younger people had higher risks of antibiotic prescriptions. Nine studies in the review examined association between comorbidities and antibiotic prescribing for RTIs. Two of these studies found presence of comorbidities was associated with prescribing, however, the type of comorbidities was varied by studies (63) (64).

Strengths of the study:

1. One of the main strengths of the study is that, there has never been such study before which investigated the pattern, distribution and trend of primary healthcare services use by local RTI patients using the routine observational data. So, these research results are expected to provide a wider, broader assessment of the healthcare services use associated with the managing of RTIs, from the perspective of both healthcare service provider and a patient.

2. We used a national level electronic database which ensured complete and valid routine observational data from the GPs, making the results generalizable to the other similar settings depending on the results based on appropriate statistical methods.

3. The results are based on appropriate statistical methods, which are clinically meaningful and in line with those observed in the literature

Weaknesses of the study:

1- There are total 23 PHCCs in Qatar but the CERNER electronic database has complete patient-level information for only 7 primary healthcare centres over the study period. The availability of primary care electronic database in Qatar has also restricted the study duration for only being 2 and half years. But the study assumed it will not hamper the result because these selected healthcare centres are largest among other centres, also the geographic distribution of Qatar and services that are available in the PHCCs are almost same.

2- The study couldn't capture RTI-related healthcare services at hospitals due to data linkage issue but it will not impact the study results because the study focus was to investigate the utilization of healthcare services at primary care level.

3- Not many individual-level information from the current version of the CERNER system.

4- This was an observational study with no intention to intervene in the on-going treatment, thus the final diagnoses registered for each patient were not confirmed by results from microbiology tests or from culture and sensitivity test. The absence of results from microbiology and culture and sensitivity tests will make it difficult to decide whether diagnosis or treatment was rational or not and misclassification of diagnosis which may leads to overestimation or underestimation of association.

Further Research:

There are total 23 PHCCs in Qatar but the CERNER electronic database has complete patient-level information for only 7 primary healthcare centres. The accessibility of primary care electronic database in Qatar has also restricted the study duration for only being 2 and half years. For further research all 23 PHCCs with at least 5years more patient level complete data along with other health care services i.e. Number of patients referred to hospital, number of specialist visits, number of emergency visits and Length of hospital stay could be included.

Also, our study only included the Qatari population, for further research both Qatari and non-Qatari could be included to get the full picture and along with healthcare resource burden, economic burden could be investigated.

Concluding Remarks:

The study reveals that, monthly rate of antibiotic consumptions by Qatari patients for RTIs decreased by about one antibiotic per 1000 all-cause visits, as did consultation rates but tests and investigations usage rate significantly increased. The large seasonal variation indicates additional likelihoods to decrease healthcare resource use. After the bi-variate analysis of individual patient-level data of selected 4 healthcare services across age-categories, gender and various comorbidity status, healthcare services varied significantly across age-categories (younger patients relatively used more healthcare services compared to older patients) and whether patients had one of the five comorbidities. We have also found that age and comorbidity status (whether patients had a comorbidity or not) were important predictors for determining individual patient-level healthcare services use. Decision makers will decide whether these selected healthcare services utilization by RTI patients at primary care setting are still a clinical burden, however, the evidence generated in this study will facilitates an effective and efficient use of services needed to manage these patients. Strengthening of signs and symptoms of viral respiratory illnesses, as well as supportive clear communication between physicians and patients, may be useful areas of focus. The study results may help policymakers to comprehend the scale of the burden and to plan a better management of RTIs at primary care setting in Qatar. It may also assist the Government to organize and ensure efficient wellbeing for its RTI patients with limited resources.

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