

Air quality and seasonal variations in consultations for respiratory, allergic, dermatological and gastrointestinal diseases in Bahrain, 2007

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جودة الهواء والتفاوتات الفصلية في الاستشارات حول الأمراض التنفسية والأليرجية والجلدية والهضمية في البحرين، 2007
رندة حمادة، خلدون الرومي

الخلاصة: إن البيانات حول الصحة البيئية شحيحة في البحرين. وقد أجرى الباحثان هذه الدراسة في 4 محافظات في البحرين بهدف توطيد بيانات خط الأساس حول معدل الانتشار الفصلي لبعض مجموعات الأمراض ذات الحساسية الفصلية (أمراض تنفسية، وأليرجية، وجلدية، وأمراض هضمية غير نوعية)، وذلك على مدى سنة كاملة، مع تسجيل البيانات حول المناخ المحلي وملوثات الهواء في السنة ذاتها. وقد أخذت عينة مقدارها 5% من السجلات الطبية لمن حضر إلى مراكز الرعاية الصحية الأولية خلال عام 2007. وقد اتضح أن الزيارات للأمراض الأربعة تبلغ ذروتها في فصلي الربيع وفي الخريف وتصل إلى حضيضها في فصل الصيف عندما تبلغ درجات الحرارة ذروتها وتكون الرطوبة أقل. وقد كانت الزيارات ذات الصلة بالأمراض التنفسية في ذروتها عندما بلغ تركيز ثاني أكسيد الكبريت SO_2 ذروته، مما يدل على وجود إنشاء نظام ترصد مستمر للأمراض الحساسة للمناخ لرصد الاتجاهات البيئية والصحية ذات الصلة بها.

ABSTRACT Environmental health data in Bahrain are scarce. This study in 4 governorates of Bahrain aimed to establish baseline data on the seasonal prevalence of certain disease groups that are sensitive to climate (respiratory, allergic, dermatological and non-specific gastrointestinal diseases) over a 1-year period and to record local climate and air pollutant data for the same year. A 5% sample of medical records for those who attended primary health-care centres during 2007 was taken. Visit rates for all 4 diseases had peaks, in spring and in autumn, with the lowest rates in the summer season when the average temperatures were highest and average humidity was lower. Respiratory-related visits were highest when the air concentrations of SO_2 were highest. An ongoing surveillance system for climate-sensitive diseases should be initiated to monitor and relate health and environmental trends.

Qualité de l'air et variations saisonnières dans des consultations pour des maladies respiratoires, allergiques, dermatologiques et gastrointestinales à Bahreïn en 2007

RÉSUMÉ Les données sur la salubrité de l'environnement sont rares à Bahreïn. La présente étude menée dans quatre gouvernorats de Bahreïn visait à recueillir des données initiales sur la prévalence saisonnière de certains groupes de maladies qui sont sensibles au climat (maladies respiratoires, allergiques, dermatologiques et troubles gastrointestinaux non spécifiques) sur une période d'un an et à enregistrer les données sur le climat local et les polluants atmosphériques pour la même année. Un échantillon de 5 % des dossiers médicaux des patients ayant consulté dans des centres de soins de santé primaires en 2007 a été sélectionné. Les fréquences de consultation pour les quatre groupes de maladies avaient des pics, au printemps et en automne, et des creux pendant la saison d'été, lorsque les températures moyennes étaient les plus élevées et que le taux d'humidité était le plus faible. Les consultations pour un motif respiratoire étaient plus nombreuses lorsque la concentration atmosphérique en dioxyde de soufre était la plus élevée. Un système de surveillance permanent pour les maladies sensibles au climat devrait être instauré pour surveiller et corrélérer les tendances sanitaires et environnementales.

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Introduction

Climate change is increasingly seen as a threat to public health, and climate-sensitive diseases are predicted to be a major component of the future global burden of disease and premature death [1–3]. There is accumulating evidence of the growing vulnerability of humans due to the global climate changes and the critical challenges that the world would continue to face [4–8]. Diseases that are sensitive to climate and that could be affected by global climate changes include vector-borne diseases [9] and heat-related mortality [10], malnutrition [4], allergies [11], infectious diseases [9] and diarrhoeal diseases [1,12]. The percentage of global disability-adjusted life years due to climate-sensitive diseases in 2004 was estimated to be 0.4% [6].

A recent study of temporal trends in air temperatures in Bahrain showed a significant warming of the dry season temperatures between 1947 and 2005. Moreover, the overall rate of warming in the dry season during the day was 7 times that during the night and the trends were statistically significant for the months of May to July and October [13]. Furthermore, in a survey of country-specific environmental impact Bahrain was the 7th worst-ranked country by proportional environmental impact among the 20 worst countries [14].

Data about environmental health in Bahrain are scarce, although the latest available data indicate that the current environmental health burden of disease is low [15]. Seasonal variation in the mortality rates in Bahrain was reported since the 1970s, showing more deaths in the winter season [16]. Badawi and Al Hoda stated that a mean average number of 4.6 patients per day were admitted to the emergency department at the Salmaniya Medical Complex when the mean average heat index was 69 °C and 2.4 patients per day when it was 54 °C [17]. Husain and Chaudhary in their human health

risk assessment on global warming in the Arab Gulf countries have reported that there is an anticipated increase in mortality rates due to cardiovascular diseases, respiratory diseases, thermal stress and infectious vector-borne illnesses between 2070 and 2099 [18]. In Bahrain, the projected excess mortality increases would be 39.2 per 1000 population, with substantial increases in the adjusted all-cause disability adjusted life years due to temperature rises in 2100.

This study in Bahrain aimed to establish baseline data on the seasonal prevalence of certain disease groups that are sensitive to climate. The specific objectives were to determine the rate of consultations for respiratory, allergic, dermatological and non-specific gastrointestinal diseases among patients attending health centres in different governorates of Bahrain over a 1-year period and to record seasonal variations in local temperature, humidity and air pollutant levels in the same year.

Methods

Study setting and sample

The Ministry of Health In Bahrain provides primary health care services through 24 general health centres and 2 clinics, distributed in the 5 governorates. All the health centres are served by board-certified family physicians and offer curative and mother and child care services but vary in the provision of additional services such as radiology, physiotherapy and social and health education [19].

In 2008 a retrospective cross-sectional study was conducted of the medical records of people who attended the health centres during 2007. The inclusion criteria for health centres were those that served a population of > 30 000 [20]. Thus, all the eligible health centres from the Capital, Northern, Muharraq and Central Governorates were included in the sampling frame, except for 1 health centre that served

only labourers [16]. The Southern Governorate was excluded as it only had 2 clinics which did not satisfy the inclusion criteria. One health centre was selected from each of the 4 included governorates: Ibn Sina, Hamad Town, National Bank of Bahrain (NBB) and Sitra (representing Capital, Northern, Muharraq and Central Governorates respectively).

All people registered at the above health centres before 1 January 2007, who sought medical services during 2007, and whose family folders were available at the time of study, were included in the study. Those persons who visited the health centres for screening services (childhood, preschool and premarital), postnatal and antenatal visits, dental visits, visits for pregnancy tests and vaccinations were excluded. The sampling frame comprised all the family folders in the 4 health centres. Due to the large population size, a 5% sample of the medical files was selected from each health centre, proportional to the latest available number of active files. Thus, from the total number of files in Ibn Sina (3296), NBB (6930), Sitra (8355) and Hamad Town (6100) samples of 165, 347, 418 and 305 family folders respectively were selected. A systematic sampling method was employed whereby a random number was picked to select the required number of files.

Data collection

A structured proforma was developed for data collection. It sought information on patients' demographic data, total number of visits and number of visits for specific disease categories that were sensitive to climate. These were: respiratory diseases (upper respiratory tract infections, asthma, emphysema, bronchitis); allergic diseases (allergic rhinitis and conjunctivitis); dermatological diseases (diaper rash, eczema, atopic dermatitis); and gastroenteritis. The diseases groups were identified from the literature [4] and reconfirmed

by a panel of experts comprising family and community medicine consultants

The average monthly air temperature and humidity values in each of governorates were obtained from the Central Informatics Organization and Civil Aviation Affairs in Bahrain [21,22]. The months were categorized into 4 seasons: winter (December–February), spring (March–May), summer (June–August), and autumn (September–November) according to the Bahrain meteorological classification.

The average annual levels of selected air pollutants in each of governorates during 2007 were obtained from the Environmental Control Directorate: sulfur dioxide (SO₂), nitrogen dioxide (NO₂), carbon monoxide (CO), ozone (O₃), particulate matter with diameter ≤ 10 μm (PM₁₀) and ≤ 2.5 μm (PM_{2.5}) [Environmental Control Directorate,

Ministry of Industry and Commerce, Bahrain, personal communication, 2008).

Data analysis

The data was entered and analysed using SPSS program, version 17.0. Age-adjusted prevalence rates of the disease groups for each health centre were standardized to the total population in the sample. The 95% confidence intervals (CI) were computed for the mean rates. The chi-squared test and analysis of variance were applied.

Results

Background characteristics of study sample & health centres

During the study period 4927 patients made a total number of 7592 visits (Ibn

Sina 1408, Hamad Town 2272, NBB 2250 and Sitra 1662). Table 1 shows the sociodemographic characteristics of the study patients by health centre. The highest proportion of patients was in the age group ≤ 10 years (19.2%) and the lowest in age ≥ 60 years (6.7%). More than half (57.5%) of the study sample were never married and the majority (86.5%) were Bahraini citizens. There were statistically significant variations across the health centres in the distribution of age ($P < 0.001$), marital status ($P = 0.020$) and nationality ($P < 0.001$). The highest proportion of Bahraini nationals was in Sitra (97.7%) and the lowest in Ibn Sina (47.4%).

Consultation rates for the studied diseases

Respiratory diseases comprised the highest proportion of consultations for

Table 1 Sociodemographic characteristics of the sample of patients consulting during 2007 in the 4 studied health centres (governorate) in Bahrain

Variable	Ibn Sina (Capital)		Hamad Town (Northern)		NBB (Muharraq)		Sitra (Central)		Total		P-value
	No.	%	No.	%	No.	%	No.	%	No.	%	
Sex											0.336
Male	332	45.5	714	49.6	706	48.7	632	48.4	2384	48.4	
Female	398	54.5	725	50.4	745	51.3	675	51.6	2543	51.6	
Total	730	100.0	1439	100.0	1451	100.0	1307	100.0	4927	100.0	
Nationality											< 0.0001
Bahraini	346	47.4	1403	97.6	1237	85.3	1277	97.7	4263	86.5	
Other	384	52.6	35	2.4	214	14.7	30	2.3	663	13.5	
Total	730	100.0	1438	100.0	1451	100.0	1307	100.0	4926	100.0	
Marital status											0.020
Never married	412	56.4	876	60.9	804	55.4	743	56.8	2835	57.5	
Ever married	318	43.6	563	39.1	647	44.6	564	43.2	2092	42.5	
Total	730	100.0	1439	100.0	1451	100.0	1307	100.0	4927	100.0	
Age (years)											< 0.0001
≤ 9	164	22.7	255	18.3	241	16.7	267	21.0	927	19.2	
10–19	91	12.6	344	24.7	266	18.5	173	13.6	874	18.1	
20–29	101	14.0	279	20.0	225	15.6	289	22.7	894	18.5	
30–39	147	20.4	136	9.7	237	16.5	253	19.9	773	16.0	
40–49	115	15.9	212	15.2	230	16.0	133	10.5	690	14.3	
50–59	52	7.2	127	9.1	107	7.4	62	4.9	348	7.2	
≥ 60	52	7.2	42	3.0	134	9.3	94	7.4	322	6.7	
Total	722	100.0	1395	100.0	1440	100.0	1271	100.0	4828	100.0	

NBB = National Bank of Bahrain

the 4 disease groups studied (187 per 1000 visits) followed by gastrointestinal diseases (27 per 1000 visits), allergies (16 per 1000 visits) and dermatological diseases (7 per 1000 visits) (Figure 1). Among the health centres Ibn Sina had the highest rates of visits for respiratory (279 per 1000), allergic diseases (18 per 1000) and dermatological diseases (11 per 1000) (Figure 1). NBB had the highest rate of non-specific gastrointestinal diseases (15.6%) (32 per 1000). These differences between health centres were statistically significant ($P < 0.001$) for respiratory diseases but not for the other disease categories.

Seasonal consultation rates

Figure 2 shows the rates for all health centres combined for each of the 4 disease groups together with the average temperatures in Bahrain during the 4 seasons. Visit rates for respiratory diseases had 2 peaks, 1 in spring and 1 in autumn, with the lowest rates in the summer season. The seasonal distribution of allergic- and dermatological-related visits had a peak around the spring season. The gastrointestinal disease-related visits were lowest in summer and highest in spring.

The seasonal pattern was consistent across all health centres except for Sitra. Ibn Sina health centre had the highest rate of visits for respiratory diseases throughout the seasons (Figure 3). In NBB there were 2 peaks in the rate of respiratory-related visits (335 per 1000 visits in autumn, 295 per 1000 in winter, 273 per 1000 in spring, and 213 per 1000 in summer). The seasonal distribution of allergic- and dermatological-related visits followed a similar pattern in all the 4 health centres (Table 2). Rates were highest for the former in Ibn Sina and for the latter in NBB. NBB health centre had the highest rates of gastrointestinal disease-related visits in winter and spring.

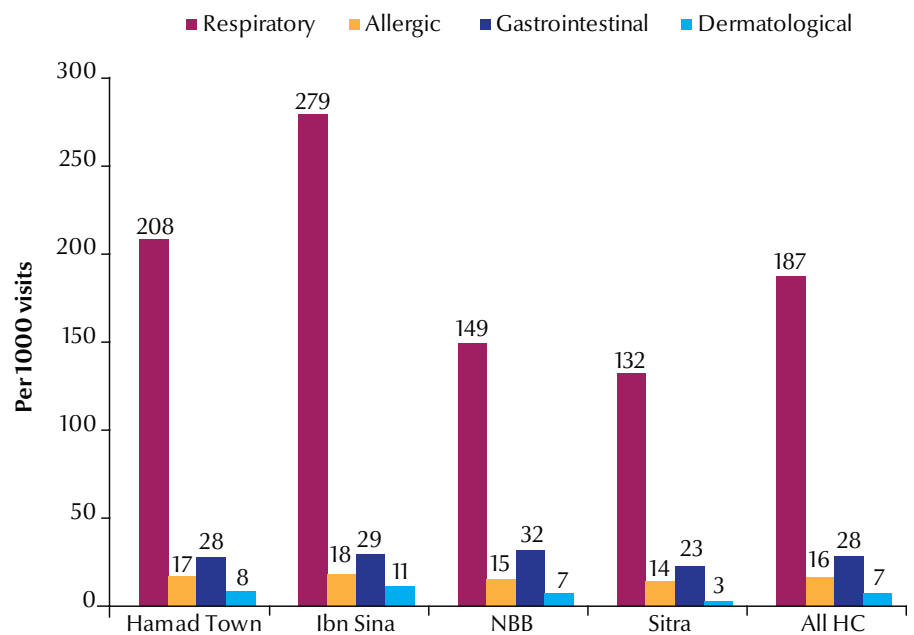


Figure 1 Total consultation rates for respiratory, allergic, dermatological and gastrointestinal diseases per 1000 visits in all studied health centres (HC) in Bahrain, 2007 (NBB = National Bank of Bahrain)

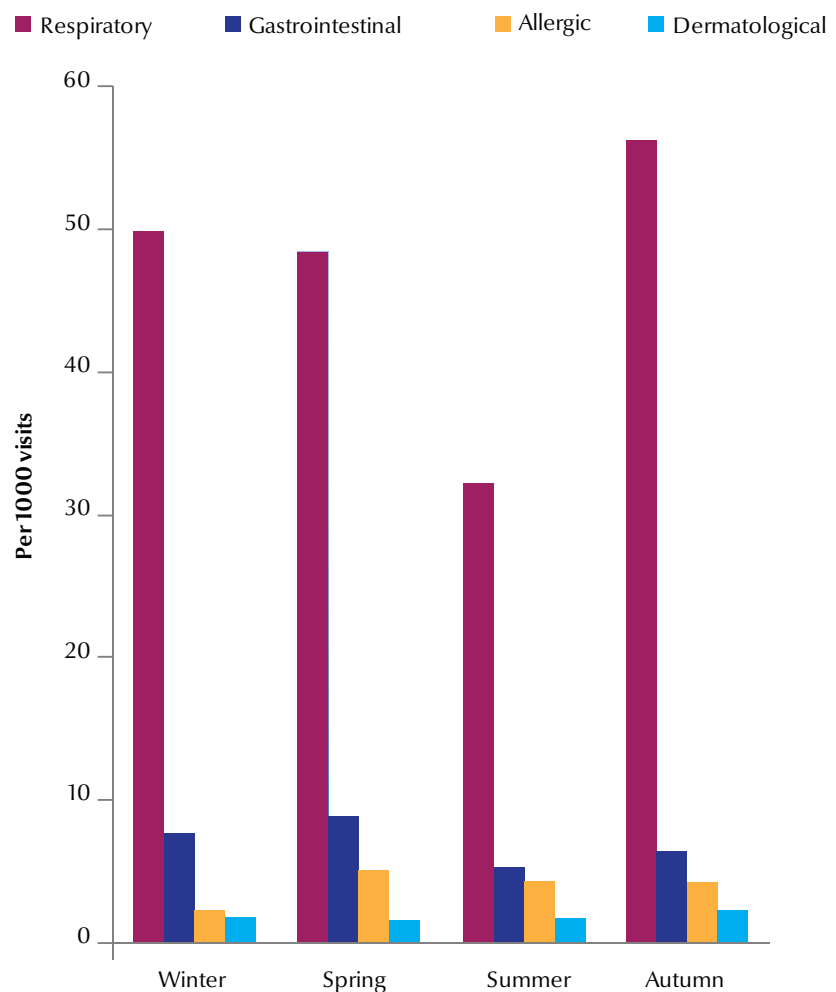


Figure 2 Seasonal variation of total consultation rates for respiratory, allergic, dermatological and gastrointestinal diseases per 1000 visits in all studied health centres in Bahrain, 2007

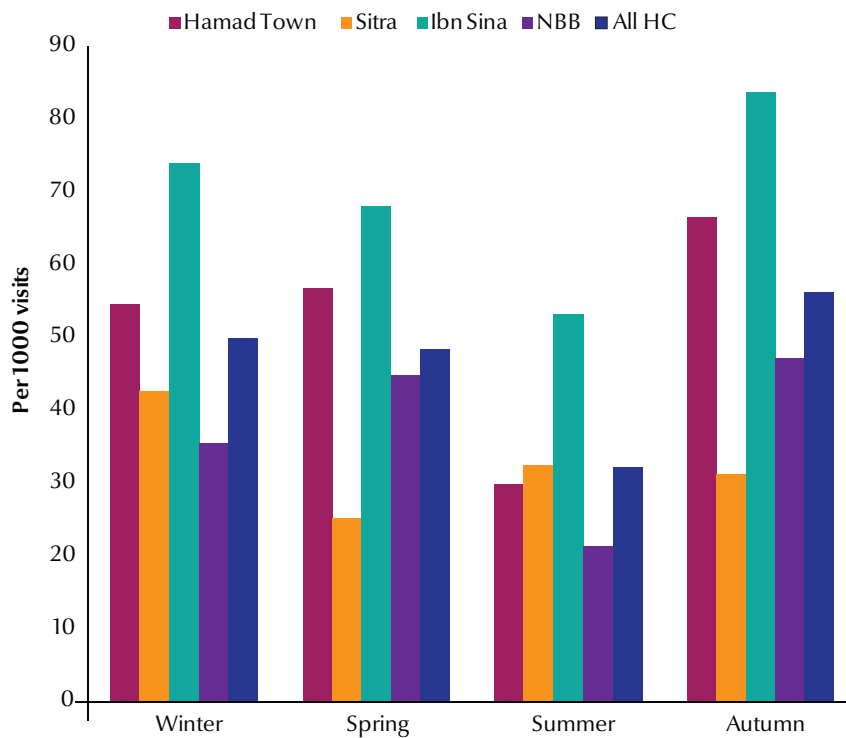


Figure 3 Seasonal rate of consultations for respiratory diseases per 1000 visits in the studied health centres (HC) in Bahrain, 2007 (NBB = National Bank of Bahrain)

Seasonal climate and pollutant levels

Table 3 presents the average annual air levels of SO₂, NO₂, CO, O₃, PM₁₀ and PM_{2.5} recorded in the governorates where the health centres are located. The SO₂ hourly average concentrations were highest in Northern Governorate (where Hamad Town health centre is located) and lowest in Muharraq Governorate (where NBB health centre is located). The NO₂ hourly average concentrations were highest during spring in all 4 governorates, while Central Governorate (where Sitra health centre is located) had the highest throughout the year. The CO hourly average concentrations were highest in Capital Governorate (where Ibn Sina health centre is located). There was no variation in the 24-hour average PM_{2.5} concentrations except for a peak in Muharraq Governorate (where NBB health centre is located). Figure 4 plots the seasonal hourly average levels of SO₂. None of the other studied pollutants showed

any variation by season and consultation visits.

The average temperature and humidity in Bahrain over the 4 seasons in 2007 are shown in Figure 5.

Discussion

There is substantial evidence from the existing literature indicating that climate impacts human health, and it is hypothesized that global and local climate changes will have an impact in the future health of population worldwide [1]. Although the health effects of climate change have attracted attention worldwide, such a concern is not fully appreciated in Bahrain, partly due to the lack of environmental and epidemiological data. In addition, this issue does not appear to be on the high priority list of the political and health agenda.

There were seasonal variations in the pattern of consultations for respiratory diseases, with the highest rates occurring in autumn and the lowest in

summer and an inverse relationship observed between average temperature and the consultation rates. The consultation rate was lowest in summer, when the average temperatures were highest and average humidity levels were lowest. Our findings are in line with other evidence that Middle Eastern populations suffer from respiratory illnesses related to weather conditions [23]. The consultation rates for the 3 other disease categories (allergic, dermatological and gastrointestinal) did not follow a seasonal pattern of variation which may be due to their low consultation rates. Since Bahrain has a warm climate with high temperatures and humidity during most of the year, high transmission of certain diseases through air, contaminated food and water are expected. In addition, conditions that are directly or indirectly related to thermal stress are expected to rise, particularly among vulnerable groups such as children and elderly people [8]. This calls for adequate responses such as establishing an online notification system for illnesses that may be climate sensitive.

There also appeared to be a relationship between the levels of some pollutants and the occurrence of respiratory diseases. When the concentrations of SO₂ were highest, the rates of respiratory-related visits were highest as well. Furthermore, there were differences between the health centres, with Ibn Sina having the highest morbidity rates from respiratory-related diseases. The concentrations of SO₂ followed a similar pattern to those of consultations for respiratory illnesses. Moreover, the SO₂ as well as CO levels were high in the regions with highest rates of visits attributed to respiratory conditions. However, the other pollutants did not show such a pattern.

The prevalence of the 4 studied disease groups was greatest among those below the age of 10 years (35.3%). Furthermore, over half of the visits of the preschool age children

Table 2 Seasonal variation of consultation rates per 1000 visits for respiratory, allergic, dermatological and gastrointestinal diseases in the 4 studied health centres (governorate) in Bahrain, 2007

Disease category/season	Consultation rate per 1000 visits			
	Ibn Sina (Capital)	Hamad Town (Northern)	NBB (Muharraq)	Sitra (Central)
Respiratory diseases				
Winter	74	55	36	43
Spring	68	57	45	25
Summer	53	30	21	32
Autumn	84	66	47	31
All seasons	279	208	149	131
Gastrointestinal diseases				
Winter	9	7	10	5
Spring	8	8	10	9
Summer	7	4	4	6
Autumn	6	9	7	2
All seasons	30	28	31	22
Allergic diseases				
Winter	1	1	4	3
Spring	9	5	4	4
Summer	5	4	4	4
Autumn	4	7	3	3
All seasons	19	17	15	14
Dermatological diseases				
Winter	2	1	3	1
Spring	2	1	3	0
Summer	2	3	0	2
Autumn	5	3	1	1
All seasons	11	8	7	4

NBB = National Bank of Bahrain

were in these 4 disease categories. The literature indicates that children are vulnerable to changes in temperature and at a higher risk of morbidity and mortality [24]. Children, particularly the very young, have a naive immune system, making them more vulnerable to infectious diseases such as

gastrointestinal diseases, respiratory diseases, malaria and parasitic infections. Furthermore, the incidence of fever, electrolyte imbalance and renal diseases increases among children during heat waves [24].

Designing studies to test hypotheses about the possible relationship

between climate changes and disease occurrence are difficult to conduct and encounter limitations. The main limitations of the current study were that data were obtained from medical records, in which information might have been influenced by the doctors' recording practices. However, if this assumption

Table 3 Average annual air pollutant concentrations in the 4 studied governorates in Bahrain, 2007

Pollutant	Annual average pollutant concentrations				P-value
	Capital	Northern	Muharraq	Central	
SO ₂ (ppb)	8.2	9.0	4.6	6.4	< 0.001
NO ₂ (ppb)	21.5	15.3	18.5	23.4	0.057
CO (ppm)	0.51	0.40	0.41	0.37	0.493
O ₃ (ppb)	37.5	56.3	65.3	38.2	0.001
PM ₁₀ (µg/m ³)	145.4	145.7	155.3	193.1	0.629
PM _{2.5} (µg/m ³)	49.7	52.3	55.3	56.9	0.929

SO₂ = sulfur dioxide; NO₂ = nitrogen dioxide; CO = carbon monoxide; O₃ = ozone; PM₁₀ = particulate matter with diameter ≤ 10 µm; PM_{2.5} = particulate matter with diameter ≤ 2.5 µm.

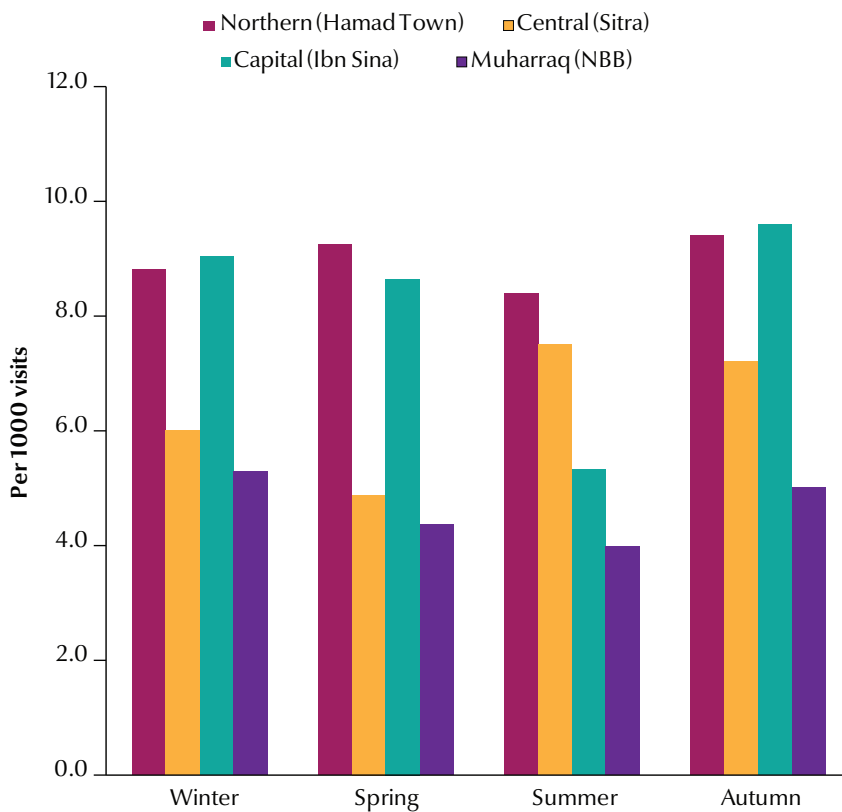


Figure 4 Seasonal average air concentrations of sulfur dioxide (SO₂) in the 4 studied governorates of Bahrain, 2007 (NBB = National Bank of Bahrain)

were true it would have resulted in under-reporting of diseases. Moreover, having qualified family physicians serving in all the health centres in Bahrain would make misdiagnosis unlikely. Secondly, the rationale of the study assumed that the subjects' exposures to

pollutants were mainly based on their area of residence and therefore data were collected from the local health centres. It is plausible that some of the working population were exposed to different levels of pollutants in their work locations. However, subjects who

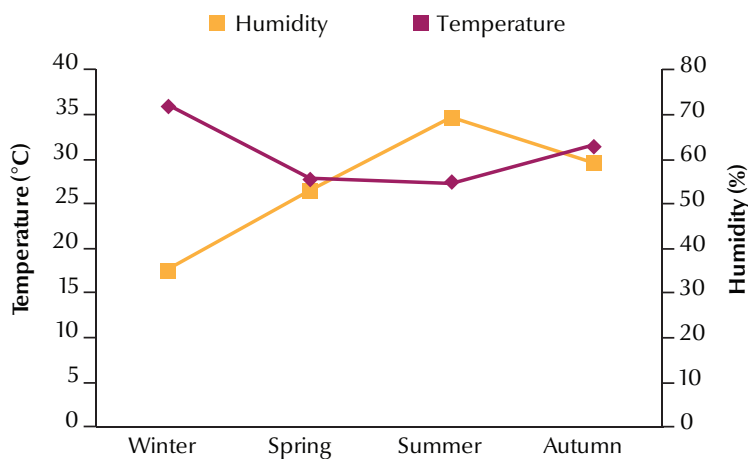


Figure 5 Seasonal average air temperature and humidity in Bahrain, 2007

were not in the main workforce age accounted for around two-thirds of the total population. Thus, such limitations were unlikely to have affected the overall direction of the results

In view of the information gap related to climate change and health in Bahrain, the first step to rectify this situation would be to establish an integrated network for environmental and epidemiological data. This requires the collaboration of the Ministry of Health with the Environmental Control Directorate and Ministry of Industry and Commerce. An ongoing surveillance system should be initiated to monitor and correlate health and environmental trends in the country. This network would also establish a link between the epidemiologic surveillance system at the Public Health Directorate and the meteorological data for prompt action by policy-makers.

Conclusions

Due to the paucity of research on the adverse health effects of climate on health in Bahrain, research should be encouraged to determine the burden of climate-sensitive diseases in the country to enable policy-makers to take action.

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Competing interests: None declared

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