Noncommunicable Diseases and Hospital Utilization in Kuwait: A Generalizable Approach Using the World Health Survey

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Highlights of the Study

- Increasing prevalence of noncommunicable diseases is a growing yet understudied burden on health systems.
- Hypertension is associated with 75\% higher hospital admission and heart disease with a 4-fold increase in hospital admission in Kuwait.
- A generalizable approach we applied in Kuwait is suitable for comparing hospital utilization risks associated with noncommunicable diseases in 70+ countries participating in the World Health Survey.

Keywords
Noncommunicable diseases · Hospital utilization · Disease burden · Kuwait

Abstract

Background: Kuwait and countries in the Arabian Gulf region face an alarming prevalence of noncommunicable diseases (NCDs) that strain their health systems and threaten their economies. To quantify a key dimension of the burden, we estimated the risk of hospital utilization in Kuwait associated with diagnoses of the most prevalent NCDs, excluding cancer, using a generalizable approach suitable for cross-country disease burden comparisons and assessments of prevention effectiveness. Methods: The study analyzed responses from a nationally representative sample of 2,165 individuals with self-reported hospital admissions over 12 months and NCD diagnoses from the World Health Survey in Kuwait in 2010. Hospital utilization rates were examined for individuals diagnosed with hypertension, diabetes mellitus, asthma, chronic lung condition, heart disease, and stroke rates and adjusted for demographic and socioeconomic factors. Count regressions were used to estimate the association between individual NCDs while adjusting for other covariates. Results: Using negative binomial regressions, we found that hypertension, the most common NCD in Kuwait, was associated with 75\% higher hospital utilization. In addition, heart disease was associated with a 495\% increase in hospital utilization rates after adjusting for potential confounders. Many other demographic, socioeconomic, and behavioral characteristics confounded the sizable increase in the risk of hospital admissions associated with NCDs. Conclusions: We estimated the substantial burden on curative services associated with NCDs in Kuwait through a standardized approach to compare hospital utilization rates associated with various NCDs; this approach is generalizable to more than 70 countries that participated in the World Health Survey.

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Introduction

More than 40 million yearly deaths, about 70% of all mortality worldwide, are attributable to noncommunicable diseases (NCDs) [1]. NCDs exact a far-reaching health and economic toll due to prolonged disability, premature deaths, reduced productivity, and increased demand for care [2, 3]. Reducing premature mortality associated with NCDs is at the heart of the United Nations Sustainable Development Goals, with a targeted reduction of one-third [4]. Despite a notable decline in premature mortality from NCDs, the pace of change and disparities in improvements deem the goals unattainable [5]. Kuwait and neighboring countries in the Gulf Cooperation Council (GCC) face more complex challenges in managing and mitigating the record-high prevalence of lifestyle-related NCDs [6].

The high prevalence of NCDs constitutes a growing strain on the health care system in GCC countries. In Kuwait, for example, more than 1 in 4 persons have been diagnosed with hypertension and nearly 1 in 5 with diabetes [7, 8]. Additionally, comorbidity of the 2 most prevalent NCDs (diabetes and hypertension) is also very common in Kuwait and the region [9–11]. This further complicates disease management and prevention and creates an impetus for overarching national strategies, considering NCD-related mortality accounts for 69–83% of all deaths in the GCC [12]. As the relatively young population in the region ages, the burden of NCDs is expected to increase, reaching USD 68 billion by 2022 [13].

Hospital admissions are one of the costliest elements of this financial burden. NCD-related hospital admissions are also regarded as indicators of the effectiveness of disease management and primary care [14]. Although isolated efforts examined the risk and cost of hospital admissions associated with the presence of individual NCDs in GCC countries, to date, the association has not been examined regarding the interactive effects of NCDs in Kuwait or the region [3, 15]. This study aimed to bridge the gap in research by estimating inpatient hospital utilization changes associated with NCD diagnoses while adjusting for comorbidities and demographic attributes. The methods used in this study are designed to be generalized across multiple countries with similar health surveillance datasets.

Quantifying the increase in hospital utilization associated with NCDs is critical for crafting, optimizing, and evaluating the impact of national prevention, control, and management strategies. Additionally, quantitative examinations of hospital admission rates for NCDs can identify at-risk groups and guide resource allocation to achieve meaningful reductions in hospital admissions and mortality [16]. Investments that target modifiable NCD risk factors and active disease management may reduce disease incidence, improve quality of life, and reduce the need for hospital admissions. The efficacy of such investments is hard to gauge when the disease burden and risks are ambiguous due to inadequate health information technology systems and surveillance studies [15, 17]. To that end, we analyzed readily available and standardized World Health Survey (WHS) data from Kuwait to answer critical questions related to changes in hospital utilization associated with the most prevalent NCDs.

The study relies on self-reported NCD diagnoses and 1-year hospital admissions reported by respondents in the Kuwait WHS 2010. The Kuwait WHS is a nationally representative survey of the adult population between 2008 and 2010 [18]. The WHS is the only nationally representative dataset that captures health utilization data and individual characteristics to date in Kuwait and many countries in the region. Therefore, this study was designed to offer an inclusive assessment of hospital utilization risks associated with NCDs in Kuwait and a unique opportunity to compare NCD-related changes in hospitalization rates across more than 70 countries participating in the WHS [19].

Material and Methods

Study Design and Data

This study involved a cross-sectional, individual-level analysis of self-reported hospital admissions and disease presence. The study utilized Kuwait WHS data, a national, cross-sectional survey of Kuwaitis and non-Kuwaitis living in Kuwait [18]. To date, the Kuwait WHS remains the only national health surveillance survey that studied both Kuwaitis and non-Kuwaiti residents in the country. Therefore, the WHS data are best suited for analyses on all segments of the population in Kuwait, including 70% of the population who are expatriates. The survey covered all six governorates in Kuwait based on a simple randomization technique, where respondents are randomly selected within each governorate for a balanced representation [18]. Unlike administrative hospital data that provide an episode-level perspectives, WHS data offer individual-level data with detailed attributes for unique insights given the limited availability of administrative hospital data in Kuwait.

Measures and Variables

Variable selection from the WHS was guided by the Andersen health care utilization model [20] to quantify the association between NCDs and changes in risk of hospital admissions. The Andersen utilization model conceptualizes factors that lead to the use of health care services, which is the aim of this study. In line with the model, the study draws variables for 3 domains that contribute to the utilization of health care: predisposing factors (such as demographics and smoking behavior), enabling factors (access and
organization), and needs (chronic health problems). The analysis measured the link between NCDs (health needs) and hospitalizations (utilization) while adjusting for predisposing and enabling factors; we included each participant’s demographic and socioeconomic attributes as predisposing and enabling aspects of health care utilization. Online supplementary Table 1 (for all online suppl. material, see www.karger.com/doi/10.1159/000526673) shows all survey questions and variables used in the analysis.

The primary outcome variable in this study was the number of hospital admissions during the previous 12 months. Respondents were asked to enter a number in response to the following: “over the last 12 months, how many different times were you a patient in a hospital for at least one night”? Respondents were asked to specify the reason for each admission. Admissions due to maternal care were excluded; all other reasons for admissions were included.

The key independent variables in this study were the individuals’ NCDs. We included all NCDs collected in the WHS: hypertension, diabetes, asthma, chronic lung disease, heart disease or angina, and stroke. Each respondent’s answer to “have you ever been diagnosed with [condition]?” was coded as a binary variable based on the respondent’s answer (0 = no, 1 = yes). Other measures of chronic conditions in the survey, such as actual blood glucose measurement or blood pressure, were considered. However, low response rates drastically limited the sample size and power of the conclusions. Therefore, only self-reported measures of chronic conditions were studied. It is worth noting that the Kuwait WHS did not include any questions on cancer diagnoses; therefore, this study did not include cancer as an NCD.

Several demographic and behavioral variables were considered: age, gender, education level, employment status, socioeconomic status, nationality, smoking behavior, and physical activity. All demographic variables were categorical variables except age, which was categorized into age groups derived from the respondents’ age. Individuals were assigned a wealth score using factor analysis based on responses to wealth-related questions from the household survey, such as property and asset ownership (cars, television, etc.). Individuals were then divided into 5 quintiles based on their wealth score (1 = poorest, 5 = richest). The variables and approach used to arrive at the wealth quintiles are outlined in the World Food Programme guidance paper [21]. Participants were grouped as Kuwaiti or non-Kuwaiti. It is worth mentioning that Kuwait offers universal health coverage for nationals and expatriates, but expatriates have higher copays. Therefore, financial, language, and economic status. Because the number of hospital admissions in the last 12 months was a count variable, Poisson and negative binomial regressions were fit to measure the association between study covariates and the number of hospital admissions. Multivariable linear regression was also used as a validation mechanism.

The group analysis also guided potential interactions between critical independent variables (NCDs) and confounders such as age, gender, wealth score, nationality, etc. These interactions were examined iteratively by fitting models with interaction terms and noting the statistical significance of the new terms and changes to the model’s fit measures using the χ² test of significance.

This approach offered a comprehensive method of quantifying the associations between individual NCDs and hospital utilization rates, then stratifying the risk associated with each condition by examining difference in utilization rates associated with a diagnosis for subgroups. Multivariable regression was adjusted for potential confounding by examining the isolated and interactive effects of each NCD. The study employed a pairwise deletion approach for missing data to maximize the sample size in each analytical step. The same analyses were also run using listwise deletion to verify the robustness of findings and randomness of missing data.

Results

A total of 2,165 responses (out of 3,826 responses) from the Kuwait WHS individual survey reported the number of overnight hospital admissions during the last 12 months. Respondents who provided the number of admissions are referred to as the study sample hereafter. The average number of reported hospital admissions in the last 12 months was 0.206 overnight hospital admissions per individual, with a variance of 0.726. Most respondents reported no inpatient hospital admissions during the previous 12 months (1,921 of 2,165; 88.7%). The most common NCDs were hypertension (16.1%), diabetes (15%), and asthma (13.5%). Additionally, 4.1% reported being diagnosed with a chronic lung condition, 3.6% with heart disease or angina, and 0.8% with stroke. The three most prevalent NCDs and obesity were associated with age, nationality, highest educational attainment, and employment (Pearson χ² test of association, p < 0.01). Approximately 34% of the respondents had at least one NCD, and 14% had 2 or more NCDs. Figure 1 shows an intersection plot capturing the frequency conditions and combinations of comorbidities in the study sample.
A substantial proportion of the respondents were found to be obese (35.3%). Summary statistics were calculated for the whole sample and based on the three most prevalent NCD diagnoses, obesity, and no NCDs (Table 1). Patients with hypertension reported 175% higher hospital admission rates than individuals without hypertension: 0.44 overnight hospital admissions per person per year with hypertension compared to 0.16 for those without hypertension ($p < 0.001$). Individuals with diabetes reported a 94% higher inpatient hospital admission rate: 0.35 overnight hospital admissions per year for individuals with diabetes versus 0.21 for individuals without diabetes ($p = 0.007$). Asthma diagnoses were associated with 68% higher overnight hospital admission rates: 0.32 overnight hospital admissions per year for individuals diagnosed with asthma compared to 0.19 for individuals not diagnosed with asthma ($p = 0.029$). The absolute difference in hospital admission rates by NCD diagnoses may be confounded because individuals with NCDs tend to be older, less educated, retired, and more likely to have comorbidities, as seen in the summary statistics for each NCD.

Utilization rates were examined across subgroups in the study to explore the significance of the association between NCDs and risk of hospital admissions at the subgroup level. The findings confirmed an overall increase in the risk of hospital utilization associated with NCDs for the entire sample and several subgroups based on the variables studied. Detailed results regarding differences in hospital utilization rates for different NCDs across the sample and subgroups are presented in online supplementary Table 2.

Hospital admission rates were modeled as the dependent variable in several exploratory regression models. Specifically, ordinary least squares, Poisson, and negative binomial regressions were constructed to explore the association between NCDs and hospital admission rate while adjusting for demographic and health covariates. Findings across all models consistently showed an association between NCDs and a higher risk of hospital admission. The results of the three regressions are reported.

![Fig. 1. Frequency of conditions and multiple comorbidities occurring in the study sample.](image-url)
### Table 1. Count and percentage of the most prevalent NCDs in the study sample and subsamples based on key independent variables

|                      | Full sample (N = 2,165) | Obese (n = 764) | Hypertension (n = 346) | Diabetes (n = 324) | Asthma (n = 291) | No NCD (n = 1,428) |
|----------------------|--------------------------|----------------|-------------------------|------------------|-----------------|------------------|
| **Utilization**      |                          |                |                         |                  |                 |                  |
| Hospitalizations in last 12 months | 0.21 (0.17, 0.24) | 0.22 (0.16, 0.28) | 0.44 (0.31, 0.57) | 0.35 (0.23, 0.46) | 0.32 (0.21, 0.44) | 0.15 (0.11, 0.19) |
|                      | 1.92 (0.88, 0.94) | 0.63 (0.45, 0.51) | 0.27 (0.14, 0.21) | 0.26 (0.13, 0.20) | 0.24 (0.12, 0.20) | 0.15 (0.11, 0.19) |
|                      | 166 (7.6%) | 74 (44.58%) | 42 (25.30%) | 34 (20.48%) | 30 (18.07%) | 88 (53.01%) |
|                      | 36 (1.66%) | 13 (36.11%) | 15 (41.67%) | 13 (36.11%) | 6 (16.67%) | 14 (38.89%) |
|                      | 42 (1.94%) | 14 (33.33%) | 16 (38.10%) | 10 (23.81%) | 12 (28.57%) | 17 (40.48%) |
| **Predisposing factors** |                          |                |                         |                  |                 |                  |
| Gender               |                          |                |                         |                  |                 |                  |
| Female               | 1,297 (59.90%) | 488 (37.63%) | 213 (16.42%) | 198 (15.27%) | 200 (15.42%) | 847 (65.30%) |
| Male                 | 868 (40.10%) | 276 (31.80%) | 133 (15.32%) | 126 (14.52%) | 91 (10.48%) | 581 (66.94%) |
| Age                  |                          |                |                         |                  |                 |                  |
| Average (n = 2,149)  | 40.1 (39.5, 40.6) | 43 (20.9) | 53 (31.0, 54.4) | 53.6 (52.1, 55.1) | 42.4 (40.6, 44.1) | 36.31 (35.7, 36.9) |
| <29                  | 558 (25.80%) | 118 (21.15%) | 15 (2.59%) | 18 (3.32%) | 64 (11.47%) | 465 (83.33%) |
| 30–39                | 625 (28.9%) | 211 (33.76%) | 43 (6.88%) | 30 (4.80%) | 85 (13.60%) | 480 (76.80%) |
| 40–49                | 453 (20.9%) | 197 (43.49%) | 73 (16.11%) | 67 (14.79%) | 50 (11.04%) | 290 (64.02%) |
| 50–59                | 293 (13.50%) | 145 (49.49%) | 103 (35.15%) | 95 (32.42%) | 44 (15.02%) | 127 (43.34%) |
| 60–69                | 161 (7.40%) | 72 (44.72%) | 66 (40.99%) | 71 (44.10%) | 28 (17.39%) | 52 (32.30%) |
| 70+                  | 75 (3.5%) | 21 (28.00%) | 46 (61.33%) | 43 (57.33%) | 20 (26.67%) | 14 (18.67%) |
| Smoking status (n = 2,149) | 1,750 (81.43%) | 59 (3.37%) | 43 (2.46%) | 22 (1.26%) | 91 (5.20%) | 1,159 (66.23%) |
| Never smoked         | 1,750 (81.43%) | 59 (3.37%) | 43 (2.46%) | 22 (1.26%) | 91 (5.20%) | 1,159 (66.23%) |
| Past smoker          | 61 (2.84%) | 22 (35.31%) | 15 (24.59%) | 18 (29.51%) | 6 (9.84%) | 33 (54.10%) |
| Current smoker       | 388 (18.05%) | 107 (27.58%) | 43 (11.08%) | 52 (13.40%) | 44 (11.34%) | 225 (57.99%) |
| Physical activity (n = 2,138) | 807 (37.7%) | 287 (35.56%) | 85 (10.53%) | 64 (7.93%) | 116 (14.37%) | 569 (70.51%) |
| Some moderate or vigorous activity | 1,331 (62.3%) | 470 (35.31%) | 254 (19.08%) | 252 (18.93%) | 169 (12.70%) | 847 (63.64%) |
| Education (n = 2,042) |                          |                |                         |                  |                 |                  |
| Primary school or less | 162 (7.93%) | 70 (43.21%) | 52 (32.10%) | 56 (34.57%) | 28 (17.28%) | 74 (45.68%) |
| Secondary school     | 351 (17.19%) | 135 (38.46%) | 59 (16.81%) | 54 (15.38%) | 55 (15.67%) | 222 (63.25%) |
| College or more      | 690 (33.79%) | 241 (34.93%) | 89 (12.90%) | 81 (11.74%) | 98 (14.20%) | 462 (69.66%) |
| Employment status (n = 2,159) | 795 (36.90%) | 313 (39.37%) | 153 (19.25%) | 148 (18.62%) | 126 (15.85%) | 494 (62.14%) |
| Never worked         | 795 (36.90%) | 313 (39.37%) | 153 (19.25%) | 148 (18.62%) | 126 (15.85%) | 494 (62.14%) |
| Public sector        | 797 (37.00%) | 257 (32.25%) | 88 (11.04%) | 67 (8.41%) | 104 (13.05%) | 571 (71.64%) |
| Private sector       | 315 (14.6%) | 98 (31.11%) | 29 (9.21%) | 37 (11.75%) | 22 (6.98%) | 235 (75.65%) |
| Retired              | 249 (11.5%) | 92 (36.95%) | 73 (29.32%) | 70 (28.11%) | 38 (15.26%) | 120 (48.19%) |

**Enabling factors**

**Nationality (n = 2,161)**

|                      |                      |                |                      |                  |                 |                  |
|----------------------|----------------------|----------------|----------------------|-----------------|-----------------|-----------------|
| Kuwait               | 1,548 (71.60%) | 557 (35.98%) | 271 (17.51%) | 260 (16.80%) | 248 (16.02%) | 964 (62.27%) |
| Wealth score (5 is highest; n = 2,042) | 422 (20.70%) | 161 (38.15%) | 71 (16.82%) | 67 (15.88%) | 61 (14.45%) | 275 (65.17%) |

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in Table 2. All models agreed in terms of magnitude, directionality, and significance of the associations from the data. However, we only discuss the findings from the negative binomial model because fit measures indicated a strong match with observed data (comparisons of fit are depicted in online suppl. Fig. 1).

The hospital admission incidence rate ratio (IRR) associated with hypertension was 1.752 (95% CI: 1.017, 3.049). In other words, a hypertension diagnosis was associated with 75% higher hospital utilization rates compared to individuals with no hypertension, with all other studied variables held equal ($p = 0.01$). Hypertension constituted the most considerable burden, given it is the most prevalent NCD observed in the data. Additionally, being diagnosed with heart disease or angina was associated with the highest hospital admission increase based on the models. Specifically, hospital admissions for individuals who reported being diagnosed with heart disease or angina were 495% higher ($IRR = 5.948$, $p < 0.001$). Findings also suggest that obesity can be associated with higher rates of hospital admissions, as seen in the Poisson model ($IRR = 1.300$, $p < 0.05$).

Aside from NCDs, the highest wealth quintile was associated with a 51.1% lower hospital admission rate compared to individuals in the middle wealth quintile ($IRR = 0.498$; 95% CI: 0.284, 0.836; $p = 0.02$). Similarly, the low wealth quintile was associated with a significant reduction in hospital admission risks ($IRR = 0.430$, 95% CI: 0.239, 0.767, $p < 0.01$). Effectively, being further from either end of the median wealth group was associated with a lower hospital admission rate.

**Discussion**

The prevalence of NCDs and the associated risk of hospital admissions in Kuwait are alarming. We found that more than 25% of individuals in Kuwait reported having at least one NCD, and nearly 40% of the sample was obese. Approximately 12% of individuals reported being admitted to a hospital in the last 12 months. On average, the hospital admission rate was 0.206 admissions per person per year. For individuals with no NCDs, the average annual hospital admission rate was 0.147. Individuals with any of the three most prevalent NCDs reported statistically significant higher admission rates relative to those with no such NCDs (hypertension: 0.44, diabetes: 0.35, and asthma: 0.32; all $p < 0.05$). The prevalence of hypertension and diabetes increased among older respondents, which means age may confound the rela-

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**Table 1** (continued)

| Need factors | Obese | Hypertension | Diabetes | Asthma | Chronic lung condition | Heart disease or angina | Stroke | Two or more NCDs |
|--------------|-------|--------------|----------|--------|-----------------------|------------------------|--------|-----------------|
| Full sample  | -     | -            | -        | -      | -                     | -                      | -      | -               |
| (n = 2,165)  |       |              |          |        |                       |                        |        |                 |
| Obese       | 764   | 100.00%      | 181      | 52.31% | 161                   | 43.30%                 | 18     | 59.88%          |
| Hypertension| 346   | 16.10%       | 181      | 52.31% | 161                   | 43.30%                 | 18     | 59.88%          |
| Diabetes    | 324   | 15.00%       | 161      | 50.00% | 161                   | 43.30%                 | 18     | 59.88%          |
| Asthma      | 291   | 13.50%       | 126      | 43.30% | 81                    | 27.84%                 | 18     | 59.88%          |
| Chronic lung condition | 88  | 4.10%        | 38       | 37.50% | 38                    | 37.50%                 | 18     | 59.88%          |
| Heart disease or angina | 77  | 3.60%        | 26       | 33.77% | 26                    | 33.77%                 | 18     | 59.88%          |
| Stroke      | 18    | 0.80%        | 4        | 22.22% | 4                     | 22.22%                 | 4      | 22.22%          |
| Two or more NCDs | 300 | 14.00%      | 150      | 50.00% | 150                   | 50.00%                 | 45     | 15.00%          |

For the full sample, the percentage represents the proportion compared to those who responded to this category. For each NCD, the percentage represents the proportion of each row subgroup that reported the column NCD. For numerical variables (hospital admission and age), means and 95% confidence intervals are reported.
Table 2. Summary of coefficients from three regression models on yearly hospital admissions for individuals using (1) ordinary least squares regression, (2) Poisson regression, and (3) negative binomial regression

|                      | Ordinary least squares | Poisson | Negative binomial |
|----------------------|------------------------|---------|-------------------|
|                      | Coeff  | 95% CI   | IRR   | 95% CI   | IRR   | 95% CI   |
| Predisposing factors |         |         |       |         |       |         |
| Gender (male)        | -0.033 | -0.127, 0.061 | 0.853 | 0.642, 1.126 | 0.778 | 0.492, 1.226 |
| Age (ref: 30–49)     |         |         |       |         |       |         |
| 18–29                | 0.053  | -0.043, 0.148 | 1.356* | 1.020, 1.795 | 1.269 | 0.827, 1.950 |
| 50–69                | -0.009 | -0.126, 0.108 | 0.997 | 0.701, 1.405 | 1.006 | 0.592, 1.708 |
| 70+                  | 0.209  | -0.114, 0.533 | 2.041* | 1.033, 3.787 | 1.395 | 0.375, 5.841 |
| Smoking behavior (ref: never) |         |         |       |         |       |         |
| Past smoker          | -0.081 | -0.325, 0.164 | 0.565 | 0.216, 1.215 | 0.722 | 0.197, 2.498 |
| Current smoker       | 0.059  | -0.059, 0.177 | 1.369 | 0.986, 1.884 | 1.4   | 0.804, 2.455 |
| Active lifestyle     | 0.035  | -0.047, 0.117 | 1.223 | 0.959, 1.557 | 1.27  | 0.875, 1.847 |
| Education (ref: high school) |         |         |       |         |       |         |
| Secondary school or less | -0.039 | -0.146, 0.068 | 0.818 | 0.588, 1.131 | 0.78  | 0.473, 1.282 |
| College or more      | 0.037  | -0.056, 0.130 | 1.24  | 0.943, 1.634 | 1.123 | 0.718, 1.755 |
| Employment status (ref: public sector) |         |         |       |         |       |         |
| Never worked         | -0.008 | -0.111, 0.095 | 0.981 | 0.721, 1.332 | 0.977 | 0.599, 1.595 |
| Private sector       | 0.013  | -0.120, 0.146 | 1.088 | 0.722, 1.615 | 1.034 | 0.539, 1.990 |
| Retired              | -0.001 | -0.140, 0.139 | 0.969 | 0.653, 1.416 | 0.955 | 0.509, 1.796 |
| Enabling factors     |         |         |       |         |       |         |
| Nationality (ref: Kuwaiti) |         |         |       |         |       |         |
| Non-Kuwaiti          | -0.034 | -0.133, 0.064 | 0.79  | 0.581, 1.061 | 0.653 | 0.402, 1.057 |
| Wealth (ref: median) |         |         |       |         |       |         |
| Lowest quintile      | -0.083 | -0.211, 0.045 | 0.671* | 0.474, 0.940 | 0.68  | 0.384, 1.203 |
| Low quintile         | -0.168** | -0.291, -0.045 | 0.403*** | 0.266, 0.593 | 0.430** | 0.239, 0.767 |
| High quintile        | -0.085 | -0.203, 0.034 | 0.696* | 0.508, 0.948 | 0.704 | 0.421, 1.176 |
| Highest quintile     | -0.140* | -0.260, -0.020 | 0.512*** | 0.363, 0.714 | 0.489** | 0.284, 0.836 |
| Need factors         |         |         |       |         |       |         |
| NCDs                 |         |         |       |         |       |         |
| Obesity              | 0.053  | -0.029, 0.135 | 1.300* | 1.024, 1.647 | 1.268 | 0.871, 1.849 |
| Hypertension         | 0.117  | -0.013, 0.248 | 1.598** | 1.146, 2.208 | 1.752* | 1.017, 3.049 |
| Diabetes             | 0.061  | -0.071, 0.193 | 1.341 | 0.950, 1.872 | 1.237 | 0.701, 2.194 |
| Asthma               | -0.011 | -0.134, 0.113 | 0.981 | 0.697, 1.353 | 1.082 | 0.623, 1.889 |
| Chronic lung condition | 0.127 | -0.097, 0.351 | 1.477 | 0.902, 2.319 | 1.096 | 0.423, 2.948 |
| Heart disease or angina | 0.919*** | 0.668, 1.170 | 5.848*** | 4.103, 8.198 | 5.948*** | 2.502, 16.285 |
| Stroke               | -0.392 | -0.963, 0.178 | 0.276 | 0.015, 1.282 | 0.728 | 0.025, 15.648 |
| Constant             | 0.192** | 0.058, 0.325 | 0.163*** | 0.111, 0.236 | 0.189*** | 0.106, 0.340 |
| Observations         | 1,683  |         | 1,683 |         | 1,683 |         |
| Log likelihood       | -2,014.99 |         | -917.616 |         | -734.401 |         |
| Theta                |         |         |       | 0.153*** (0.022) |         |         |
| Akaike information criterion | 4,079.98 |         | 1,885.23 |         | 1,518.80 |         |

tionship between NCD diagnoses and hospital admissions. Expectedly, quitting smoking and physical activity had protective associations with hospital admissions when individuals reported NCDs compared to smokers and nonactive individuals with the same NCDs.

Regression models showed a strong and consistent association between NCDs and hospital admission risk across all models. The directionality of associations from the regression models in Table 2 agreed with findings from group comparisons (online suppl. Table 2). Hypertension was associated with a nearly 75% increase in hospital admission rates relative to similar individuals with no hypertension. Interestingly, age was not associated with an increase in admission rates for individuals after
adjusting for NCDs and other covariates. Wealth was found to protect against hospital admissions, and the second-lowest wealth quintile was also found to be associated with lower hospital admission risk. That lower wealth was associated with fewer hospital admissions was an unexpected finding in this analysis.

The negative binomial regression model performed significantly better than other regression models in studying the number of yearly hospital admissions. The model-predicted zeros were not found to differ from observed zeros in the outcome variable, so a zero-inflated negative binomial model was not needed. The interaction effects between the most prevalent NCDs and between NCDs, wealth quintile, and age group were explored. No interactions were significant, indicating a stable regression model that behaved consistently across various modeling structures.

Missing hospital admission responses were widespread in the Kuwait WHS, with approximately 43% of the respondents not providing the number of overnight hospital admissions. Missing responses raise many concerns about the robustness of the findings due to the reduced sample size and nonrandom missing values. Preliminary comparisons of NCD prevalence and demographics between available and missing admission data indicated potential nonrandom patterns of missing data. Online supplementary Figure 2 shows the frequency of missing values for the whole Kuwait WHS sample and the study sample (respondents who provided admission responses). In future iterations of the survey, better data collection techniques may reduce missing values and improve the overall robustness of the analysis.

Still, findings from the model are comparable to hospital admission risks for NCDs found using other methods and data sources. A study on 11,817 individuals in China found that each additional NCD was associated with a 38% increase in inpatient days [22]. Another study that used a similar approach with the Serbian National Health Survey included 13,765 adults and found that each additional NCD was associated with a 60% increase in the number of overnight stays in hospital for men [23]. Estimates from literature are comparable to the findings of this study, notwithstanding differences in methodology and specificity.

Conclusion

The estimates obtained from this analysis have vast implications for health care planning in Kuwait and the region. Specifically, the calculated risks serve as a sound baseline to evaluate and improve primary care effectiveness, considering that it is the first line for delaying the onset, managing progression, and mitigating risks of NCDs [16]. As Kuwait and countries in the region migrate toward novel reimbursement models, understanding and quantifying the risks associated with prevalent NCDs are imperative for designing well-aligned and comprehensive payment reforms. The findings can also help prioritize strategies and mobilize resources to reduce the measurable risk associated with NCDs. Additionally, the findings pave the way for targeted research efforts and interventions to bridge gaps in NCD research in Kuwait and the region [17].

This study’s nationally representative sample provides a unique perspective on NCDs and hospital utilization rates that have not been previously reported. However, the data have several shortcomings, including missing cancer diagnoses, missing values, and susceptibility to biases in self-reported hospital admissions and NCD diagnoses. Although self-reported NCD diagnoses are known to be susceptible to downward bias [24], we expect that self-reports of overnight hospital admissions during the last year are less prone to recall bias due to their gravity. Further, self-reported health measures have been used extensively in epidemiologic studies. They derive their validity based on associations with subsequent morbidity and mortality [25]. Despite the limitations of this data source, the approach may be considered the best available method to answer a critical question in the wake of inadequate national-level administrative data that deem it challenging to quantify NCD-related hospital services directly.

The methods applied in this study represent a readily available and general approach to quantify changes in hospital utilization associated with prevalent lifestyle-related NCDs in countries with slower adoption of health information systems. As more than 70 countries have adopted the WHS, there is a compelling opportunity to conduct a standardized cross-country comparative assessment of hospital admission risks associated with NCDs. Estimates can serve as a baseline, then be studied over time based on subsequent iterations of the WHS to refine strategies to accomplish the NCD-related Sustainable Development Goals.

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Statement of Ethics

The data used in the analysis are considered a secondary use of previously collected data. The Standing Committee Coordination of Health and Medical Research approved the original survey in 2008 in the Ministry of Health in Kuwait under the ethical guidelines in the Helsinki Declaration. This study obtained ethics approval to access the data from the Standing Committee for Coordination of Health and Medical Research in the Ministry of Health in Kuwait (Approval 2019/1150).

Conflict of Interest Statement

The authors declare no competing interests.

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Author Contributions

Abdullah Alibrahim conceived the scope of the project, acquired the data, designed the study, analyzed data, and wrote the manuscript. Abdullah AlAjeel contributed to writing the manuscript. Both authors reviewed and approved this manuscript for submission.

Data Availability Statement

Data used in this study are from the World Health Survey conducted in Kuwait and were retrieved from the Ministry of Health, Kuwait; these data are available for researchers upon completion of the ethical approval process.

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