

## Changing mortality and place of death in response to refugee influx

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1 **Changing mortality and place of death in response to refugee influx: a population-**  
2 **based cross-sectional study in Jordan, 2005-2016**

3  
4 **Abstract**

5 **Background** Jordan faces complex healthcare challenges due to refugee influx and an  
6 ageing population. Palliative care planning and delivery require data to ensure services  
7 respond to changing population needs.

8 **Objectives** To determine the trend in mortality and place of death in Jordan.

9 **Design** Population-based study.

10 **Setting/subjects** Death registry data of adult decedents (n=143,215), 2005-2016.

11 **Measurements** Descriptive statistics examined change in demographic and place of death  
12 (categorised as hospital and non-hospital). Binomial logistic regression compared the  
13 association between hospital deaths and demographic characteristics in 2008-2010, 2011-  
14 2013, 2014-2016, with 2005-2007.

15 **Results** The annual number of deaths increased from 6,792 in 2005 to 17,018 in 2016 (151%  
16 increase). Hospital was the most common place of death (93·7% of all deaths) in Jordan,  
17 and percentage of hospital deaths increased for Jordanian (82·6%-98·8%) and non-  
18 Jordanian decedents (88·1%-98·7%). There was an increased likelihood of hospital death  
19 among Jordanian decedents who died from non-ischaemic heart disease (OR: 1·11, 95% CI:  
20 1·09-1·13,  $P<0\cdot001$ ), atherosclerosis (OR: 1·10, 95% CI: 1·08-1·13,  $P<0\cdot001$ ), renal failure  
21 (OR: 1·05, 95% CI: 1·02-1·08,  $P<0\cdot001$ ), haemorrhagic fevers (OR: 1·09, 95% CI: 1·06-1·13,  
22  $P<0\cdot001$ ), and injury (OR: 1·18, 95% CI: 1·06-1·33,  $P<0\cdot001$ ) in the period 2014-2016,  
23 compared with 2005-2007. There were similar increases in the likelihood of hospital death  
24 amongst non-Jordanians in 2014-2016 for the following conditions: malignant neoplasms  
25 (except leukaemia), non-ischaemic heart disease, atherosclerosis, injury, and HIV,  
26 compared with 2005-2007.

27 **Conclusions** Country-level palliative care development must respond to both internal  
28 (ageing) and external (refugee influx) population trends. Universal Health Coverage requires

29 palliative care to move beyond cancer and meet population-specific needs. Community-  
30 based services should be prioritised and expanded to care for the patients with non-  
31 ischaemic heart disease, atherosclerosis, renal failure, haemorrhagic fevers, and injury.

32

33

## 34 **Introduction**

35 Palliative care is a human right.<sup>1</sup> Universal Health Coverage (UHC)<sup>2</sup> and the World Health  
36 Assembly (WHA) Resolution 67.19<sup>3</sup> call for palliative care to be integrated into national  
37 health services, accessible globally for all individuals and communities in need. However,  
38 palliative care and pain relief were identified as neglected dimensions of global health by the  
39 Lancet Commission on Global Access to Palliative Care and Pain Relief.<sup>4</sup> Only 10% of the  
40 20 million people each year who need palliative care actually receive it, and 80% of this  
41 need is in low- and middle-income countries (LMICs).<sup>5</sup> The WHO Global Atlas reports that  
42 only 30 countries (15%) in the world have fully integrated palliative care into their national  
43 healthcare systems, and 47 countries (24%) have no known hospice-palliative care activity.<sup>6</sup>

44

45 By 2060, there will be an estimated 48 million people who will die each year with serious  
46 health-related suffering.<sup>7</sup> The vast majority of these deaths (83%) will occur in LMICs, an  
47 increase of 94% between 2016 and 2060. These increases are primarily in cancer<sup>8</sup>,  
48 cerebrovascular disease, lung disease and dementia. Progressive illness in LMIC places a  
49 huge burden on patients and (largely female) family caregivers<sup>9,10</sup>, and costs in the final year  
50 of life, accounting for 20% of health spending.<sup>11</sup>

51

52 Jordan faces a complex refugee situation, hosting the second-greatest ratio of refugees to  
53 citizens of any country in the world.<sup>12</sup> Although Jordan is a non-signatory state to the  
54 Refugee Convention, it has received millions of refugees over the years: Somalians,  
55 Sudanese, Chechens, Circassians, Armenians, Palestinians (the most majority of the  
56 refugee population), Mandeans, Iraqis and, most recently, Syrians.<sup>13,14</sup> Since the outbreak of

57 political violence in Syria in 2011, Jordan is grappling with the challenge of accommodating  
58 significant numbers of Syrian refugees over the long term. Even though international NGOs  
59 and local social workers have begun to develop intervention plans for Syrian refugees in  
60 camps, the large majority of Syrian refugees (84%) live outside refugee camps in Jordanian  
61 communities.<sup>15</sup> Compared to the other neighbouring countries hosting Syrian refugees  
62 (Lebanon, Iraq, and Turkey), Jordan hosts the highest number of urban Syrian refugees, and  
63 the constant influx of Palestinian, Syrian, and Iraqi refugees has placed considerable strain  
64 on its capacity to ensure regular and effective access to basic services.<sup>16</sup>

65

66 Jordan has a population of approximately 10 million people and faces unique and complex  
67 challenges in health care due to the refugee influx<sup>12,16,17</sup> and rising incidence of cancer.<sup>18-20</sup>  
68 As of September 2016, over 656,000 Syrian refugees were registered with the United  
69 Nations High Commissioner for Refugees (UNHCR) in Jordan, accounting for approximately  
70 10% of Jordan's native resident population. The annual cost of providing cancer care to  
71 Syrian refugees in Jordan in 2017 was estimated at €2.09 million, which represents a  
72 significant financial burden for the host country.<sup>21</sup>

73

74 The development of palliative care in Jordan is still in its infancy, and many challenges  
75 persist in promoting palliative care at the national level.<sup>18,19,22</sup> These include: (1) Lack of  
76 national palliative care strategy implementation, with resource allocation heavily skewed to  
77 curative and acute care, compared to palliative care; (2) Negative public and healthcare  
78 provider attitudes towards palliative care and delayed referral; (3) Constraints in opioids  
79 prescribing and supply; (4) Concealment of diagnosis and prognosis to patients; (5) Unmet  
80 psychosocial and family support needs; (6) Research on palliative care is limited. Palliative  
81 care began in Jordan several decades ago<sup>23</sup>, and is provided in a comprehensive centre of  
82 excellence and across the public health system.<sup>22,24</sup> The Jordan Palliative Care Society  
83 (JPCS) initiatives aim to expand, develop, and rehabilitate the Oncology Department and  
84 Palliative Care Services across eight public hospitals.<sup>25-27</sup>

85

86 The number of refugees registered in Jordan currently stands at 744,795 persons of concern,  
87 among a Jordanian population of 10 million people.<sup>28</sup> The influx of refugees from  
88 neighbouring countries (i.e. Palestine, Syria, and Iraq) has placed additional strain on health  
89 systems and budgets.<sup>29</sup> Palliative care provision and planning require data to ensure that  
90 services respond to changing population needs. This study aimed to determine the trends in  
91 mortality and place of death in Jordan for both Jordanian and non-Jordanian decedents for  
92 the years 2005-2016.

93

## 94 **Methods**

### 95 **Study design and settings**

96 A population-based study using routine anonymised death registry data in Jordan. The study  
97 was approved by the Research Ethics Committee at King's College London (Reference no.  
98 HR-17/18-7243), Jordanian Ministry of Health (Reference no. MOH REC 1800110) and King  
99 Hussein Cancer Centre in Jordan (Reference no. 18KHCC70).

100

### 101 **Data sources**

102 Data for all adult deaths (aged 18 years and above) registered in Jordan from 2005 to 2016  
103 inclusive were obtained from the Ministry of Health, Jordan. The data included age (an  
104 ordered categorical variable, 25-54, 55-64, 65-74, 75-84 and 85+), gender (men, women),  
105 marital status (married, single, divorced, widowed, and other), underlying cause of death  
106 (CoD), country of origin, place of death, and year of death of the deceased persons in  
107 Jordan.

108

109 CoD was recorded according to the 10th revision of the International Classification of  
110 Diseases (ICD-10) codes<sup>30</sup>, and categorised into the 20 health conditions most commonly  
111 requiring palliative care, defined by the Lancet Commission on Palliative Care and Pain

112 Relief (Table 1).<sup>4</sup> Decedent country of origin was stratified into Jordanian and non-Jordanian  
113 (refugees who migrated from other countries but died in Jordan between 2005 and 2016).  
114 Place of death was grouped into hospital (including deaths in private and public hospitals)  
115 and non-hospital deaths (deaths at home or other places).

116

## 117 **Analysis**

118 Patients' sociodemographic characteristics were presented using descriptive statistics.  
119 Percentage trends in hospital and non-hospital deaths for Jordanians and non-Jordanians  
120 were plotted against the year of death (2005-2016) using a line graph. Data were grouped  
121 into four time periods: 2005-2007, 2008-2010, 2011-2013 and 2014-2016 to examine the  
122 changing trends in hospital deaths and patients' sociodemographic characteristics. The cut-  
123 off boundaries for four time periods were based on the data distribution considering the start  
124 of the Syrian civil war in 2011.

125

126 Binomial logistic regression was used to estimate the association between hospital deaths  
127 and patient demographic characteristics. We developed three models separately, and each  
128 model compared the association between patients' demographic characteristics and hospital  
129 deaths for Jordanians and non-Jordanians. The dependent variable consisted of hospital  
130 deaths in 2005-2007 (0), compared with other periods 2008-2010 (1), 2011-2013 (1), and  
131 2014-2016 (1). All explanatory variables (age, gender, CoDs, marital status) were forced to  
132 remain in the model. Odd Ratios (OR) and 95% confidence intervals (95% CI) were used to  
133 quantify the association between hospital deaths and patients' demographic characteristics.  
134 Bonferroni correction was applied to adjust for family-wise error rate (0.05/6). All statistical  
135 analyses were completed using R Version 3.5.2.

136

## 137 **Results**

138 A total of N=143,215 people aged 18 years or above died in Jordan between 2005 and 2016  
139 inclusive (Table 1). The annual number of deaths increased from 6,792 in 2005 to 17,018 in  
140 2016 (an 151% increase). The majority of the decedents were male (55.8% - 58.0%)  
141 (Appendix 1). The top leading CoD across all years were malignant neoplasms (except  
142 leukaemia) (17.4%), chronic ischaemic heart diseases (13.6%), cerebrovascular diseases  
143 (12.4%), and non-ischaemic heart diseases (10.9%), followed by atherosclerosis (6.7%),  
144 liver diseases (3.5%), lung diseases (3.3%), and renal failure (3.3%). Figure 1 shows the  
145 percentages of deaths by country of origin (Jordanian and non-Jordanian decedents)  
146 stratified by the leading CoD between 2005 and 2016.

147

148 In terms of country of origin, the proportion of total deaths for non-Jordanians increased from  
149 6.4% (n=1974) in 2008-2010 to 7.2% (n=2917) in 2011-2013. This increase corresponds  
150 with the period of the Syrian civil war, which started from 15<sup>th</sup> March 2011. Hospital was the  
151 most common place of death. The percentage of deaths at hospitals increased over time for  
152 both Jordanian (82.6% in 2005 to 98.8% in 2016) and non-Jordanian population (88.1% in  
153 2005 to 98.7% in 2016) (Figure 2).

154

155 Results from binomial logistic regression showed a decreased likelihood (OR: 0.91, 95% CI:  
156 0.88-0.94,  $P<0.001$ ) of hospital deaths among Jordanian decedents aged 75-84 who died  
157 within the period 2014-2016, compared with 2005-2007. There was also a similar decrease  
158 in the likelihood of hospital deaths (OR: 0.91, 95% CI: 0.88-0.95,  $P<0.001$ ) for Jordanian  
159 aged 85 year and above (Table 2). By contrast, there was an increased likelihood of hospital  
160 deaths amongst non-Jordanians aged 75-84 years (OR: 1.03, 95%CI: 0.94-1.13,  $P=1.00$ )  
161 and in the oldest age group (85+) (OR: 1.02, 95% CI: 0.92-1.13,  $P=1.00$ ) for the period  
162 2014-2016, compared with 2005-2007, but this result was not statistically significant (Table  
163 3). Regarding marital status, there was an increased likelihood of hospital deaths among  
164 Jordanian decedents who were married (OR: 1.10, 95% CI: 1.08-1.13,  $P<0.001$ ), divorced  
165 (OR: 1.47, 95% CI: 1.39-1.56,  $P<0.001$ ), or widowed (OR: 1.49, 95% CI: 1.44-1.54,

166  $P<0\cdot001$ ), for the period 2014-2016, compared with 2005-2007 (Table 2). The similar pattern  
167 was found among non-Jordanians, but the result was not statistically significant (Table 3).

168

169 Among Jordanian decedents in the period 2014-2016, there was an increased likelihood of  
170 hospital deaths from non-ischaemic heart disease (OR: 1·11, 95% CI: 1·09-1·13,  $P<0\cdot001$ ),  
171 atherosclerosis (OR: 1·10, 95% CI: 1·08-1·13,  $P<0\cdot001$ ), renal failure (OR: 1·05, 1·02-1·08,  
172  $P<0\cdot001$ ), haemorrhagic fevers (OR: 1·09, 95% CI: 1·06-1·13,  $P<0\cdot001$ ), and injury (OR:  
173 1·18, 95% CI: 1·06-1·33,  $P<0\cdot001$ ), compared with 2005-2007. For non-Jordanian  
174 decedents in 2014-2016, the non-significant increases in CoD were found for malignant  
175 neoplasms (except leukaemia), non-ischaemic heart disease, atherosclerosis, injury, and  
176 HIV (Table 2 and 3).

177

## 178 **Discussion**

179 This is the first population-based study to determine changing demographics, place of death,  
180 and CoD in a country with a large refugee influx. An increase was found in the proportion of  
181 total deaths for non-Jordanians from 6·4% ( $n=1974$ ) in 2008-2010 to 7·2% ( $n=2917$ ) in 2011-  
182 2013, which corresponds with the period of the Syrian civil war. This represented a 47·8%  
183 increase in the number of deaths in Jordan for non-Jordanians. Among Jordanian decedents  
184 in the period 2014-2016, there was a significantly increased likelihood of hospital deaths  
185 from non-ischaemic heart disease, atherosclerosis, renal failure, haemorrhagic fevers, and  
186 injury, compared with 2005-2007. For non-Jordanian decedents in 2014-2016, the increase  
187 in CoD were malignant neoplasms (except leukaemia), non-ischaemic heart disease,  
188 atherosclerosis, injury, and HIV, however neither was statistically significant. Community-  
189 based services should be developed to prioritise care for these conditions.

190

191 Hospital was the most common place of death (93·7%) among all deaths. During the study  
192 period, the percentage of hospital deaths increased for both Jordanian (from 82·6% in 2005  
193 to 98·8% in 2016) and non-Jordanian population (from 88·1% in 2005 to 98·7% in 2016).



194 Contrary to previous studies conducted in European countries<sup>31,32</sup>, our results indicate that  
195 the likelihood of hospital deaths increased amongst Jordanian and non-Jordanians during  
196 the period 2014 -2016. The dramatic increase in hospital deaths may be due to  
197 epidemiologic transition in the population structure induced by the increase in non-  
198 communicable diseases<sup>33</sup> and other factors such as improved reporting of mortality data<sup>34</sup>  
199 and lack of community-based services in Jordan (lack of supply of the home care services  
200 and stand-alone hospices and nursing homes).<sup>22</sup> And it also could be that the cost of home  
201 care service provision is usually covered out of pocket and not reimbursed by public or  
202 private insurance in Jordan.

203  
204 Palliative care in Jordan is mostly delivered in hospitals, and mainly focus on cancer  
205 patients.<sup>22</sup> A recent study, which analysed routinely collected data comprising 630 patients  
206 with cancer (including Jordanian and non-Jordanian) referred to the palliative care service at  
207 KHCC and died between 1<sup>st</sup> January 2011 and 31<sup>st</sup> December 2012, showed that over 87.3%  
208 died in hospitals.<sup>35</sup> Hospital deaths are more prevalent than home deaths in cancer patients  
209 in Jordan. This phenomenon that families transfer the patients to the hospital when they are  
210 getting terminal is most likely attributed to a lack of afterhours and extended home care  
211 coverage, and the costs of hospitalisations covered by the public and private insurance for  
212 cancer patients. This study found that male patients, aged over 65 years, with earlier  
213 palliative care involvement, and involvement of home care services were significantly  
214 associated with dying at home.<sup>35</sup> We also found a decreased likelihood in hospital deaths  
215 amongst older Jordanians aged 75 years and above. It is consistent with the results of the  
216 above retrospective analysis of 630 cancer patients who received palliative care at KHCC  
217 which showed that home death is more likely amongst older age group in Jordan, especially  
218 those with cancer.<sup>35</sup> The decreased likelihood of hospital deaths for those aged 75 years  
219 may be partly due to patients' preference for home deaths or the influence of palliative care  
220 programmes, designed to encourage out-of-hospital deaths.<sup>22,36</sup>

221

222 Although the number of deaths per year have increased globally<sup>37</sup>, palliative care is not  
223 widely available. There is no structured palliative care programme operating outside  
224 Jordan's capital Amman. Within Amman, these services are primarily limited to the private  
225 sector and cancer care.<sup>18,22</sup> In the public sector, the oncology team at the government  
226 hospital of Al-Bashir in Amman recently began offering palliative care to cancer patients  
227 within limited resources.<sup>38</sup> Now is the time to promote contextually appropriate palliative care  
228 development, addressing the needs of refugees and people with cancer and non-cancer  
229 conditions, particularly those with cardiovascular diseases. We found an increased likelihood  
230 of dying in hospitals from non-ischaemic heart disease and atherosclerosis in the period  
231 2014-2016, compared with 2005-2007, among Jordanians and non-Jordanians. This finding  
232 confirms that palliative care should not only focus on people with advanced cancer, but it  
233 also needs to extend to benefit people with other progressive illness. This is crucial given the  
234 projection data for death with serious health-related suffering.<sup>8,39</sup>

235

236 Refugees, as a minority group in any society, experience many stressful and traumatic  
237 situations prior to, during, and after transfer.<sup>40</sup> The challenges and difficulties they face  
238 include family disturbances, the loss of close relatives, unsafe situations, physical and  
239 sexual abuse, bombing, arrest, and torture,<sup>41,42</sup> social exclusion or discrimination after  
240 migration caused by their exclusion from the social system, lack of social status, increased  
241 rates of unemployment, and financial difficulties associated with low levels of services and  
242 lack of social containment.<sup>43-45</sup> In addition, refugees are exposed to posttraumatic stress  
243 disorder, depression, and anxiety.<sup>46-48</sup> The prevalence of psychological distress and mental  
244 disorders among refugees indicates that they have poor coping mechanisms and need  
245 professional assistance to cope with their stressful situations effectively.<sup>49</sup> These data  
246 suggest that the palliative care needs of these populations are likely to be more complex.

247

248 Many refugees with serious health problems experienced significant physical, emotional, and  
249 social suffering due to a lack of access to pain and symptom relief and other essential

250 components of palliative care.<sup>24,50</sup> Palliative care delivery for refugees must happen within a  
251 wider context of poor refugees' access to healthcare. There is a growing body of literature  
252 demonstrating the barriers in access to health care services among refugees, particularly  
253 those with older age.<sup>51,52</sup> Practical barriers impede access to health services for refugees,  
254 including inadequate information and awareness about the availability of services,  
255 insufficient financial support, restricted access to transport, culturally insensitive care, and  
256 inadequate provision of interpreters.<sup>53</sup> Developing and evaluating effectiveness of palliative  
257 care models in conflict-affected areas is a priority.<sup>54</sup>

258

259 Although the Global Humanitarian Response Plan for COVID-19 includes a strategic  
260 framework, countries in conflict and those experiencing humanitarian emergencies have  
261 fragile health systems and limited capacity to contain the COVID-19 spread and treat  
262 existing cases.<sup>55</sup> A modelling study<sup>56</sup> suggests that after a single infectious person enters a  
263 refugee camp, over 70%–98% of the population is likely to be infected within the first year,  
264 and a large number of deaths is expected should no effective interventions be in place. Due  
265 to the gradual easing of lockdown measures in June in Jordan, there has been a steady  
266 increase of confirmed cases across the country, reaching its largest refugee camp - Zaatari  
267 refugee camp (hosting around 76,000 Syrian refugees) in which seven persons have been  
268 tested positive for COVID-19 as of 29<sup>th</sup> October 2020. The recent emergence of COVID-19  
269 in Zaatari camp and the consequent restrictions, coupled with high density, limited WASH  
270 facilities and health services, have added another layer of complexity for refugees who have  
271 been living away from home for years.<sup>57</sup> In the refugee camps in Jordan, palliative care  
272 services were provided mainly through NGOs, and the locally trained staff in the  
273 neighbouring community clinics. Some strategies applied during the pandemic included the  
274 use of telemedicine palliative care clinics, local delivery of medications to avoid crowdedness,  
275 and occasionally home care visits.<sup>58,59</sup>

276

277 **Strengths and limitations**

278 The analysis of a whole population data set is a strength of this study. However, there are  
279 some limitations. Firstly, the method relies on data accuracy. Second, the data were limited  
280 by the variables available for analysis. For example, patient demographics such as  
281 deprivation (social-economic status or place of residence) are known to be associated with  
282 place of death<sup>60</sup> but were not available in the data set. Future studies that compare  
283 deprivation trends with regional variation in service provision and funding models should be  
284 planned. Third, no information was available on preference for place of death, symptoms,  
285 functional status, need of specialist palliative care and care trajectory, which may influence  
286 place of death. Fourth, data on place of death may not be recorded accurately. A decedent  
287 brought to hospital for certification could potentially be recorded as a hospital death.

288

## 289 **Conclusions**

290 The intersectionality of palliative care and refugee health bring a unique challenge. Palliative  
291 care services must meet the needs of people who have experienced trauma and now face  
292 end of life within social support networks that are likely to be fractured. To meet the palliative  
293 care goals of UHC, the specific dimensions of serious health-related suffering at end of life  
294 must be understood and addressed considering the changing CoD and nationality of  
295 decedents. Community based services should be prioritised and enhanced to care for all  
296 patients and their families, with specific attention to those dying with non-ischaemic heart  
297 disease, atherosclerosis, renal failure, haemorrhagic fevers, and injury.

298 **Author Contributions:**

299 RH and PG conceptualised and designed the study, with input from MA, ON, KA, SA, AM,  
300 RS, and OS. EC and PG analysed and interpreted the data. PG wrote the manuscript and  
301 EC produced the figures and tables. All authors revised the manuscript critically for important  
302 intellectual content and approved the final version.

303

304 **Data management and sharing:**

305 Data are held at Non-Communicable Diseases, Jordan Cancer Registry, The Ministry of  
306 Health (MOH), Amman, Jordan. The anonymised datasets supporting the conclusions of this  
307 manuscript are available upon request to the corresponding author.

308

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472



473 **Table 1.** Demographic characteristics of deaths in Jordan, 2005-2016 (n=143215).

Variables	2005-2016		2005-2007		2008-2010		2011-2013		2014-2016	
N	143215	%	23281	%	30639	%	40661	%	48634	%
Age, mean (SD)	65.9 (17.0)		65.4 (16.7)		65.7 (16.9)		66.3 (17.0)		66.0 (17.3)	
Age group										
18-24	3566	2.5	596	2.6	763	2.5	935	2.3	1272	2.6
25-54	28701	20.0	4432	19.0	6101	19.9	8120	20.0	10048	20.7
55-64	23223	16.2	4307	18.5	5035	16.4	6224	15.3	7657	15.7
65-74	38123	26.6	6656	28.6	8650	28.2	10873	26.7	11944	24.6
75-84	34257	23.9	5090	21.9	7045	23.0	9993	24.6	12129	24.9
85+	15345	10.7	2200	9.4	3045	9.9	4516	11.1	5584	11.5
Gender										
Men	81530	56.9	13444	57.7	17292	56.4	23110	56.8	27684	56.9
Women	61685	43.1	9837	42.3	13347	43.6	17551	43.2	20950	43.1
Marital status										
Married	91312	63.8	15529	66.7	19483	63.6	25887	63.7	30413	62.5
Single	8599	6.0	1572	6.8	2049	6.7	2719	6.7	2259	4.6
Divorced	540	0.4	4	0.0	0	0	4	0.0	532	1.1
Widowed	3961	2.8	120	0.5	31	0.1	106	0.3	3704	7.6
Other	38803	27.1	6056	26.0	9076	29.6	11945	29.4	11726	24.1
Underlying cause of death										
Malignant neoplasms (except leukaemia)	24855	17.4	3841	16.5	5463	17.8	7323	18.0	8228	16.9
Non-ischaemic heart	15598	10.9	1716	7.4	2880	9.4	4853	11.9	6149	12.6
Cerebrovascular	17823	12.4	3131	13.4	3944	12.9	4690	11.5	6058	12.5
Chronic ischaemic heart	19498	13.6	4014	17.2	4662	15.2	5214	12.8	5608	11.5
Atherosclerosis	9526	6.7	1231	5.3	1756	5.7	2490	6.1	4049	8.3
Renal failure	4712	3.3	704	3.0	891	2.9	1271	3.1	1846	3.8
Liver diseases	5074	3.5	932	4.0	1074	3.5	1404	3.5	1664	3.4
Lung diseases	4796	3.3	1027	4.4	1051	3.4	1264	3.1	1454	3.0
Haemorrhagic fevers	2736	1.9	321	1.4	481	1.6	779	1.9	1155	2.4
Leukaemia	2198	1.5	394	1.7	548	1.8	657	1.6	599	1.2
Degenerative CNS	645	0.5	101	0.4	139	0.5	194	0.5	211	0.4
Musculoskeletal disorders	457	0.3	88	0.4	132	0.4	124	0.3	113	0.2
Congenital malformation	334	0.2	50	0.2	76	0.2	96	0.2	112	0.2
Injury	189	0.1	18	0.1	25	0.1	49	0.1	97	0.2
Inflammatory CNS	278	0.2	41	0.2	53	0.2	91	0.2	93	0.2
Dementia	301	0.2	112	0.5	79	0.3	59	0.1	51	0.1
Tuberculosis	212	0.1	57	0.2	70	0.2	56	0.1	29	0.1
HIV	29	0.0	8	0.0	6	0.0	3	0.0	12	0.0
Birth trauma, low birth weight & prematurity	4	0.0	2	0.0	0	0.0	0	0.0	2	0.0
Malnutrition	5	0.0	0	0.0	2	0.0	2	0.0	1	0.0
Diseases not stated above	33945	23.7	5493	23.6	7307	23.8	10042	24.7	11103	22.8
County of origin										
Jordanian	133440	93.2	21768	93.5	28665	93.6	37744	92.8	45263	93.1
Non-Jordanian	9775	6.8	1513	6.5	1974	6.4	2917	7.2	3371	6.9
Place of death										
Hospital	134222	93.7	19786	85.0	27528	89.8	38840	95.5	48068	98.8
Non-hospital	8993	6.3	3495	15.0	3111	10.2	1821	4.5	566	1.2

**Table 2.** Odds ratios (ORs) and 95% confidence intervals (CIs) for variables associated with hospital deaths for Jordanian decedents in 2008-2010, 2011-2013, and 2014-2016 compared with 2005-2007.

	2008-2010 compared with 2005-2007			2011-2013 compared with 2005-2007			2014-2016 compared with 2005-2007		
	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value
<b>Age group (years)</b>									
18-24	1.00	-	-	1.00	-	-	1.00	-	-
25-54	1.02	0.97-1.07	1.00	1.05	1.01-1.10	0.05	0.94*	0.91-0.97	<0.001
55-64	0.99	0.94-1.04	1.00	1.00	0.96-1.05	1.00	0.87*	0.84-0.90	<0.001
65-74	1.02	0.97-1.07	1.00	1.03	0.98-1.07	1.00	0.86*	0.83-0.89	<0.001
75-84	1.04	0.99-1.09	1.00	1.08*	1.03-1.13	<0.001	0.91*	0.88-0.94	<0.001
85+	1.04	0.98-1.10	1.00	1.09*	1.04-1.14	<0.001	0.91*	0.88-0.95	<0.001
<b>Gender</b>									
Women	1.00	-	-	1.00	-	-	1.00	-	-
Men	0.99	0.97-1.00	0.42	1.00	0.99-1.02	1.00	1.03*	1.01-1.04	<0.001
<b>Marital status</b>									
Single	1.00	-	-	1.00	-	-	1.00	-	-
Married	1.00	0.97-1.03	1.00	0.98	0.96-1.00	0.94	1.10*	1.08-1.13	<0.001
Divorced	NA	NA	NA	NA	NA	NA	1.47*	1.39-1.56	<0.001
Widowed	NA	NA	NA	NA	NA	NA	1.49*	1.44-1.54	<0.001
Other	1.00	0.96-1.03	1.00	0.98	0.95-1.01	1.00	1.06*	1.03-1.09	<0.001
<b>Underlying cause of death</b>									
Other	1.00	-	-	1.00	-	-	1.00	-	-
Malignant neoplasms (except leukaemia)	1.03*	1.01-1.05	0.007	1.01	1.00-1.03	1.00	1.01	1.00-1.03	1.00
Non-ischaemic heart	1.05*	1.03-1.08	<0.001	1.09*	1.07-1.11	<0.001	1.11*	1.09-1.13	<0.001
Cerebrovascular	0.99	0.97-1.01	1.00	0.94*	0.92-0.96	<0.001	0.98	0.96-0.99	0.01
Chronic ischaemic heart	0.98	0.96-1.00	0.15	0.93*	0.92-0.95	<0.001	0.93*	0.92-0.95	<0.001
Atherosclerosis	1.03	1.00-1.06	0.15	1.03	1.00-1.06	0.06	1.10*	1.08-1.13	<0.001
Renal failure	1.00	0.96-1.04	1.00	0.99	0.96-1.02	1.00	1.05*	1.02-1.08	<0.001
Liver diseases	0.97	0.94-1.00	0.37	0.95*	0.92-0.97	<0.001	0.96*	0.94-0.99	<0.001
Lung diseases	0.94*	0.91-0.97	<0.001	0.90*	0.88-0.93	<0.001	0.92*	0.90-0.95	<0.001
Haemorrhagic fevers	1.04	0.98-1.09	1.00	1.05	1.01-1.09	0.07	1.09*	1.06-1.13	<0.001
Leukaemia	1.02	0.97-1.07	1.00	0.97	0.93-1.02	1.00	0.93*	0.89-0.97	<0.001
Degenerative CNS	1.01	0.92-1.12	1.00	1.02	0.94-1.10	1.00	1.04	0.97-1.11	1.00
Musculoskeletal disorders	1.04	0.94-1.14	1.00	0.94	0.86-1.03	1.00	0.90	0.83-0.99	0.09
Congenital malformation	1.04	0.90-1.19	1.00	1.04	0.93-1.16	1.00	1.04	0.94-1.15	1.00
Injury	1.05	0.81-1.35	1.00	1.16	0.98-1.38	0.48	1.18*	1.06-1.33	<0.001
Inflammatory CNS	0.99	0.85-1.16	1.00	1.03	0.91-1.17	1.00	1.00	0.90-1.13	1.00
Dementia	0.85*	0.76-0.94	0.001	0.74*	0.67-0.82	<0.001	0.73*	0.66-0.80	<0.001
Tuberculosis	0.94	0.82-1.07	1.00	0.82*	0.72-0.93	<0.001	0.69*	0.60-0.80	<0.001
HIV	0.70	0.46-1.09	0.94	0.58	0.37-0.90	0.03	0.91	0.68-1.20	1.00
Birth trauma, low birth weight & prematurity	0.58	0.16-2.13	1.00	0.53	0.15-1.84	1.00	0.53	0.17-1.71	1.00
Malnutrition	1.55	0.62-3.87	1.00	1.33	0.55-3.20	1.00	1.01	0.31-3.23	1.00

ORs were estimated from binomial logistic regression models.

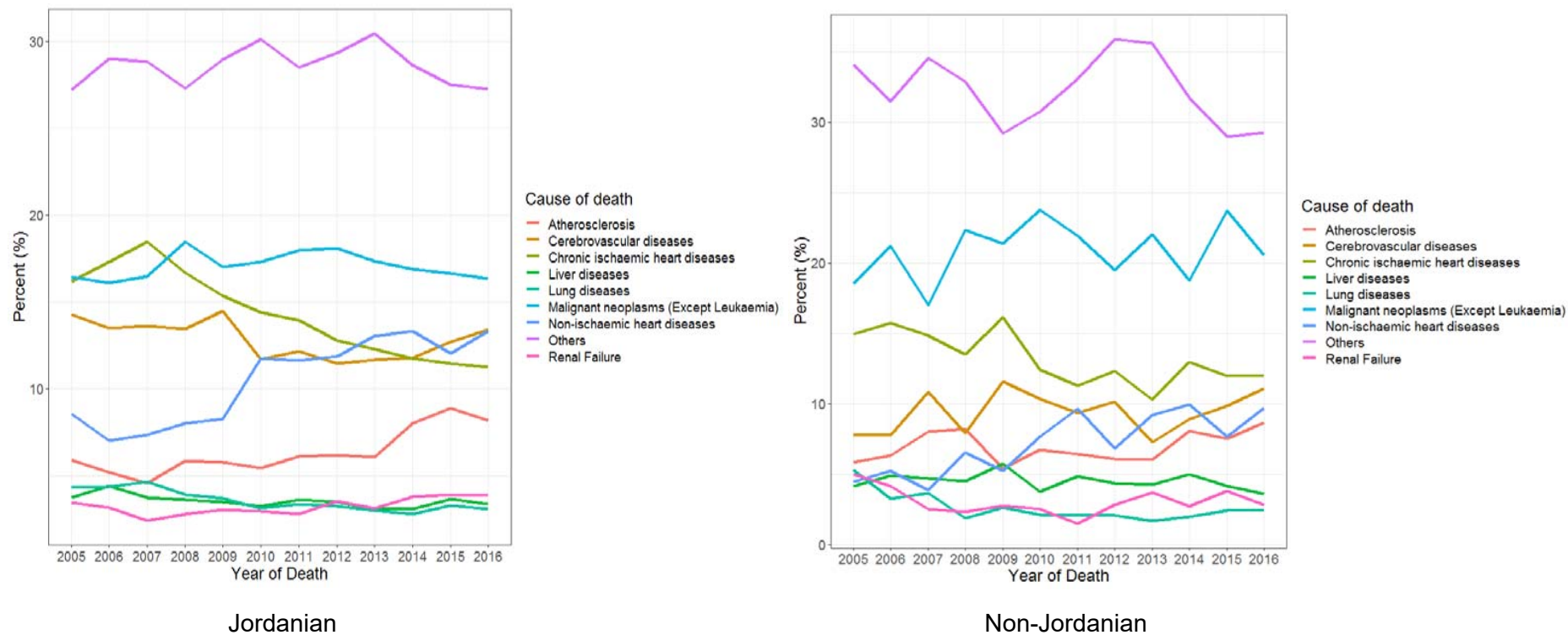
\*P value  $\leq$  0.008 (Bonferroni correction was applied to adjust for family-wise error rate 0.05/6)

**Table 3.** Odds ratios (ORs) and 95% confidence intervals (CIs) for variables associated with hospital deaths for non-Jordanian decedents in 2008-2010, 2011-2013, and 2014-2016 compared with 2005-2007.

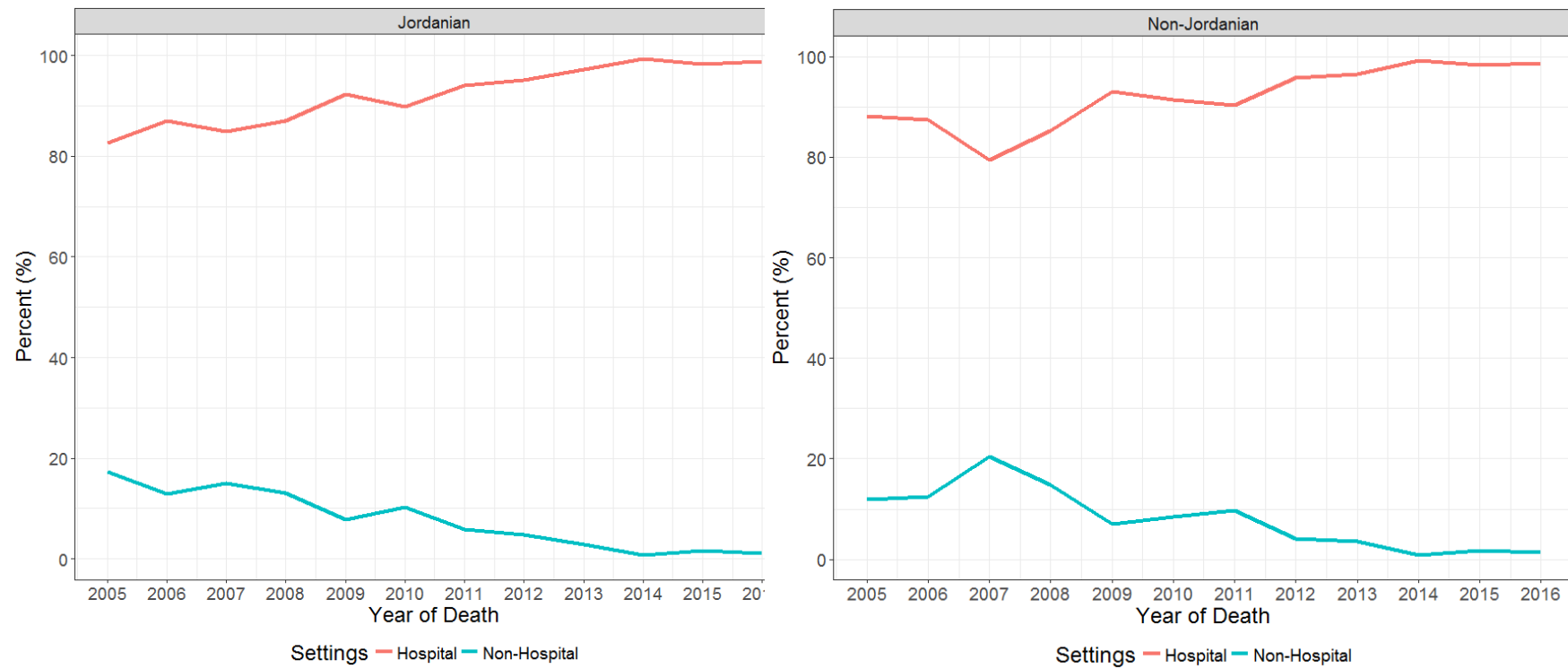
	2008-2010 compared with 2005-2007			2011-2013 compared with 2005-2007			2014-2016 compared with 2005-2007		
	OR	95% CI	P value	OR	95% CI	P value	OR	95% CI	P value
<b>Age group (years)</b>									
18-24	1.00	-	-	1.00	-	-	1.00	-	-
25-54	1.18	1.03-1.36	0.05	1.01	0.92-1.11	1.00	0.97	0.89-1.06	1.00
55-64	1.00	0.89-1.12	1.00	0.99	0.90-1.10	1.00	0.96	0.88-1.06	1.00
65-74	1.01	0.90-1.14	1.00	1.04	0.94-1.15	1.00	1.01	0.92-1.11	1.00
75-84	1.01	0.90-1.14	1.00	1.04	0.93-1.15	1.00	1.03	0.94-1.13	1.00
85+	1.00	0.89-1.13	1.00	0.99	0.88-1.11	1.00	1.02	0.92-1.13	1.00
<b>Gender</b>									
Women	1.00	-	-	1.00	-	-	1.00	-	-
Men	1.01	0.85-1.19	1.00	1.00	0.97-1.05	1.00	1.02	0.99-1.06	1.00
<b>Marital status</b>									
Single	1.00	-	-	1.00	-	-	1.00	-	-
Married	0.82	0.43-1.60	1.00	1.05	0.94-1.18	1.00	1.16	1.03-1.30	0.03
Divorced	1.00	0.88-1.15	1.00	1.09	0.69-1.72	1.00	1.25	0.79-1.96	1.00
Widowed	1.74*	1.52-1.98	<0.001	0.99	0.87-1.14	1.00	1.02	0.88-1.17	1.00
Other	1.01	0.88-1.15	1.00	1.35*	1.21-1.51	<0.001	1.69*	1.51-1.89	<0.001
<b>Underlying cause of death</b>									
Other	1.00	-	-	1.00	-	-	1.00	-	-
Malignant neoplasms (except leukaemia)	1.07	1.00-1.14	0.13	0.98	0.93-1.04	1.00	1.03	0.98-1.08	1.00
Non-ischaemic heart	1.05	0.95-1.16	1.00	1.06	0.98-1.15	1.00	1.06	1.00-1.14	0.40
Cerebrovascular	0.49	0.16-1.51	1.00	0.94	0.87-1.00	0.42	0.99	0.93-1.05	1.00
Chronic ischaemic heart	1.00	0.93-1.08	1.00	0.91	0.85-0.97	0.01	0.98	0.93-1.04	1.00
Atherosclerosis	0.99	0.95-1.04	1.00	0.95	0.88-1.04	1.00	1.05	0.98-1.12	1.00
Renal failure	0.97	0.86-1.10	1.00	0.91	0.82-1.02	0.90	0.98	0.89-1.08	1.00
Liver diseases	1.01	0.91-1.11	1.00	0.93	0.85-1.03	1.00	0.98	0.90-1.06	1.00
Lung diseases	0.88	0.77-1.00	0.25	0.81*	0.72-0.92	<0.001	0.88	0.80-0.97	0.03
Haemorrhagic fevers	0.92	0.52-1.61	1.00	0.99	0.88-1.10	1.00	1.00	0.90-1.11	1.00
Leukaemia	1.03	0.92-1.15	1.00	0.95	0.86-1.05	1.00	0.91	0.81-1.01	0.41
Degenerative CNS	0.94	0.71-1.26	1.00	0.95	0.68-1.31	1.00	0.88	0.63-1.24	1.00
Musculoskeletal disorders	1.08	0.82-1.41	1.00	0.83	0.61-1.12	1.00	0.77	0.57-1.06	0.87
Congenital malformation	1.02	0.95-1.10	1.00	0.76	0.53-1.09	1.00	0.89	0.68-1.16	1.00
Injury	1.04	0.81-1.33	1.00	1.37	0.60-3.16	1.00	1.16	0.54-2.49	1.00
Inflammatory CNS	1.32	0.69-2.54	1.00	0.94	0.75-1.19	1.00	0.95	0.76-1.18	1.00
Dementia	1.02	0.70-1.49	1.00	0.68	0.34-1.34	1.00	0.82	0.48-1.41	1.00
Tuberculosis	1.04	0.80-1.34	1.00	0.92	0.69-1.22	1.00	0.88	0.66-1.17	1.00
HIV	1.04	0.91-1.19	1.00	1.57	0.48-5.09	1.00	1.42	0.66-3.03	1.00
Birth trauma, low birth weight & prematurity	1.04	0.95-1.15	1.00	0.44	0.14-1.44	1.00	0.85	0.46-1.58	1.00
Malnutrition	NA	NA	NA	NA	NA	NA	NA	NA	NA

ORs were estimated from binomial logistic regression models.

\*P value  $\leq$  0.008 (Bonferroni correction was applied to adjust for family-wise error rate 0.05/6)



**Figure 1.** Percentage of deaths registered in Jordan for whom the decedent was Jordanian and non-Jordanian by underlying cause of death, 2005-2016.



**Figure 2.** Trend of Jordanian and non-Jordanian deaths by place of death, 2005-2016.

**Appendix 1. Demographic characteristics of deaths in Jordan across 12 years, 2005-2016 (n=143215).**

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
N	6792	7988	8501	8207	10098	12334	12225	13373	15063	15863	15753	17018
Crude death rate per 1,000*	1.19	1.30	1.36	1.25	1.46	1.70	1.60	1.65	1.77	1.78	1.70	1.78
Age group (years) %												
18-24	2.5	2.2	2.9	2.4	2.2	2.8	2.0	2.4	2.4	2.7	2.5	2.7
25-54	18.5	19.3	19.2	19.5	19.1	20.8	18.4	20.4	20.9	20.9	20.6	20.5
55-64	18.8	18.1	18.6	17.0	16.5	15.9	15.8	15.4	14.9	15.7	15.5	16.1
65-74	29.4	28.8	27.7	29.1	28.4	27.5	27.6	26.8	26.0	24.5	24.6	24.6
75-84	21.1	22.0	22.4	22.4	23.5	23.0	24.9	24.5	24.4	24.9	25.1	24.8
85+	9.7	9.6	9.1	9.5	10.3	9.9	11.3	10.5	11.5	11.4	11.8	11.3
Gender %												
Men	57.8	58.0	57.5	56.2	56.5	56.5	55.8	56.4	58.0	57.2	56.7	56.9
Women	42.2	42.0	42.5	43.8	43.5	43.5	44.2	43.6	42.0	42.8	43.3	43.1
Marital status %												
Married	67.9	67.2	65.3	64.6	64.0	62.5	63.3	63.6	64.0	62.5	63.6	61.6
Single	6.8	6.4	7.1	6.2	5.9	7.6	6.0	6.9	7.1	7.2	7.1	0.0
Divorced	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.1
Widowed	0.6	0.7	0.3	0.4	0.0	0.0	0.0	0.4	0.4	0.1	0.2	21.5
Other	24.6	25.7	27.4	28.8	30.0	29.8	30.7	29.1	28.5	30.3	29.0	13.9
Underlying cause of death %												
Haemorrhagic fevers	1.0	1.4	1.7	1.6	1.7	1.4	1.7	2.0	2.0	1.9	2.5	2.7
Tuberculosis	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.0	0.1
HIV	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malignant neoplasms (except leukaemia)	16.5	16.4	16.5	18.8	17.3	17.7	18.2	18.2	17.7	17.0	17.1	16.6
Leukaemia	1.4	2.0	1.6	2.0	2.0	1.5	1.8	1.7	1.4	1.3	1.4	1.0
Dementia	0.5	0.6	0.4	0.4	0.2	0.2	0.1	0.2	0.1	0.2	0.1	0.1
Inflammatory CNS	0.1	0.2	0.2	0.2	0.1	0.2	0.3	0.2	0.2	0.2	0.2	0.2
Degenerative CNS	0.4	0.6	0.4	0.5	0.5	0.4	0.6	0.4	0.5	0.5	0.4	0.4
Cerebrovascular	13.9	13.1	13.4	13.0	14.3	11.6	12.0	11.4	11.3	11.6	12.5	13.2
Non-ischaemic heart	8.3	6.9	7.1	7.9	8.1	11.5	11.5	11.4	12.7	13.1	11.7	13.1
Chronic ischaemic heart	16.1	17.2	18.2	16.4	15.4	14.3	13.8	12.8	12.1	11.8	11.5	11.3
Lung diseases	4.4	4.3	4.6	3.8	3.6	3.1	3.3	3.2	2.9	2.7	3.2	3.0
Liver diseases	3.7	4.4	3.8	3.7	3.6	3.3	3.7	3.5	3.2	3.2	3.7	3.4
Renal failure	3.5	3.2	2.4	2.8	3.0	2.9	2.7	3.5	3.2	3.7	3.9	3.8

Birth trauma, low birth weight & prematurity	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
Congenital malformation	0·2	0·2	0·2	0·3	0·3	0·2	0·3	0·2	0·2	0·3	0·2	0·2
Injury	0·1	0·1	0·1	0·0	0·1	0·1	0·0	0·1	0·2	0·2	0·1	0·3
Atherosclerosis	5·9	5·3	4·8	6·0	5·7	5·5	6·1	6·2	6·1	8·0	8·8	8·2
Musculoskeletal disorders	0·3	0·4	0·4	0·5	0·4	0·5	0·3	0·3	0·3	0·2	0·2	0·2
Malnutrition	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0	0·0
Diseases not stated above	23·3	23·5	23·9	22·0	23·5	25·3	23·5	24·6	25·8	24·1	22·3	22·2
County of origin %												
Jordanian	94·7	93·1	93·0	92·1	93·9	94·2	94·4	91·8	92·5	93·3	92·6	93·3
Non-Jordanian	5·3	6·9	7·0	7·9	6·1	5·8	5·6	8·2	7·5	6·7	7·4	6·7
Place of death %												
Hospital	83·0	87·1	84·6	86·8	92·3	89·8	93·9	95·2	97·1	99·3	98·4	98·9
Non-hospital	17·0	12·9	15·4	13·2	7·7	10·2	6·1	4·8	2·9	0·7	1·6	1·1

\*the total number of deaths to residents divided by the total population in Jordan each year (based on the population data for Jordan from the World Bank dataset: <https://data.worldbank.org/indicator/SP.POP.TOTL?locations=JO>) and multiplied by 1,000.