

Trends in Decubitus Ulcer Disease Burden in European Union 15+ Countries, from 1990 to 2017

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Background: Decubitus ulcers (DU) are a common pathology with significant morbidity and financial implications for health services globally. This study aimed to compare the burden of DU across European Union (EU) 15+ countries between 1990 and 2017.

Methods: Age-standardized incidence, mortality, and disability-adjusted life-years (DALYs) rates per 100,000 were extracted from the Global Burden of Disease Study online data repository for EU15+ countries (a group of 19 countries with comparable health expenditure, including the United States, Canada, the United Kingdom, and Australia). A joinpoint regression analysis was used to describe trends.

Results: The incidence of DU increased between 1990 and 2017 in 15 of 19 EU15+ countries for both men and women. Mortality from DU decreased over the time period analyzed in the majority of EU15+ countries: only in Denmark, Finland, and Germany were increasing mortality rates observed. Decreasing DALY rates were generally observed, with the largest decreases observed in Ireland for men and women. Denmark and Germany were the only countries to demonstrate unfavorable trends in mortality, incidence, and DALYs between 1990 and 2017 for men and women. The United States, the Netherlands, and France were the only EU15+ countries in which improving disease burden was identified between 1990 and 2017 for all parameters assessed.

Conclusions: Incidence of DU is increasing in EU15+ countries, whereas mortality rates and DALYs are improving. The trends in disease burden in Denmark and Germany have followed contrasting and unfavorable trends. Investigation into these trends is called for. (*Plast Reconstr Surg Glob Open* 2020;8:e3252; doi: 10.1097/GOX.0000000000003252; Published online 24 November 2020.)

INTRODUCTION

Pressure ulcers or decubitus ulcers (DU) are a common presentation in community nursing and hospital in-patient settings¹ typically resulting from tissue ischemia caused by unrelieved pressure.² Risk factors for the development of DUs include malnutrition, immobility, spinal cord injuries, diabetes mellitus, smoking, and age >65 years.²

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The morbidity associated with DU is considerable, and has been associated with increased hospital bed days and healthy years lost.³ Furthermore, the financial burden of DU is significant, costing approximately USD 11 billion annually in the United States.^{4,5} As a result of the clinical and financial expense, the monitoring and reporting of DU has been mandated by health systems, including those of the United Kingdom (UK) and the United States.^{1,6}

Despite DU being commonplace, their true global prevalence and burden of morbidity is poorly understood. Varying DU prevalence rates have been reported both within and across countries.^{7,8} No comprehensive analysis comparing international trends in the incidence or mortality from DU has been performed. This article describes the contemporary incidence, mortality, and disability-adjusted life-years (DALYs) attributed to DUs across European Union (EU) 15+ countries between 1990 and 2017.

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Related Digital Media are available in the full-text version of the article on www.PRSGlobalOpen.com.

METHODS

Characteristics of the Data Source

Data were extracted from the Global Burden of Disease (GBD) Database. Detailed methodology relating to the GBD database is published elsewhere^{9,10} and our group has previously used GBD data to analyze and describe trends in peripheral arterial disease,¹¹ abdominal aortic aneurysm,¹² and lower extremity amputation.¹³

Data Handling

We extracted age-standardized incidence rates (ASIRs), age-standardized mortality rates (ASMRs) and age-standardized DALY rates (per 100,000) from the GBD database using the GBD Results tool (<http://ghdx.health-data.org/gbd-results-tool>) for each of the EU15+ countries from 1990 to 2017. EU15+ represents a group of comparable countries with similar health expenditure, comprising Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Norway, Portugal, Spain, Sweden, the United Kingdom, and the United States.

Decubitus ulcer is defined in the GBD methodology as follows: “Decubitus ulcer, also known as pressure ulcer/sore, is an injury to the skin and underlying tissue resulting from an obstruction of blood flow due to pressure on the skin. Included in the GBD modeling were cases meeting ICD-10 criteria for decubitus ulcer (ICD-10: L89).”

Data sources for estimating ASIRs include surveys, systematic review of Pubmed and Google Scholar (to capture epidemiological data), claims data (inpatient and outpatient), USA claims data, and inpatient hospitalizations. These data are combined using Bayesian meta-regression via the DisMod-MR 2.1 tool. This tool evaluates, pools, and adjusts the data for systematic biases and produces population estimates with confidence intervals, using Bayesian statistical methods.

For ASMR estimation, the GBD cause of death database comprises data derived from 7 data source types, which include vital registration, verbal autopsy, cancer registries, police records, surveillance, survey/census, and sibling history. The majority of cause of death data on the GBD database are vital registration data obtained from the World Health Organisation Mortality Database (individual countries submit a compilation of data to the World Health Organisation annually). The GBD Study authors have designed a “map,” permitting ICD-9 and ICD-10 codes to be “mapped” to GBD causes of death, which allows adjustment for differing coding systems. Standard GBD methodology also comprises garbage-code redistribution algorithms to account for deaths attributed to ill-defined diagnoses or conditions that cannot be directly attributed as a true cause of death. These refined data are run through cause of death ensemble modeling to estimate death rates. The GBD authors characterize the quality, accessibility, and completeness of mortality data for each country per year between 1980 and 2017. All of the EU15+ countries have at least 90% vital registration and verbal autopsy completeness for each of the years from 1990 to 2017.

DALYs are calculated as the sum of years of life lost and years lived with disability. The GBD calculates years of life lost as the sum of each death by the standard life expectancy for each age, and years lived with disability as a product of disease prevalence and a disability-weight. The disability-weighting is split into 3 values for mild, moderate, and severe disability. Calculations for disability-weights are described in the GBD Study methodology.^{14,15} Years lived with disabilities are calculated for each weighting, combined to give age-standardized estimates corrected for comorbidities.

Mortality-to-incidence indices (MIIs) are presented. MIIs provide population-based case-fatality rates, wherein the ASMR is divided by the ASIR. This metric provides an additional means to compare inter-country disease burden over time.

Statistical Analysis

Trends in ASIRs, ASMRs, and DALYs from 1990 to 2017 were assessed using Joinpoint regression analysis (Joinpoint Command Line Version 4.5.0.1 provided by the United States National Cancer Institute Surveillance Research Program).¹⁶ Joinpoint software analyzes data trends over time and connects observed trends with the simplest possible model, using a logarithmic scale. The simplest trend is a straight line and is represented by zero Joinpoints. Joinpoints that are fit to the trend are only kept in the final model if a Monte Carlo permutation method indicates significance. The software also calculates Estimated Annual Percentage Changes (EAPCs) for each trend, with 95% confidence intervals, which are tested for significance. The final model for each country consists of multiple Joinpoints, described by their EAPCs (plus confidence intervals), allowing for quantitative rate of change assessments for each year.

RESULTS

2017 DU Incidence

Supplemental Digital Content 1 demonstrates the ASIRs for DU in EU15+ countries in 2017. The highest ASIRs in 2017 were observed in Norway, Belgium, and USA for men (153.8, 139.4, and 124.9/100,000, respectively). For women, the highest ASIRs were observed in Belgium, USA, and Canada (118.1, 108.6, and 101.2/100,000, respectively). The lowest 2017 ASIRs were identified in Australia and Italy for men and women (men/100,000: Australia 43.3, Italy 53.7; women/100,000: Australia 40.7, Italy 40.3).

2017 DU Mortality

The 2017 ASMRs attributed to DUs are presented in Supplemental Digital Content 1. (See figure, Supplemental Digital Content 1, which displays decubitus ulcers. 2017 age-standardized incidence rates (A), age-standardized mortality rates (B), mortality-to-incidence indices (C), and disability-adjusted life years (D) per 100,000 population for decubitus ulcers in all EU15+ countries for men and women. <http://links.lww.com/PRSGO/B512>.) In men in

2017, the highest ASMRs were observed in Belgium for men (0.51/100,000) and women (0.69/100,000). The lowest ASMRs were observed in Finland for men and women (both 0.03/100,000).

Trends in DU Incidence

Supplemental Digital Content 2 and Tables 1–2 demonstrate DU ASIR trends in EU15+ countries between 1990 and 2017. (See figure, Supplemental Digital Content 2, which displays decubitus ulcers. Trends in age-standardized incidence rates (ASIR) per 100,000 population for decubitus ulcers in EU15+ countries from 1990 to 2017. Open squares represent men, filled circles represent women. <http://links.lww.com/PRSGO/B513>.) A general trend for increasing ASIRs across EU15+ countries was observed. Only in France, Ireland, the Netherlands, and USA were reducing DU ASIRs observed for men. For women, reducing ASIRs were observed in France, Ireland, Italy, the

Netherlands, and USA. The largest increase in ASIRs from 1990 to 2017 for men were observed in Portugal (+38.2%), Germany (+27.5%), and Denmark (+24.7%). In women, the largest ASIR increases were in Germany (+22.6%), Australia (+20.8%), and Denmark (+20.7%).

Joinpoint Analysis for DU Incidence

Joinpoint analyses for ASIRs in individual EU15+ countries between 1990 and 2017 are depicted in Table 3. Significant trend changes in ASIRs were found in all EU15+ countries. The fastest relative increases in ASIR were observed in the UK between 1990 and 1992 for both men (EAPC +6.8%) and women (EAPC +7.9%). These increases in the UK were later followed by the most rapidly decreasing trends in DU ASIR of all EU15+ countries, between the years 1995 and 2002 in men (EAPC -2.7%) and between 1995 and 2001 in women (EAPC -2.7%).

Table 1. 1990, 2017, and Percentage Changes (%) for ASMRs, ASIRs, MIIs, and DALYs for Decubitus Ulcers in EU15+ Countries for Men

Country	ASIRs			ASMRs			MIIs			DALYs		
	1990	2017	% Change	1990	2017	% Change	1990	2017	% Change	1990	2017	% Change
Australia	39.05	43.30	10.9%	0.18	0.10	-44.7%	0.0046	0.0023	-50.1%	3.96	3.20	-19.2%
Austria	86.30	93.53	8.4%	0.10	0.05	-53.9%	0.0012	0.0005	-57.5%	5.52	4.96	-10.1%
Belgium	129.88	139.39	7.3%	0.58	0.51	-10.7%	0.0044	0.0037	-16.8%	13.12	12.25	-6.7%
Canada	109.93	117.09	6.5%	0.14	0.07	-50.9%	0.0013	0.0006	-53.9%	6.62	6.03	-8.9%
Denmark	65.16	81.24	24.7%	0.05	0.08	69.7%	0.0007	0.0010	36.2%	3.72	4.78	28.5%
Finland	101.80	121.76	19.6%	0.03	0.03	22.5%	0.0003	0.0003	2.4%	5.03	5.98	18.9%
France	103.98	98.17	-5.6%	1.13	0.42	-62.5%	0.0109	0.0043	-60.2%	17.17	9.16	-46.7%
Germany	85.40	108.86	27.5%	0.10	0.18	72.6%	0.0012	0.0016	35.4%	5.47	7.62	39.3%
Greece	72.59	88.50	21.9%	0.06	0.03	-53.2%	0.0008	0.0003	-61.6%	4.23	4.51	6.6%
Ireland	90.69	90.46	-0.3%	0.58	0.11	-81.1%	0.0064	0.0012	-81.0%	12.20	5.59	-54.2%
Italy	51.26	53.67	4.7%	0.19	0.15	-17.7%	0.0036	0.0029	-21.4%	4.88	4.34	-11.0%
Luxembourg	74.25	80.84	8.9%	0.26	0.19	-27.4%	0.0035	0.0024	-33.4%	6.66	5.99	-10.1%
Netherlands	98.57	98.46	-0.1%	0.85	0.33	-61.4%	0.0087	0.0034	-61.4%	13.84	7.90	-42.9%
Norway	133.18	153.75	15.4%	0.21	0.18	-16.7%	0.0016	0.0012	-27.8%	8.61	8.76	1.7%
Portugal	44.66	61.73	38.2%	0.32	0.09	-71.8%	0.0071	0.0014	-79.6%	6.21	4.09	-34.1%
Spain	82.44	95.88	16.3%	0.33	0.30	-11.0%	0.0041	0.0031	-23.5%	7.95	7.70	-3.1%
Sweden	85.42	89.61	4.9%	0.22	0.07	-68.6%	0.0026	0.0008	-70.1%	6.90	5.12	-25.8%
United Kingdom	93.21	95.58	2.5%	0.31	0.14	-55.0%	0.0033	0.0015	-56.1%	8.36	6.26	-25.1%
United States	133.19	124.90	-6.2%	0.43	0.25	-40.8%	0.0032	0.0020	-36.9%	12.19	9.27	-24.0%

Table 2. 1990, 2017, and Percentage Changes (%) for ASMRs, ASIRs, MIIs, and DALYs for Decubitus Ulcers in EU15+ Countries for Women

Country	ASIRs			ASMRs			MIIs			DALYs		
	1990	2017	% Change	1990	2017	% Change	1990	2017	% Change	1990	2017	% Change
Australia	33.68	40.69	20.8%	0.11	0.07	-40.5%	0.0034	0.0017	-50.7%	3.07	2.79	-9.0%
Austria	72.07	78.66	9.1%	0.10	0.05	-55.1%	0.0014	0.0006	-58.9%	4.80	4.31	-10.2%
Belgium	115.57	118.05	2.1%	0.69	0.60	-14.1%	0.0060	0.0051	-15.9%	12.75	11.17	-12.3%
Canada	95.82	101.23	5.6%	0.12	0.08	-33.3%	0.0013	0.0008	-36.9%	5.66	5.39	-4.8%
Denmark	55.78	67.31	20.7%	0.08	0.09	15.8%	0.0014	0.0013	-4.0%	3.61	4.18	15.7%
Finland	71.52	84.72	18.4%	0.04	0.03	-27.8%	0.0005	0.0003	-39.0%	3.84	4.29	11.7%
France	88.33	79.22	-10.3%	1.08	0.36	-67.1%	0.0123	0.0045	-63.3%	14.53	6.96	-52.1%
Germany	70.15	86.03	22.6%	0.09	0.18	100.2%	0.0013	0.0021	63.3%	4.59	6.46	40.7%
Greece	62.24	73.65	18.3%	0.10	0.06	-39.3%	0.0016	0.0008	-48.7%	4.08	4.12	1.0%
Ireland	78.65	74.76	-4.9%	0.58	0.09	-85.3%	0.0074	0.0011	-84.5%	11.82	4.68	-60.4%
Italy	40.38	40.30	-0.2%	0.16	0.14	-12.2%	0.0039	0.0035	-12.1%	3.98	3.48	-12.4%
Luxembourg	65.48	71.19	8.7%	0.25	0.17	-30.1%	0.0038	0.0025	-35.7%	5.79	5.04	-12.9%
Netherlands	88.82	83.44	-6.1%	1.15	0.56	-51.7%	0.0130	0.0067	-48.5%	15.82	8.94	-43.5%
Norway	85.75	95.79	11.7%	0.21	0.18	-13.3%	0.0025	0.0019	-22.4%	6.37	6.23	-2.2%
Portugal	43.71	51.03	16.7%	0.29	0.07	-77.7%	0.0067	0.0013	-80.9%	5.58	3.27	-41.3%
Spain	71.45	78.49	9.9%	0.36	0.33	-10.1%	0.0051	0.0042	-18.2%	7.24	6.72	-7.2%
Sweden	72.50	77.67	7.1%	0.19	0.09	-50.6%	0.0026	0.0012	-53.9%	5.59	4.74	-15.2%
United Kingdom	92.59	96.80	4.5%	0.43	0.15	-64.8%	0.0047	0.0016	-66.3%	9.66	6.44	-33.4%
United States	114.60	108.57	-5.3%	0.27	0.22	-18.3%	0.0024	0.0021	-13.8%	9.07	8.07	-11.1%

Table 3. Joinpoint Analysis for ASIR per 100,000 Population for Decubitus Ulcers in Men and Women in EU15+ Countries

Country	Trend 1			Trend 2			Trend 3			Trend 4		
	Years	EAPC	P	Years	EAPC	P	Years	EAPC	P	Years	EAPC	P
MEN												
Australia	1990-2000	+1.1 (+1.1 to +1.2)	<0.05	2000-2011	-0.3 (-0.3 to -0.2)	<0.05	2011-2017	+0.3 (+0.3 to +0.4)	<0.05	2011-2017	+0.4 (+0.4 to +0.4)	<0.05
Austria	1990-1995	+0.2 (+0.2 to +0.2)	<0.05	1995-2000	+0.7 (+0.6 to +0.7)	<0.05	2000-2011	+0.1 (0 to +0.1)	<0.05	2011-2017	-0.6 (-0.6 to -0.6)	<0.05
Belgium	1990-1995	+0.9 (+0.9 to +1)	<0.05	1995-2000	+1.8 (+1.8 to +1.9)	<0.05	2000-2006	0 (0 to +0.1)	0.3	2006-2017	+0.7 (+0.7 to +0.8)	<0.05
Canada	1990-2000	0 (0 to 0)	<0.05	2000-2005	-0.1 (-0.2 to -0.1)	<0.05	2005-2012	+0.4 (+0.4 to +0.5)	<0.05	2012-2017	+0.5 (+0.4 to +0.6)	<0.05
Denmark	1990-1995	+0.5 (+0.4 to +0.6)	<0.05	1995-2000	+2.2 (+2.1 to +2.3)	<0.05	2000-2005	+0.8 (+0.7 to +0.9)	<0.05	2005-2017	+0.4 (+0.4 to +0.4)	<0.05
Finland	1990-1995	+0.5 (+0.4 to +0.6)	<0.05	1995-2003	+1.4 (+1.4 to +1.5)	<0.05	2003-2012	+0.2 (+0.2 to +0.3)	<0.05	2012-2017	+0.5 (+0.4 to +0.6)	<0.05
France	1990-1995	-0.1 (-0.2 to 0)	0.1	1995-2000	+0.8 (+0.7 to +0.9)	<0.05	2000-2004	-0.1 (-0.3 to +0.1)	0.2	2004-2017	-0.7 (-0.7 to -0.7)	<0.05
Germany	1990-1996	0 (-0.1 to +0.1)	0.9	1996-1999	+2.8 (+2.3 to +3.4)	<0.05	1999-2003	+1.6 (+1.3 to +1.8)	<0.05	2003-2017	+0.7 (+0.7 to +0.7)	<0.05
Greece	1990-1995	0.1 (0 to 0.1)	0.1	1995-2001	+1.5 (+1.4 to +1.5)	<0.05	2001-2017	+0.7 (+0.7 to +0.7)	<0.05			
Ireland	1990-2001	+0.9 (+0.8 to +1)	<0.05	2001-2005	-0.4 (-1 to +0.2)	0.2	2005-2010	-1.2 (-1.6 to -0.8)	<0.05	2010-2017	-0.3 (-0.5 to 0.2)	<0.05
Italy	1990-1994	+0.3 (+0.1 to +0.5)	<0.05	1994-2001	+0.7 (+0.6 to +0.8)	<0.05	2001-2012	-0.4 (-0.4 to -0.3)	<0.05	2012-2017	+0.4 (+0.3 to +0.6)	<0.05
Luxembourg	1990-1995	+0.4 (+0.3 to +0.5)	<0.05	1995-2001	+0.8 (+0.7 to +0.9)	<0.05	2001-2012	0 (0 to 0)	0.7	2012-2017	+0.3 (+0.3 to +0.4)	<0.05
Netherlands	1990-1995	0 (-0.1 to +0.1)	0.8	1995-2000	+1 (+1 to +1.1)	<0.05	2000-2004	0 (-0.1 to +0.1)	0.8	2004-2017	-0.4 (-0.4 to -0.4)	<0.05
Norway	1990-2000	+0.2 (+0.1 to +0.2)	<0.05	2000-2005	+2.9 (+2.8 to +3.1)	<0.05	2005-2012	0 (-0.1 to 0.1)	0.8	2012-2017	-0.3 (-0.4 to -0.2)	<0.05
Portugal	1990-1999	+2.9 (+2.9 to +3)	<0.05	1999-2005	+1.6 (+1.4 to +1.8)	<0.05	2005-2009	+0.2 (-0.2 to +0.6)	0.3	2009-2017	-0.5 (-0.6 to -0.5)	<0.05
Spain	1990-1995	+0.7 (+0.6 to +0.7)	<0.05	1995-2000	+1.7 (+1.7 to +1.8)	<0.05	2000-2004	+1 (+0.9 to +1.1)	<0.05	2004-2017	0 (-0.1 to 0)	<0.05
Sweden	1990-2000	+0.4 (+0.3 to +0.4)	<0.05	2000-2005	-0.4 (-0.6 to -0.2)	<0.05	2005-2012	+0.1 (0 to +0.2)	0.2	2012-2017	+0.6 (+0.4 to +0.7)	<0.05
United Kingdom	1990-1992	+6.8 (+4.2 to +9.5)	<0.05	1992-1995	+2.2 (-0.3 to +4.8)	0.1	1995-2002	-2.7 (-3.1 to -2.3)	<0.05	2002-2017	0 (-0.1 to +0.1)	0.6
United States	1990-1994	-3.1 (-3.3 to -2.8)	<0.05	1994-2002	-0.3 (-0.4 to -0.2)	<0.05	2002-2011	+0.8 (+0.7 to +0.9)	<0.05	2011-2017	+0.2 (0 to +0.3)	<0.05
WOMEN												
Australia	1990-1995	+1 (+0.8 to +1.1)	<0.05	1995-1999	+2 (+1.7 to +2.3)	<0.05	1999-2011	0 (0 to +0.1)	<0.05	2011-2017	+0.9 (+0.8 to +1)	<0.05
Austria	1990-1996	+0.4 (+0.3 to +0.4)	<0.05	1996-2000	+0.5 (+0.4 to +0.6)	<0.05	2000-2012	+0.2 (+0.1 to +0.2)	<0.05	2012-2017	+0.6 (+0.5 to +0.6)	<0.05
Belgium	1990-1995	+0.7 (+0.5 to +0.8)	<0.05	1995-2000	+1.8 (+1.6 to +2)	<0.05	2000-2006	+0.2 (+0.1 to +0.4)	<0.05	2006-2017	-1 (-1 to -0.9)	<0.05
Canada	1990-1999	+0.1 (+0.1 to +0.1)	<0.05	1999-2005	-0.1 (-0.1 to -0.1)	<0.05	2005-2012	+0.4 (+0.3 to +0.4)	<0.05	2012-2017	+0.5 (+0.4 to +0.5)	<0.05
Denmark	1990-2005	+1.2 (+1.2 to +1.2)	<0.05	2005-2009	+0.7 (+0.5 to +0.9)	<0.05	2009-2013	+0.1 (0 to +0.3)	0.3	2013-2017	-0.4 (-0.5 to -0.3)	<0.05
Finland	1990-1995	+0.6 (+0.6 to +0.6)	<0.05	1995-2003	+1 (+1 to +1)	<0.05	2003-2010	+0.7 (+0.6 to +0.7)	<0.05	2010-2017	+0.2 (+0.2 to +0.2)	<0.05
France	1990-1995	-0.4 (-0.4 to -0.3)	<0.05	1995-2000	+0.2 (+0.1 to +0.3)	<0.05	2000-2011	-0.4 (-0.5 to 0.4)	<0.05	2011-2017	-0.8 (-0.9 to -0.8)	<0.05
Germany	1990-1995	+0.4 (+0.3 to +0.4)	<0.05	1995-2000	+0.9 (+0.9 to +1)	<0.05	2000-2005	+1.4 (+1.3 to +1.5)	<0.05	2005-2017	+0.6 (+0.6 to +0.6)	<0.05
Greece	1990-1995	+0.2 (+0.1 to +0.2)	<0.05	1995-2001	+1 (+1 to +1.1)	<0.05	2001-2010	+0.8 (+0.8 to +0.8)	<0.05	2010-2017	+0.4 (+0.4 to +0.4)	<0.05
Ireland	1990-2000	+0.5 (+0.4 to +0.5)	<0.05	2000-2004	-0.5 (-0.7 to -0.3)	<0.05	2004-2010	-1.1 (-1.2 to -1)	<0.05	2010-2017	+0.2 (+0.2 to +0.2)	<0.05
Italy	1990-2000	+0.2 (+0.2 to +0.2)	<0.05	2000-2004	0 (0 to 0.2 to +0.1)	0.6	2004-2011	-0.5 (-0.6 to -0.4)	<0.05	2011-2017	+0.2 (+0.2 to +0.3)	<0.05
Luxembourg	1990-2000	+0.7 (0.7 to +0.8)	<0.05	2000-2005	+0.5 (+0.4 to +0.6)	<0.05	2005-2012	0 (0 to +0.1)	0.5	2012-2017	-0.3 (-0.4 to -0.2)	<0.05
Netherlands	1990-2001	+0.5 (+0.4 to +0.5)	<0.05	2001-2007	-0.4 (-0.5 to -0.3)	<0.05	2007-2012	-0.7 (-0.8 to -0.5)	<0.05	2012-2017	-1.1 (-1.2 to -1)	<0.05
Norway	1990-2001	+0.2 (+0.1 to +0.2)	<0.05	2001-2004	+4 (+3.7 to +4.3)	<0.05	2004-2010	+0.2 (+0.1 to +0.2)	<0.05	2010-2017	-0.4 (-0.5 to -0.4)	<0.05
Portugal	1990-1994	+1.2 (+0.7 to +1.7)	<0.05	1994-2004	+1.8 (+1.6 to +1.9)	<0.05	2004-2011	-1 (-1.2 to -0.7)	<0.05	2011-2017	0 (-0.3 to +0.3)	0.9
Spain	1990-2004	+0.6 (+0.4 to +0.7)	<0.05	1994-2003	+0.9 (+0.9 to +1)	<0.05	2003-2010	+0.3 (+0.2 to +0.3)	<0.05	2010-2017	-0.4 (-0.4 to -0.3)	<0.05
Sweden	1990-1998	+0.6 (+0.6 to +0.7)	<0.05	1998-2000	+0.5 (+0.5 to +0.5)	<0.05	2000-2012	0 (0 to 0)	<0.05	2012-2017	+0.2 (+0.2 to +0.2)	<0.05
United Kingdom	1990-1992	+7.9 (+6 to +9.9)	<0.05	1992-1995	+2.9 (+1.1 to +4.8)	<0.05	1995-2001	-2.7 (-3.1 to -2.3)	<0.05	2001-2017	-0.3 (-0.3 to -0.2)	<0.05
United States	1990-1994	-1.5 (-1.6 to -1.4)	<0.05	1994-2001	+0.1 (+0.1 to +0.2)	<0.05	2001-2005	-0.3 (-0.5 to -0.1)	<0.05	2005-2017	+0.1 (+0.1 to +0.1)	<0.05

Data presented as EAPC (%), with 95% confidence intervals in brackets. $P < 0.05$ is deemed significant.

Trends in DU Mortality

Trends in DU ASMRs are presented in Supplemental Digital Content 3 and Tables 1–2. (See figure, Supplemental Digital Content 3, which displays decubitus ulcers. Trends in ASMR per 100,000 population for decubitus ulcers in EU15+ countries from 1990 to 2017. Open squares represent men, filled circles represent women. <http://links.lww.com/PRSGO/B514>.) Overall, decreasing mortality trends were observed between 1990 and 2017. The largest overall relative decrease in ASMR was observed in Ireland for men (–81.1%) and women (–85.3%). Increasing overall trends were observed in 3/19 EU15+ countries for men (Denmark +69.7%; Finland +22.5% and Germany +72.6%) and in 2 countries for women (Germany +100.2% and Denmark +15.8%).

Joinpoint Analysis for DU mortality

Table 4 demonstrates Joinpoint analyses for individual EU15+ countries' ASMRs between 1990 and 2017. Significant trend changes in ASMRs are identified in all EU15+ countries. Rapid increases in ASMRs from 1990 to the mid-late 1990s/early 2000s, followed by sharp decreases until around 2010, were observed in both Belgium and Portugal for men and women. Specifically, in Portugal between 2005 and 2010, ASMR EAPCs of –25.6% for men and –32% for women were observed. Time periods covered by the most recent trends revealed insignificant changes in ASMRs in 14/19 EU15+ countries for men and 11 countries for women, including the UK and USA for both sexes.

Trends in DU Mortality-to-Incidence Indices

Sex-specific trends in MII from 1990–2017 are displayed in Tables 1–2. In men, decreasing MII trends were observed in 16/19 EU15+ countries; only Denmark (+36.2%), Finland (+2.4%), and Germany (+35.4%) had increasing trends. In women, decreasing MII trends were observed in all EU15+ countries except Germany (+63.3%).

DU Disability-adjusted Life Years

In 2017, Belgium and USA had the highest DALY rates observed for both men and women. The lowest 2017 DALY rates were in Australia for both men (3.2/100,000) and women (2.8/100,000). Trends in DALYs were decreasing in 14/19 EU15+ countries for men and 15 countries for women, with the largest overall relative increases observed in Germany (men +39.3%; women +40.7%). Results are displayed in Supplemental Digital Contents 1 and 4. (See figure, Supplemental Digital Content 4, which displays decubitus ulcers. Trends in age-standardized DALYs per 100,000 population for decubitus ulcers in EU15+ countries 1990 to 2017. Open squares represent men, filled circles represent women. <http://links.lww.com/PRSGO/B515>.) Despite the overall decreases in DALYs between 1990 and 2017, Joinpoint regression analysis demonstrates increasing DALY EAPCs over the time periods covered by the most recent trends in 11 EU15+ countries for men and in 9 countries for women. (Table 5).

DISCUSSION

In this analysis of the trends in DU disease burden across EU15+ countries between 1990 and 2017, we identify increasing trends in the incidence of DUs across the majority of EU15+ countries for men and women. France, Ireland, the Netherlands, and USA were the only countries with decreasing DU incidence in both men and women over the time period analyzed. Trends in mortality from DU were decreasing across the majority of EU15+ countries, with the exception of Denmark, Germany, and Finland for men, and Denmark and Germany for women. Decreasing DALY rates were generally observed across included countries, suggesting improvements in the overall burden of DU in 2017 compared with 1990. USA, the Netherlands, and France were the only EU15+ countries in which improving disease burden was identified between 1990 and 2017 for all parameters assessed. Contrastingly, Denmark and Germany demonstrated unfavorable trends in mortality, incidence, and DALYs between 1990 and 2017 for both sexes.

The observation of general increases in DU incidence is consistent with the natural history of DU being primarily associated with chronic health conditions in dependent individuals with complex health needs, which are increasing in prevalence globally.¹⁷ The trends observed in Denmark and Germany were counter to expectations and represent important findings of this analysis.

Previous reports on the global epidemiology of DU have been inconsistent and provide estimates with wide ranges and large confidence-intervals. A 2019 systematic review of 79 studies of DU prevalence in Europe demonstrated a mean prevalence of 10.8% (range 4.6%–27.2%) across 12 different types of clinical settings.¹⁸ The US National Pressure Injury Advisory Panel (NPIAP) estimated that the incidence in USA ranged from 0.4–38% in hospitals, 2.2–23.9% in skilled nursing facilities, and from 0–17% percent for home health agencies.¹⁹ The 2017 incidence rates observed in USA in the present analysis were 124.9 and 108.6/100,000 for men and women, respectively, and across the EU15+ countries ranged from 40.7/100,000 in Australian women to 139.4/100,000 in Belgian men.

To our knowledge, this is the first study comparing international mortality rates from DU. The observed ASMRs from DU in the present analysis were low. Attributing a death directly to a DU is uncommon; however, they are significant indicators of frailty and are associated with mortality. The GBD methodology attributes mortality to a disease that is the single underlying cause of death: an example of how DU would be reported as such would be a death resulting from the complications of a DU, for example septicemia from an infected pressure sore. In a US-based study²⁰ using data obtained from national multiple cause-coded death records from 1990 to 2001, DUs were reported as a contributing cause of death among 114,380 individuals (age-adjusted mortality rate 3.79/100,000); in 18.7% of these deaths, DUs were identified as the underlying cause. In the present analysis, improving mortality rates are observed in most EU15+ countries. By calculating MIIs, we present population-based case-fatality rates, which were down-trending over the 28-year period in all

Table 4. Joinpoint Analysis for ASMR per 100,000 Population for Decubitus Ulcers in Men and Women in EU15+ Countries

Country	Trend 1			Trend 2			Trend 3			Trend 4		
	Years	EAPC	P	Years	EAPC	P	Years	EAPC	P	Years	EAPC	P
MEN												
Australia	1990–1995	+4.0 (+3.0 to +5.1)	<0.05	1995–2002	-6.1 (-6.8 to -5.4)	<0.05	2002–2013	-3.4 (-3.8 to -3.1)	<0.05	2013–2017	+0.9 (-0.5 to +2.4)	0.2
Austria	1990–2003	-5.8 (-6.4 to -5.3)	<0.05	2003–2017	-0.4 (-0.1 to +0.1)	0.1						
Belgium	1990–1994	+17.4 (+14.3 to +20.6)	<0.05	1994–2001	-0.6 (-2 to +0.8)	0.4	2001–2012	-6.2 (-6.8 to -5.6)	<0.05	2012–2017	-0.3 (-2.2 to +1.6)	0.7
Canada	1990–1997	+1.6 (+0.9 to +2.3)	<0.05	1997–2002	-8.9 (-10.4 to -7.4)	<0.05	2002–2006	-6.3 (-8.7 to -3.9)	<0.05	2006–2017	-1.2 (-1.5 to -0.8)	<0.05
Denmark	1990–1999	+10.8 (+9 to +12.6)	<0.05	1999–2004	+2.5 (-3.1 to +7.5)	0.4	2004–2011	-5.6 (-8.4 to -2.7)	<0.05	2011–2017	+0.1 (-2.9 to +3.2)	0.9
Finland	1990–2006	+1 (+0.7 to +1.4)	<0.05	2006–2009	-3 (-12.3 to +7.3)	0.5	2009–2012	+8.7 (-1.8 to +20.2)	0.1	2012–2017	-1.8 (-4 to +0.5)	0.1
France	1990–1996	+0.7 (-0.1 to +1.5)	0.1	1996–2001	-3.7 (-5.1 to -2.3)	<0.05	2001–2014	-6.6 (-6.8 to -6.3)	<0.05	2014–2017	+2.1 (-0.2 to +4.5)	0.1
Germany	1990–1996	+1 (-0.4 to +2.3)	0.1	1996–2000	-3.5 (-7.2 to +0.4)	0.1	2000–2013	+5.6 (+5.1 to +6.1)	<0.05	2013–2017	-0.9 (-3.4 to +1.6)	0.5
Greece	1990–1996	+0.8 (-0.9 to +2.6)	0.3	1996–2000	-10.6 (-15.1 to -6)	<0.05	2000–2008	-4.8 (-6.1 to -3.5)	<0.05	2008–2017	+0.6 (-0.3 to +1.6)	0.2
Ireland	1990–1999	-0.1 (-1.2 to +0.9)	0.8	1999–2003	-9.7 (-14.9 to -4.1)	<0.05	2003–2011	-15 (-16.4 to -13.7)	<0.05	2011–2017	+0.2 (-1.8 to +2.2)	0.9
Italy	1990–1993	+0.1 (-1.5 to +1.7)	0.9	1993–1998	+2.5 (+1.5 to +3.5)	<0.05	1998–2008	-3.4 (-3.7 to -3.1)	<0.05	2008–2017	+0.4 (+0.1 to +0.6)	<0.05
Luxembourg	1990–1996	+1.1 (+0.6 to +1.6)	<0.05	1996–2004	-1.3 (-1.7 to -0.9)	<0.05	2004–2012	-4 (-4.4 to -3.6)	<0.05	2012–2017	+0.6 (0 to +1.3)	0.1
Netherlands	1990–1993	+1.6 (-2.6 to +6)	0.4	1993–1999	-2.5 (-4.4 to -0.7)	<0.05	1999–2004	-6.8 (-9.3 to -4.2)	<0.05	2004–2017	-4.2 (-4.6 to -3.7)	<0.05
Norway	1990–2000	-1.2 (-1.7 to -0.7)	<0.05	2000–2003	-12.1 (-14.8 to +9.6)	0.5	2003–2017	-1.1 (-1.4 to -0.8)	<0.05	2010–2017	0 (-2.6 to +2.6)	1
Portugal	1990–2000	+9.5 (+7.9 to +11.1)	<0.05	2000–2005	-12.8 (-18 to -7.4)	<0.05	2005–2010	-25.6 (-30 to -20.9)	<0.05	2014–2017	+1 (-2.1 to +4.1)	0.5
Spain	1990–1993	-0.3 (-3.3 to +2.9)	0.9	1993–2000	+4.3 (+3.2 to +5.4)	<0.05	2000–2014	-3 (-3.3 to -2.7)	<0.05	2014–2017	+1 (-2.1 to +4.1)	0.5
Sweden	1990–1995	+0.9 (-1.8 to +3.8)	0.5	1995–1999	-13.1 (-18.4 to -7.5)	<0.05	1999–2006	-7.8 (-9.8 to -5.9)	<0.05	2006–2017	-1.3 (-2.2 to -0.5)	<0.05
United Kingdom	1990–1996	+0.5 (-0.3 to +1.3)	0.2	1996–2004	-6.5 (-7 to -5.9)	<0.05	2004–2012	-3.4 (-3.9 to -2.8)	<0.05	2012–2017	-0.8 (-1.8 to +0.2)	0.1
United States	1990–1997	-3.3 (-3.6 to -3.1)	<0.05	1997–2013	-1.8 (-1.9 to -1.8)	<0.05	2013–2017	+0.5 (-0.1 to +1)	0.1			
WOMEN												
Australia	1990–1996	+3.4 (+2.4 to +4.4)	<0.05	1996–2000	-9.5 (-12.1 to -6.8)	<0.05	2000–2006	-5.9 (-7.1 to -4.6)	<0.05	2006–2017	+0.5 (+0.1 to +0.9)	<0.05
Austria	1990–1993	-5 (-9.2 to -0.7)	<0.05	1993–1997	-11.3 (-15.2 to -7.3)	<0.05	1997–2001	-6.4 (-10.5 to -2.1)	<0.05	2001–2017	+0.8 (+0.5 to +1.2)	<0.05
Belgium	1990–1994	+17.5 (+14.4 to +20.7)	<0.05	1994–2003	-2.1 (-3 to -1.2)	<0.05	2003–2011	-6.4 (-7.6 to -5.5)	<0.05	2011–2017	-1.3 (-2.7 to +0.1)	0.1
Canada	1990–1998	+4.3 (+3.7 to +4.9)	<0.05	1998–2007	-5.7 (-6.3 to -5.2)	<0.05	2007–2013	-3.7 (-4.8 to -2.6)	<0.05	2013–2017	+1 (-0.7 to +2.6)	0.2
Denmark	1990–2003	+7.4 (+6.7 to +8)	<0.05	2003–2010	-5 (-6.8 to -3.2)	<0.05	2010–2015	-9.6 (-12.8 to -6.4)	<0.05	2015–2017	+6.1 (-5.1 to +18.6)	0.3
Finland	1990–1997	+1.7 (+1 to +3.2)	<0.05	1997–2017	-2.2 (-2.5 to -1.9)	<0.05						
France	1990–1999	-0.4 (-0.8 to -0.1)	<0.05	1999–2003	-3.7 (-5.3 to -2.1)	<0.05	2003–2014	-8.8 (-9 to -8.5)	<0.05	2014–2017	+3.4 (+1.7 to +5.2)	<0.05
Germany	1990–1996	+2.7 (+0.7 to +4.8)	<0.05	1996–2001	-6 (-9.4 to -2.4)	<0.05	2001–2014	+7.6 (+6.9 to +8.4)	<0.05	2014–2017	-2.4 (-8 to +3.6)	0.4
Greece	1990–1996	+2.5 (+0.3 to +4.6)	<0.05	1996–2009	-4.1 (-4.8 to -3.4)	<0.05	2009–2014	+1.7 (-2.2 to +5.8)	0.4	2014–2017	-5.4 (-11.1 to +0.7)	0.1
Ireland	1990–1998	+0.8 (-0.4 to +2.1)	0.2	1998–2003	-8.1 (-11.4 to -4.7)	<0.05	2003–2010	-21.2 (-22.7 to -19.7)	<0.05	2010–2017	+1.1 (-0.5 to +2.6)	0.2
Italy	1990–1999	+2.7 (+2.1 to +3.4)	<0.05	1999–2007	-6.4 (-7.2 to -5.5)	<0.05	2007–2015	+3.1 (+2.2 to +4.1)	<0.05	2015–2017	-3.2 (-9.6 to +3.6)	0.3
Luxembourg	1990–1999	+1.1 (+0.6 to +1.5)	<0.05	1999–2008	-4.7 (-5.2 to -4.2)	<0.05	2008–2012	-2 (-4.5 to +0.5)	<0.05	2012–2017	+1.5 (+0.3 to +2.6)	<0.05
Netherlands	1990–1994	+3 (+1.5 to +4.5)	<0.05	1994–1999	-1.2 (-2.6 to +0.2)	0.1	1999–2015	-5 (-5.2 to -4.8)	<0.05	2015–2017	+1.8 (-2.7 to +6.6)	0.4
Norway	1990–1993	+1.6 (-2.8 to +6.2)	0.5	1993–1996	-5.7 (-13.7 to +3.1)	0.2	1996–2000	+3.4 (-1.1 to +8.1)	0.1	2000–2017	-0.8 (-1.2 to -0.5)	<0.05
Portugal	1990–1999	+13.4 (+11.6 to +15.2)	<0.05	1999–2005	-9.9 (-13.3 to 6.3)	<0.05	2005–2010	-32 (-35.6 to 28.1)	<0.05	2010–2017	-1.5 (-3.8 to +0.8)	0.2
Spain	1990–1994	+1.3 (-0.9 to +3.5)	0.2	1994–1999	+5 (+2.7 to +7.3)	<0.05	1999–2003	-0.8 (-4.1 to +2.7)	0.6	2003–2017	-2.9 (-3.2 to -2.5)	<0.05
Sweden	1990–1995	+1.2 (-0.6 to +3.1)	0.2	1995–2005	-6.7 (-7.4 to -6)	<0.05	2005–2017	-1.3 (-1.7 to 0.8)	<0.05	2012–2017	-0.1 (-1.4 to +1.1)	0.8
United Kingdom	1990–1998	-1.3 (-1.9 to -0.7)	<0.05	1998–2002	-9.7 (-12.2 to -7.1)	<0.05	2002–2012	-5.5 (-6 to -5.1)	<0.05	2012–2017	+0.1 (-0.3 to +0.6)	0.6
United States	1990–1994	-2.6 (-3.4 to -1.7)	<0.05	1994–2003	+1.2 (+0.9 to +1.5)	<0.05	2003–2011	-2.5 (-2.9 to -2.2)	<0.05	2011–2017	+0.1 (-0.3 to +0.6)	0.6

Data presented as EAPC (%), with 95% confidence intervals in brackets. $P < 0.05$ is deemed significant.

Table 5. Joinpoint Analysis for DALYs per 100,000 Population for Decubitus Ulcers in Men And Women in EU15+ Countries.

Country	Trend 1			Trend 2			Trend 3			Trend 4		
	Years	EAPC	P	Years	EAPC	P	Years	EAPC	P	Years	EAPC	P
MEN												
Australia	1990-1995	+2.2 (+1.8 to +2.7)	<0.05	1995-2003	-2.6 (-2.9 to -2.3)	<0.05	2003-2013	-1.3 (-1.5 to -1.1)	<0.05	2013-2017	+0.7 (0 to +1.4)	<0.05
Austria	1990-1999	-1.4 (-1.5 to -1.2)	<0.05	1999-2009	-0.2 (-0.3 to 0)	0.1	2009-2017	+0.3 (+0.1 to +0.5)	<0.05			
Belgium	1990-1994	+10.2 (+8.4 to +12)	<0.05	1994-2001	-0.2 (-1.1 to +0.7)	0.6	2001-2011	-3.9 (-4.4 to -3.5)	<0.05	2011-2017	-0.7 (-1.5 to +0.2)	0.1
Canada	1990-1997	+0.3 (+0.1 to +0.5)	<0.05	1997-2003	-2.3 (-2.6 to -1.9)	<0.05	2003-2008	-0.4 (-0.9 to 0)	0.1	2008-2017	+0.4 (+0.3 to +0.5)	<0.05
Denmark	1990-1994	+1.2 (-0.2 to +0.6)	0.1	1994-1999	+4.6 (+3.1 to +6)	<0.05	1999-2003	+1 (-1.2 to +3.2)	0.4	2003-2017	-0.5 (-0.7 to -0.3)	<0.05
Finland	1990-1995	+0.4 (+0.2 to +0.7)	<0.05	1995-2003	+1.3 (+1.1 to +1.4)	<0.05	2003-2009	0.2 (-0.1 to +0.4)	0.1	2009-2017	+0.6 (+0.4 to +0.7)	<0.05
France	1990-1995	+0.3 (-0.1 to +0.7)	0.2	1995-2000	-1.9 (-2.4 to -1.3)	<0.05	2000-2013	-4.1 (-4.2 to -4)	<0.05	2013-2017	0 (-0.6 to 0.5)	0.9
Germany	1990-1999	+0.4 (+0.2 to +0.6)	<0.05	1999-2013	+2.2 (+2.1 to +2.3)	<0.05	2013-2017	+0.1 (-0.5 to +0.7)	0.7			
Greece	1990-2007	+0.1 (0 to +0.2)	<0.05	2007-2017	+0.5 (+0.3 to +0.6)	<0.05						
Ireland	1990-1999	+0.1 (-0.4 to +0.7)	0.6	1999-2010	-6.8 (-7.2 to -6.4)	<0.05	2010-2017	-0.6 (-1.4 to +0.2)	0.1			
Italy	1990-1993	0 (+0.7 to +0.7)	1	1993-1998	+1.3 (+0.8 to +1.7)	<0.05	1998-2009	-1.8 (-2 to -1.7)	<0.05	2009-2017	+0.3 (+0.1 to +0.4)	<0.05
Luxembourg	1990-1995	+0.7 (+0.4 to +1.1)	<0.05	1995-2001	-0.2 (-0.6 to +0.1)	0.2	2001-2011	-1.5 (-1.6 to -1.4)	<0.05	2011-2017	+0.3 (0 to +0.5)	<0.05
Netherlands	1990-1993	+0.7 (-1.1 to +2.6)	0.4	1993-1999	-1.8 (-2.6 to -1)	<0.05	1999-2004	-4.3 (-5.4 to -3.2)	<0.05	2004-2017	-2.1 (-2.3 to -1.9)	<0.05
Norway	1990-2000	-0.3 (-0.5 to -0.2)	<0.05	2000-2004	+2.2 (+1.4 to +3.1)	<0.05	2004-2017	-0.3 (-0.4 to -0.2)	<0.05			
Portugal	1990-2000	+7.4 (+6.3 to +8.6)	<0.05	2000-2010	-10.4 (-11.5 to -9.3)	<0.05	2010-2017	-0.1 (-1.9 to +1.8)	0.9			
Spain	1990-1994	+0.2 (-1 to +1.4)	0.7	1994-2000	+2.7 (+1.8 to +3.6)	<0.05	2000-2014	-1.4 (-1.6 to -1.2)	<0.05	2014-2017	+0.2 (-1.7 to +2.1)	0.9
Sweden	1990-1994	+1 (+0.1 to +1.8)	<0.05	1994-1999	-3.9 (-4.7 to -3.2)	<0.05	1999-2006	-2 (-2.5 to -1.6)	<0.05	2006-2017	0 (-0.2 to +0.1)	0.5
United Kingdom	1990-1995	+2.5 (+2.1 to +2.9)	<0.05	1995-2003	-3.9 (-4.1 to -3.7)	<0.05	2003-2012	-1.2 (-1.4 to -1.1)	<0.05	2012-2017	+0.1 (-0.3 to +0.4)	0.7
United States	1990-1993	-3.4 (-3.7 to -3)	<0.05	1993-1998	-1.9 (-2.1 to -1.7)	<0.05	1998-2013	-0.5 (-0.6 to -0.5)	<0.05	2013-2017	+0.2 (-0.1 to +0.4)	0.1
WOMEN												
Australia	1990-1996	+1.9 (+1.5 to +2.3)	<0.05	1996-2001	-3.2 (-4 to -2.5)	<0.05	2001-2007	-1.8 (-2.3 to -1.3)	<0.05	2007-2017	+0.6 (+0.4 to +0.8)	<0.05
Austria	1990-1993	-1.3 (-2 to -0.6)	<0.05	1993-1997	-2.5 (-3.2 to -1.8)	<0.05	1997-2001	-0.7 (-1.4 to +0)	<0.05	2001-2017	+0.4 (+0.3 to +0.5)	<0.05
Belgium	1990-1994	+11.1 (+9.2 to +13)	<0.05	1994-2003	-1.5 (-2 to -0.9)	<0.05	2003-2010	-4.6 (-5.4 to -3.7)	<0.05	2010-2017	-1.4 (-2.1 to -0.7)	<0.05
Canada	1990-1998	+1.1 (+0.9 to +1.3)	<0.05	1998-2005	-1.8 (-2 to -1.5)	<0.05	2005-2013	-0.4 (-0.6 to -0.2)	<0.05	2013-2017	+0.7 (+0.2 to +1.2)	<0.05
Denmark	1990-2003	+2.9 (+2.7 to +3.1)	<0.05	2003-2010	-1.4 (-2.1 to -0.8)	<0.05	2010-2015	-2.7 (-3.8 to -1.5)	<0.05	2015-2017	+1.3 (-2.4 to +5.1)	0.5
Finland	1990-2003	+0.6 (+0.6 to +0.7)	<0.05	2003-2011	+0.4 (+0.2 to +0.5)	<0.05	2011-2017	0 (-0.3 to +0.2)	0.8			
France	1990-1999	-0.5 (-0.7 to -0.3)	<0.05	1999-2002	-2.8 (-4.8 to -0.6)	<0.05	2002-2013	-5.4 (-5.6 to -5.3)	<0.05	2013-2017	+0.2 (-0.4 to +0.9)	0.5
Germany	1990-1996	+0.9 (+0.4 to +1.4)	<0.05	1996-2001	-0.5 (-1.4 to +0.5)	0.3	2001-2014	+2.7 (+2.5 to +2.9)	<0.05	2014-2017	-0.7 (-2.2 to +0.8)	0.3
Greece	1990-1996	+0.7 (+0.3 to +1.2)	<0.05	1996-2004	-0.5 (-0.9 to -0.1)	<0.05	2004-2017	+0.2 (+0.1 to +0.4)	<0.05			
Ireland	1990-1998	+0.7 (+0.3 to +1.1)	<0.05	1998-2003	-6.1 (-7.2 to -4.9)	<0.05	2003-2009	-10.7 (-11.4 to -9.9)	<0.05	2009-2017	-0.2 (-0.6 to +0.2)	0.4
Italy	1990-1999	+1 (+0.7 to +1.3)	<0.05	1999-2007	-3.2 (-3.7 to -2.8)	<0.05	2007-2017	+0.7 (+0.4 to +0.9)	<0.05			
Luxembourg	1990-1997	+0.9 (+0.7 to +1.2)	<0.05	1997-2000	-0.7 (-2.7 to +1.4)	0.5	2000-2009	-1.9 (-2.1 to -1.7)	<0.05	2009-2017	0 (-0.3 to +0.2)	0.7
Netherlands	1990-1995	+1.4 (+0.6 to +2.3)	<0.05	1995-1999	-1.4 (-3.2 to +0.4)	0.1	1999-2014	-3.8 (-4 to -3.6)	<0.05	2014-2017	-0.4 (-2.2 to +1.4)	0.6
Norway	1990-1993	+0.6 (-0.9 to +2.1)	0.4	1993-1996	-2.2 (-5 to +0.8)	0.1	1996-2003	+1.2 (+0.6 to +1.7)	<0.05	2003-2017	-0.3 (-0.4 to -0.1)	<0.05
Portugal	1990-1999	+9.4 (+8.4 to +10.5)	<0.05	1999-2004	-6.6 (-9.6 to -3.5)	<0.05	2004-2009	-16.5 (-19.2 to -13.7)	<0.05	2009-2017	-1 (-2.1 to +0.1)	0.1
Spain	1990-1994	+0.6 (-0.3 to +1.6)	0.2	1994-1999	+2.7 (+1.7 to +3.7)	<0.05	1999-2003	-0.5 (-2 to +1)	0.5	2003-2017	-1.6 (-1.7 to -1.5)	<0.05
Sweden	1990-1994	+1.4 (+0.5 to +2.3)	<0.05	1994-2005	-1.9 (-2.1 to -1.7)	<0.05	2005-2017	-0.2 (-0.4 to -0.1)	<0.05			
United Kingdom	1990-1995	+2.4 (+1.7 to +3.2)	<0.05	1995-2003	-4.3 (-4.8 to -3.9)	<0.05	2003-2012	-2.1 (-2.5 to -1.8)	<0.05	2012-2017	+0.1 (-0.6 to +0.9)	0.7
United States	1990-1994	-1.9 (-2.3 to -1.6)	<0.05	1994-2003	+0.5 (+0.4 to +0.6)	<0.05	2003-2011	-1.1 (-1.2 to -0.9)	<0.05	2011-2017	+0.1 (-0.1 to +0.3)	0.3

Data presented as EAPC (%), with 95% confidence intervals in brackets. P < 0.05 is deemed significant.

EU15+ countries except Germany, Denmark, and Finland for men, and Germany alone for women.

In the context of a chronic and disabling process such as DU, DALYs represent a further tool to understand the disease burden, which combine both morbidity and mortality. The improving trends in DALYs observed across the majority of EU15+ countries, including USA and the UK, is an important finding of this analysis and matches the finding of down-trending MIIs across most of the included EU15+ countries over the time period studied. Being aware that the present analysis is observational, we cannot attribute causality to the observed trends; however, contributors to the general improvements in DALY rates and MIIs observed may include the drive for a more evidence-based, international consensus on DU management which has occurred during the observation period. Indeed, in 2009, the NPIAP collaborated with the European Pressure Ulcer Advisory Panel (EPUAP) and the Pan Pacific Pressure Injury Alliance (PPPIA) to produce an international clinical practice guideline (CPG) for the prevention and treatment of pressure ulcers.²¹ The first edition was published in 2009, the second in 2014, and the third edition in 2019. Interestingly, Joinpoint analyses demonstrate that over the time periods covered by the most recent trends (since approximately 2009), relatively static and insignificant trend changes in mortality and DALYs were observed for most EU15+ countries, alongside significantly increasing incidence EAPCs in 11/19 EU15+ countries for men and 9/19 EU15+ countries for women. Marked, quantifiable, and significant improvements in terms of DU incidence, mortality, and DALYs resulting from the instigation of the CPG across EU15+ countries remain to be seen.

Despite general overall improvements in the trends in mortality, DALYs, and MIIs from DU observed in the present analysis, these positive findings were not universally consistent across the cohort of countries included. Most notably, unfavorable increasing trends in mortality, DALYs, and ASIRs were observed in Denmark and Germany for both sexes. These findings were unexpected, in the context of uniform international CPGs as described above, implemented in countries with comparable health expenditure. Such inconsistencies warrant further analysis of standard care pathways country by country. Future research should target scrutinizing individual nation data, focusing on the criteria for DU diagnosis and treatment options offered (notably the differential tendencies to surgical intervention in severe pressure sores).

LIMITATIONS

To our knowledge, this is the first study to present international trends in the disease burden from DU, and the first to use Joinpoint regression analysis to describe these trends. Using age-standardized estimates of disease incidence, mortality and DALYs permits comparisons between countries with adjustments made for country-specific demographics. However, important limitations should be considered when interpreting these results. First, this analysis is observational: causal statements about the trends observed cannot be made. Second, variable data-coding practice exists amongst included countries: the GBD Study

maps deaths to causes lists to adjust for differing coding systems. Furthermore, we accept that changes in coding practices (notably from ICD-9 to ICD-10) that occurred during the study period may compromise the robustness of the presented data. Third, death certification accuracy has international variability and the co-morbidities that are often associated with DU can add further ambiguity when identifying the true cause of death. In 2013, only 38% of worldwide deaths were centrally registered.²² Europe, North America, and Australasia demonstrated the best-performing systems for vital statistics and civil registration,²² which supports the reliability of the data from the EU15+ countries included in this analysis. Lastly, due to the observational nature of this analysis, there are likely to be a number of unmeasured confounding factors not discussed. There is evidence to suggest inter-rater reliability²³ in the diagnosis and subsequent management of DU: this is apparent within single nation populations and likely to be more profound country to country. To minimize the confounding effects on the results presented, we present age-standardized, sex-specific mortality rates and compare nations with similar health expenditure.

CONCLUSIONS

Varying trends in the burden of DU were observed between 1990 and 2017 in EU15+ countries. Despite internationally consistent clinical practice guidelines, Denmark and Germany demonstrated opposing and unfavorable trends in mortality, incidence, and DALY rates over the 28-year period analyzed when compared with the other EU15+ countries. Contrastingly, favorably directed trends for all measured parameters of DU disease burden were observed in USA, France, and the Netherlands. Investigation into the differential trends across countries with a similar health expenditure is warranted.

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