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# National Variations in Recent Trends of Sudden Unexpected Infant Death Rate in Western Europe

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## **ABBREVIATIONS**

CI - Confidence Interval

Eurostat - Statistical office of the European Union

ICD-10 - International Classification of Diseases, 10<sup>th</sup> Revision

SIDS - Sudden infant death syndrome

SUDI - Sudden unexpected death in infancy

WHO – World Health Organization

**Objective:** to study recent epidemiological trends of sudden unexpected death in infancy (SUDI) in Western Europe.

**Study design** Annual national statistics of death causes for 14 Western European countries from 2005 to 2015 were analyzed. SUDI cases were defined as infants younger than one year with the underlying cause of death classified as “sudden infant death syndrome” (SIDS), “unknown/unattended/unspecified cause” or “accidental threats to breathing”. Poisson regression models were used to study temporal trends of SUDI rates and source of variation.

**Results** From 2005 to 2015, SUDI accounted for 15,617 deaths, for an SUDI rate of 34.9 per 100,000 live births. SUDI was the second most common cause of death after the neonatal period (22.1%) except in Belgium, Finland, France and United Kingdom, where it ranked first. The overall SUDI rate significantly decreased from 40.2 to 29.9 per 100,000, with a significant rate reduction experienced for six countries, no significant evolution for seven countries, and a significant increase for Denmark. The SIDS/SUDI ratio was 56.7%, with a significant decrease from 64.9% to 49.7% during the study period, and ranged from 6.1% in Portugal to 97.8% in Ireland. We observed between-country variations in SUDI and SIDS sex ratios.

**Conclusions** In studied countries, SUDI declined during the study period but remained a major cause of infant deaths, with marked between-country variations in rates, trends and components. Standardization is needed to allow for comparing data to improve the implementation of risk-reduction strategies.

**KEYWORDS** Sudden unexpected death in infancy; Sudden infant death syndrome; Infant mortality; Epidemiology; Public health; Europe; Trends

Sudden unexpected death in infancy (SUDI) is defined as the death in an infant less than one year old that occurs suddenly and unexpectedly and whose cause is not immediately obvious before investigation (1,2). After a complete investigation, including a review of clinical history, an observation of the scene investigation, and an autopsy, SUDI can be attributed to various causes. Death is classified as sudden infant death syndrome (SIDS) when the thorough investigation fails to identify a cause (3–6). SIDS must be considered a specific subcategory of SUDI. After the discovery of the prone sleeping position as a major risk factor, massive “back-to-sleep” prevention campaigns were conducted in the early 1990s and led to a huge decrease in SIDS incidence in many countries (7–10). However, SIDS and SUDI remain an important cause of infant mortality in countries with high-income economies (9,11).

According to the last international comparisons (7,9,12), SUDI and SIDS rates in Europe varied strongly around mean rates of 39 and 25 cases per 100,000 live births. Austria, Germany, France and Ireland have particularly high SIDS rates (7). Such high rates led SUDI to be the most common cause of death for infants aged 28 days to 1 year old (12). Previous studies have shown that male sex is a SIDS risk factor in some countries (13,14), but no between-country comparisons have been made on SUDI and SIDS sex ratios. Besides geographical and sex variations in SIDS rates, some studies have identified important variations in the definition of SUDI, SUDI case investigation protocols, and death coding practices leading to highly variable SIDS/SUDI ratios (9,10,12,15–18) and impairing reliable international comparisons.

Despite the public health burden of SUDI, no European analysis of SUDI trends has been performed since 2010 (12). However, such analyses are necessary to justify, inform and implement future SUDI risk-reduction campaigns in Western Europe countries, notably those with high or increasing SUDI rates. Such comparisons could also help identify the need to standardize investigation protocols, definitions and coding practices to improve the reliability

of data from routine surveillance practices and allow the evaluation of risk-reduction campaigns. In this context, we aimed to study the geographical, sex and time variations of SUDI and SUDI subcategories from 2005 to 2015 in Western European countries.

## **POPULATIONS AND METHODS**

### ***General design and study data***

We performed a secondary analysis of national data on causes of death derived from death certificates. These data were available from the official website of the World Health Organization database on mortality (WHO) (19) for the 14 European countries (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Norway, Portugal, Spain, Sweden, The Netherlands, United Kingdom; Figure 1) that participated in the Eurostat Task Force dedicated to improving the quality and comparability of European cause-of-death statistics (20). Available data were aggregated by year and totally anonymous, so no ethical and regulatory approvals were required. For each country, WHO publishes annual numbers of deaths by causes, based on the International Classification of Diseases, 10<sup>th</sup> Revision (ICD-10) transmitted by national death registries. During the study period, except for Portugal where specific codes were used in 2005, the 14 countries used the ICD-10 for coding the causes of death. WHO provides correspondence tables between the specific Portuguese codes and ICD-10 codes. We used annual numbers of live births from the European Union's statistical office (Eurostat) (21) database and transmitted by the national institutes of statistics. To calculate ratios, rates and trends in SUDI and SUDI subcategories, we used data from 2005 to 2015, the last year for which data were completely available for all countries.

All deaths in infants younger than 364 days old from 2005 to 2015 were included. By definition, there is no ICD-10 code for SUDI, just as there is no well-establish list of ICD-10

codes to define it. We selected a set of ICD-10 codes corresponding to death causes found in most cases after SUDI investigations (22) and those previously used for international comparison (12). Thus, we defined SUDI with the ICD-10 cause-of-death codes R95 “sudden infant death syndrome”, R96 “other sudden death, cause unknown”, R98 “Unattended death, R99 “other ill-defined and unspecified causes of mortality”, W75 “accidental suffocation and strangulation in bed”, W76 “other accidental hanging and strangulation”, W78 “inhalation of gastric contents”, W79 “inhalation and ingestion of food causing obstruction of respiratory tract”, W80 “inhalation and ingestion of other objects causing obstruction of respiratory tract”, W81 “confined to or trapped in a low-oxygen environment”, W83 “other specified threats to breathing” and W84 “unspecified threat to breathing”. Because some of these codes accounted for limited numbers, we grouped them in three categories: SIDS (R95), unknown/unattended/unspecified cause (R96-R99) and accidental threats to breathing (W75-W84).

To assess and compare the SUDI ratio of infant mortality and those of other death causes, we selected the two chapters of the ICD-10 classification with the highest ratios: P00-P96, chapter XVI “Certain conditions originating in the perinatal period” and Q00-Q99, chapter XVII “Congenital malformations, deformations and chromosomal abnormalities”. Ratios of SUDI and main causes of death among infant mortality was described overall (0-364 days) and by age subgroups (neonatal death from 0 to 27 days and post-neonatal infant death from 28 to 364 days). SUDI rates were calculated overall and then by SUDI subcategories, sex, age classes.

### ***Statistical analyses***

SUDI rates were calculated as number of deaths for 100,000 live births. SUDI subcategory ratios were calculated by dividing SUDI subcategory cases by overall SUDI (R95, R96-R99



and W75-W84) cases. Poisson regression models of annual death rates were used to assess temporal trends from 2005 to 2015. Annual change in coefficient was calculated with a 95% confidence interval. The statistical significance threshold was fixed at  $P < .05$  and a Rainbow test was used to verify the fit of the models (23). SUDI sex rate ratios were estimated by median-unbiased estimation (mid-p) and Wald unconditional maximum likelihood estimation. To visualize SUDI rate variations by geographical region, specific rates for 2005–2015 were calculated, and a map of these rates, divided into quartiles, was plotted for 14 European countries. R/RStudio was used for all analyses (R Foundation for Statistical Computing, Vienna, Austria. URL <https://www.R-project.org/>).

## RESULTS

From 2005 to 2015, in the 14 European countries studied, SUDI accounted for 9.7% of infant mortality, and was the third cause of death after those classified as “certain conditions originating in the perinatal period” (ICD-10 P00-P96) and “congenital malformations or chromosomal abnormalities” (ICD-10 Q00-Q99) which accounted for 52.2% and 25.0% of deaths, respectively (Table 1). SUDI accounted for 22.1% of infant deaths between 28 and 364 days, the second cause of death after “congenital malformations or chromosomal abnormalities”. In four countries (Belgium, Finland, France and United Kingdom), SUDI was the first cause of death after the neonatal period and for four countries (Italy, The Netherlands, Portugal and Spain), it was the third or fourth cause (Table I). Deaths coded P00-P96, Q00-Q99 and SUDI occurred during the neonatal period (0-27 days) in 89.2%, 67.4% and 30.3% of cases, respectively. For SUDI, deaths occurring during the neonatal period accounted for 88.9% and 91.3% of cases in Denmark and Portugal, respectively, but ranged from 12.8% (Austria) to 46.5% (Sweden) for the 12 other countries.

From 2005 to 2015, 15,617 infants died of SUDI in the 14 Western European countries, for an SUDI rate of 34.9 per 100,000 live births and with a significant decrease ( $p < 0.001$ ) from 40.2 to 29.9 (Table 2 and Figure 1). The four countries in the upper quartile of SUDI rate from 2005 to 2015 ( $> 41.9$  per 100,000 live births) were, by decreasing rate, Denmark, France, Belgium and Germany (Figure 2). From 2005 to 2015, six countries (Austria, France, Germany, Portugal, Spain, United-Kingdom) showed a significant decrease in SUDI rate, with no significant trend in seven (Belgium, Finland, Ireland, Italy, The Netherlands, Norway, Sweden), and a significant increase in Denmark (Table 2).

During 2005-2015, the SIDS/SUDI ratio was 56.7% in the 14 Western European countries, with a significant decrease ( $p < 0.001$ ) from 64.9% to 49.7% during this period (Table 2). The SIDS/SUDI ratio ranged from 6.1% in Portugal to 97.8% in Ireland; five countries (Denmark, Italy, The Netherlands, Portugal and Sweden) had a ratio lower than 50%. We observed a significant decrease in SIDS/SUDI ratio for five countries (Belgium, Denmark, France, Germany and The Netherlands) (Figure 3; available at [www.jpeds.com](http://www.jpeds.com)), a significant increase for Portugal and no significant variations for the eight other countries (Table 2).

For the 14 Western European countries studied, the rates of SUDI overall, SUDI classified as SIDS, SUDI classified as “unknown/unattended/unspecified cause” and SUDI classified as “accidental threats to breathing” were 39.9, 22.2, 14.4 and 2.7 per 100,000 live births for male infants and 29.5, 15.4, 11.7 and 2.0 for female infants, respectively (Table 3; available at [www.jpeds.com](http://www.jpeds.com)). The male/female sex ratios were 1.4, 1.4, 1.2 and 1.3 for SUDI overall, SIDS, “unknown/unattended/unspecified” cause and “accidental threats to breathing”, respectively, with all these sex ratios significantly greater than one ( $p < 0.001$ ). The sex ratios of SUDI classified as SIDS, SUDI classified as “unknown/unattended/unspecified cause” and

SUDI classified as “accidental threats to breathing” were not significantly greater than one in four, ten and eleven countries, respectively (Table 3).

Among the three SUDI subcategories in 14 European countries, we observed significant ( $p < 0.001$ ) negative and positive trends for SUDI classified as SIDS (R95), “unknown/unattended/unspecified cause” (R96-R99) and “accidental threats to breathing” (W75-W84) (Figure 1). SIDS and “accidental threats to breathing” rates decreased significantly during the study period, but the “unknown/unattended/unspecified cause” rate increased significantly. The SIDS rate was 19.8 per 100,000 live births, contributing up to 56.7% of SUDI mortality (Table 4; available at [www.jpeds.com](http://www.jpeds.com)). “Unknown/unattended/unspecified cause” and “accidental threats to breathing” rates were 12.7 and 2.4 per 100,000 live births and contributed to 36.3% and 7.0% of SUDI mortality, respectively. SIDS rates significantly decreased in seven countries (Austria, Belgium, France, Germany, Norway, Spain and United Kingdom). “Unknown/unattended/unspecified cause” rates significantly increased in six countries (Belgium, Denmark, France, The Netherlands, Norway and Portugal) and significantly decreased in the United Kingdom. We observed a significant decrease of accidental threats to breathing only in Germany and Italy (Table 4). The contribution of each SUDI subcategory to the overall SUDI rate showed important between-country variations, from 6.1% (Portugal) to 97.8% (Ireland) for SIDS, 2.2% (Ireland) to 83.7% (Denmark) for “unknown/unattended/unspecified cause”, and 0% (Ireland) to 19.4% (The Netherlands) for “accidental threats to breathing” (Figure 4; available at [www.jpeds.com](http://www.jpeds.com)).

## **DISCUSSION**

From 2005 to 2015, SUDI accounted 9.7% of infant mortality in Western European countries, with 15,617 infant deaths during the study period. We found a 26% reduction in SUDI rates, 40.2 to 29.9 per 100,000 live births from the beginning to the end of the study period. This reduction confirms the previous trend observed in Europe from the end of the 1990s (7,9,12,24). However, this satisfactory trend on the scale of Western Europe masks more complex national patterns. SUDI national rates varied greatly, with six-fold differences between countries with the highest and lowest rates, respectively. Moreover, during the study period, trends in SUDI rates showed no reduction in Belgium, Finland, Ireland, Italy, The Netherlands, Norway, and Sweden and a significant increase in Denmark. These marked between-country differences may result from variations in different potential contributors: definition of SUDI, SUDI case investigation protocols, and death certifying and coding practices. An important part of the between-country variations in the contribution of each SUDI category to overall SUDI may reflect heterogeneity in how information is collected and analyzed to achieve classification (17,25). It may also result from disparities in the geographical distributions of modifiable and non-modifiable SUDI risk factors such as ethnic origin, socio-economic status, longitude/latitude data (26) or genetic data (27,28). A last explanation may be found in national variations regarding the implementation level of risk-reduction campaigns (9,29). Indeed, little is known about current sleeping practices for European children. The few available data suggest that there is not a good implementation level, with, for example, only 72.4% of infants having safe sleeping positions in The Netherlands in 2017, a country with one of the lowest SUDI rates in Western Europe (30). Thus, thousands of infants are dying each year in Western Europe with the lack of implementation of simple risk-reduction campaigns.

Between-country variations were not limited to SUDI rates and were similarly observed for SIDS/SUDI ratios. These variations were significant (from 6.1% in Portugal to

97.8% in Ireland) and raise the question of major between-country heterogeneity due to the absence of an international consensus on SUDI definition, post-mortem exploration protocols and/or certifying and coding practices for SIDS. Such variations have been described between regions in the United States and France (31,32), for post-mortem exploration protocols and certifying practices, and between countries (9,12) for coding practices. Persistent geographical heterogeneity is highly prejudicial because it precludes effective public health efforts using international comparisons and benchmarking between countries with low and high SUDI rates in order to better implement risk-reduction strategies. The importance of multiagency review is highlighted by several authors and contributes to better-quality investigation and classification (16–18,33,34). Efforts were made to standardize definitions in other fields of perinatal and pediatric health to allow for international comparisons and guide corrective actions to improve patient outcomes. For example, the Euro-Peristat Project, which has compared perinatal health statistics since 2000 in European countries, highlighted difficulties in comparing data among countries. This project had made proposals for a better use of existing statistics and provided a stimulus to countries to improve the quality of national statistics (35,36).

As expected, we observed a significant male/female sex ratio, from 1.2 to 1.4, for SUDI overall, SIDS, “unknown/unattended/unspecified cause,” and “accidental threats to breathing.” Male infants are well known to be at greater risk of SIDS (13,14,24,37). To explain this sex ratio, several hypothesis were proposed: recessive X-linked genetic disorders inducing fatal acute anoxic events (38) or sex differences in the brain, notably brain stem, maturation (39–41). However, we found important between-country variability in this sex ratio, with four and five countries not sharing it for SIDS and SUDI, respectively. The between-country heterogeneity in sex ratio is complex to analyze. It is not likely related to variations in definitions of SUDI and/or certifying and coding practices. Because male sex is

also a risk factor for accidental suffocation and strangulation in bed (13,14,24,37) or shaken baby syndrome (42), a sex-related difference must be hypothesized in the implementation of risk-reduction strategies and/or in post-mortem exploration protocols. For these exploration protocols, sex differences may occur in investigation strategies of death causes depending on health professionals or the request of parents. If the several European countries with no significant sex ratio have effectively tackled this sex-related excess risk in the implementation of risk-reduction strategies, then thousands of theoretically avoidable male infant deaths have occurred in the other European countries.

Among studied European countries, the distribution of SUDI before and after 28 days of life varied widely. Again, these variations may reflect the differences in certifying and coding practices with no international agreed-upon definition, but another source of variation can be hypothesized: national policies on screening for congenital anomalies and legal gestational age limit for late terminations of pregnancy in some countries such as France (43). These policies could result in a lower number of “Congenital malformations, deformations and chromosomal abnormalities” after the neonatal period. Finally, the decrease in SIDS/SUDI ratio observed in several countries is generally attributed to a change in the certification and coding of death causes at the country level (9,12,22,44).

Belgium, Finland, France, and the United Kingdom were notable regarding SUDI during the study period. These were the only countries where SUDI was the first cause of death after 28 days of life. In the United States and probably in other countries (45), death certificates are classified with a temporary cause of death until the death investigation is completed and the definitive cause of death is attributed. If the death certificate is not appropriately modified after investigation, the temporary cause of death will remain indefinitely, probably most often “unknown/unattended/unspecified cause” or SIDS. One study has shown that 85% of the

French SUDI referral centers do not update death certificates with a definitive cause of death (31). Thus, results of post-mortem investigations and the autopsy do not participate substantially in the official death coding. These inconsistencies create difficulties in United States and France (9,45) and probably explain why in the four countries SUDI was the first cause of death after 28 days of life or more generally why “accidental threats to breathing” causes are rare. If death certificates were properly updated “Congenital malformations, deformations and chromosomal abnormalities” may had a ratio of infant mortality higher than SUDI in these four countries. Because we did not directly use death certificates but rather aggregated national statistics on the causes of death (number of deaths by causes), we do not know how many death certificates had more than one code documented and how each team dealt with this situation. Finally, the epidemiologic units in this study were countries. Recent study in the United States assumed geographic variations in SUDI beyond national borders such as ethnic origin, socio-economic status and longitude/latitude data (26).

A careful analysis of data from WHO suggests pathways to improve the public health management of SUDI. SUDI remains a major cause of death in Western Europe infants, but no reliable data are available because of a lack of standardization of the SUDI definition, investigation of SUDI cases, and death certifying and coding practices. Our results suggest the need for a systematic and comparative appraisal of the definitions used in Europe and national registries are needed to gather reliable data on SUDI cases; thus, consensus efforts at the European level are mandatory. Such consensus may be a long term objective, but it was achieved in other fields such as perinatal health (35). It could allow for standardization and then European comparison of data and benchmarking to improve the implementation and impact of risk-reduction campaigns.

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**FIGURES AND TABLES**

**Figure 1 Temporal trends of SUDI and SUDI subcategory rates in 14 European countries (Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Norway, Portugal, Spain, Sweden, The Netherlands, and United Kingdom) between 2005 and 2015**

SUDI (Sudden Unexpected Death in Infancy) was defined as deaths in infants < 365 days old with death codes R95 (SIDS, sudden infant death syndrome), R96-99 (unknown/unattended/unspecified cause) or W75-W84 (accidental threats to breathing) in the International Classification of Diseases, 10<sup>th</sup> Revision.

95% CI, confidence interval

**Figure 2 SUDI rates per 100,000 live births for the 2005-2015 period in 14 European countries participating in the Eurostat Task Force**

SUDI, Sudden Unexpected Death in Infancy

**Table 1 Ratios and rank of infant mortality, and age distribution of the three major leading causes of death in neonates and infants in 14 European countries 2005-2015**

\* P00-P96, Certain conditions originating in the perinatal period

\*\* Q00-Q99, Congenital malformations, deformations and chromosomal abnormalities

\*\*\* SUDI, sudden unexpected death in infancy

\*\*\*\*\* Data were not available for Ireland from 2005 to 2006 and for Portugal in 2005, 2006, 2009, 2012 and 2013

¶ % among infant mortality

# % among 0-364 days by death cause category

**Table 2 SUDI rates per 100,000 live births and SIDS/SUDI ratios in 14 European countries for 2005, 2015, and 2005-2015 trends**

\* Per 100,000 live births

\*\* Coefficient of a Poisson regression model of the annual change in rate by calendar year; 95% CI: 95% confidence interval

\*\*\* For Ireland, data were not available in 2005 and 2006 and for Portugal in 2005, 2006, 2009, 2012 and 2013; trends were calculated over a 9-year period only for Ireland and a 6-year period for Portugal

SIDS, sudden infant death syndrome

SUDI, sudden unexpected death in infancy



**Figure 3 Temporal trends of SIDS/SUDI ratios and Poisson linear model (95% CI) for five European countries (Belgium, Denmark, France, Germany and The Netherlands) between 2005 and 2015**

SUDI, Sudden Unexpected Infant Death in Infancy

SIDS, sudden infant death syndrome

95% CI, confidence intervals

#### **Figure 4 Ratios of SUDI subcategories to total SUDI in the 14 European countries 2005-2015**

SUDI (Sudden unexpected death in infancy) was defined as deaths in infants <365 days old with codes R95 (SIDS, Sudden infant death syndrome), R96-99 (unknown/unattended/unspecified cause) or W75-W84 (accidental threats to breathing) for the cause of death in the International Classification of Diseases, 10<sup>th</sup> Revision.

**Table 3 SUDI and subcategory rates per 100,000 live births by sex and sex ratios in 14 European countries 2005-2015**

\* R95, sudden infant death syndrome

\*\* R96-R99, unknown/unattended/unspecified cause

\*\*\* W75-W84, accidental threats to breathing

\*\*\*\* Sex ratio, 95% confidence interval and p value were computed as rate ratio Wald

T, total; M, male; F, female

SUDI, sudden unexpected death in infancy

**Table 4 Numbers, ratios, rates per 100,000 live births and trends of SUDI and subcategories in 14 European countries 2005-2015**

\* R95, sudden infant death syndrome

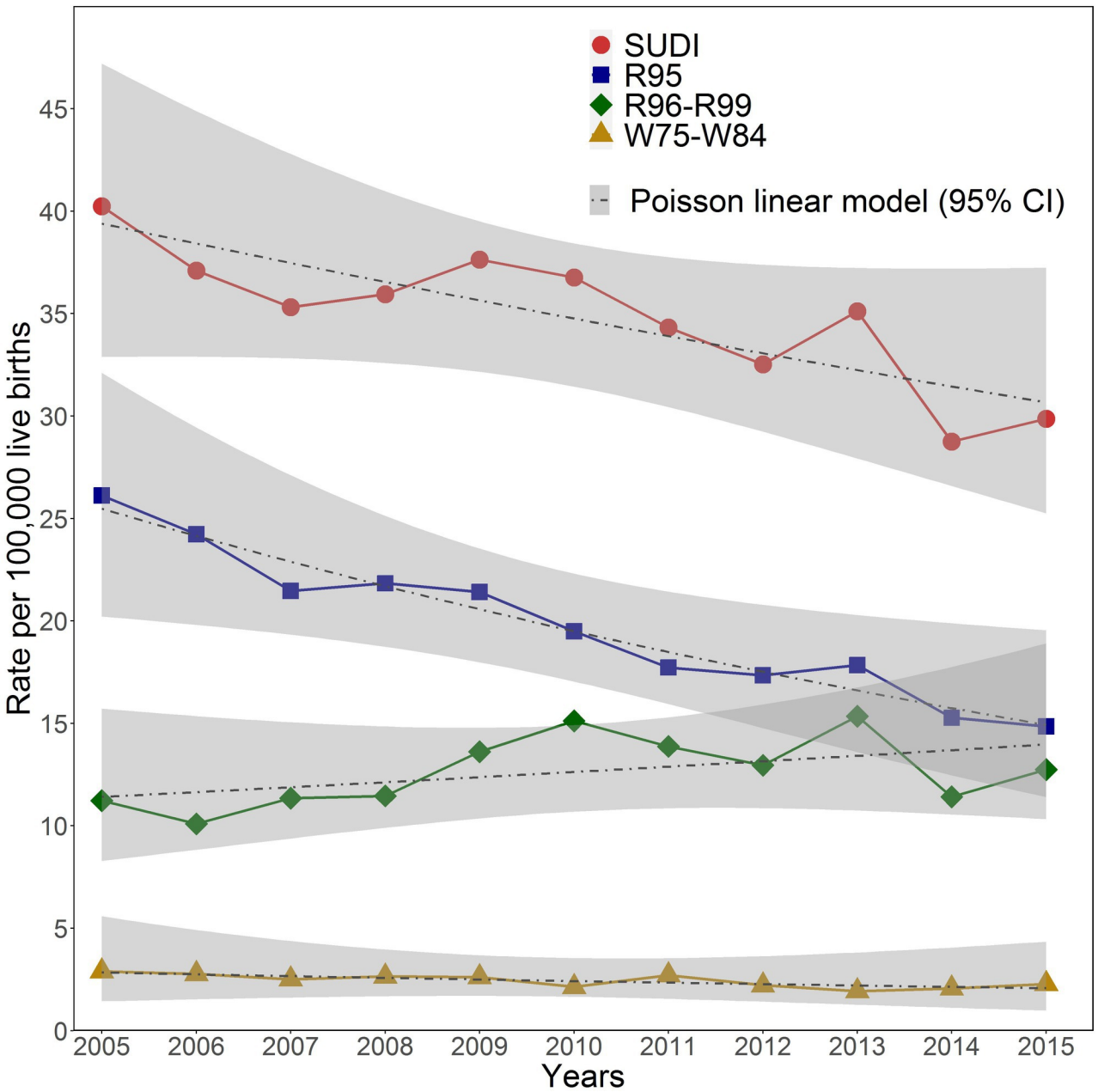
\*\* R96-R99, unknown/unattended/unspecified cause

\*\*\* W75-W84, accidental threats to breathing

\*\*\*\* Per 100,000 live births

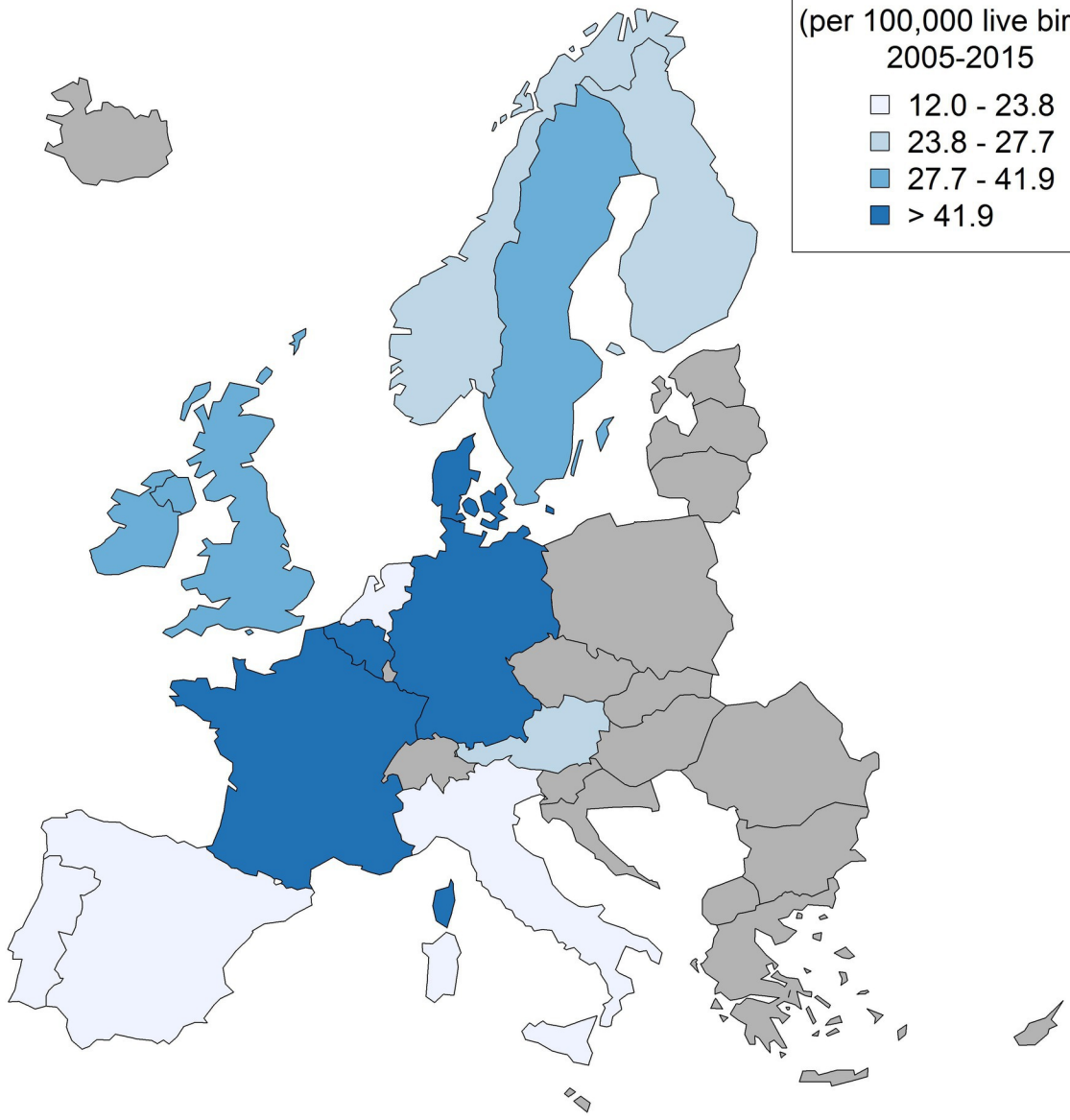
\*\*\*\*\* Coefficient of a Poisson regression model of the annual rate by calendar year; 95% CI: 95% confidence interval

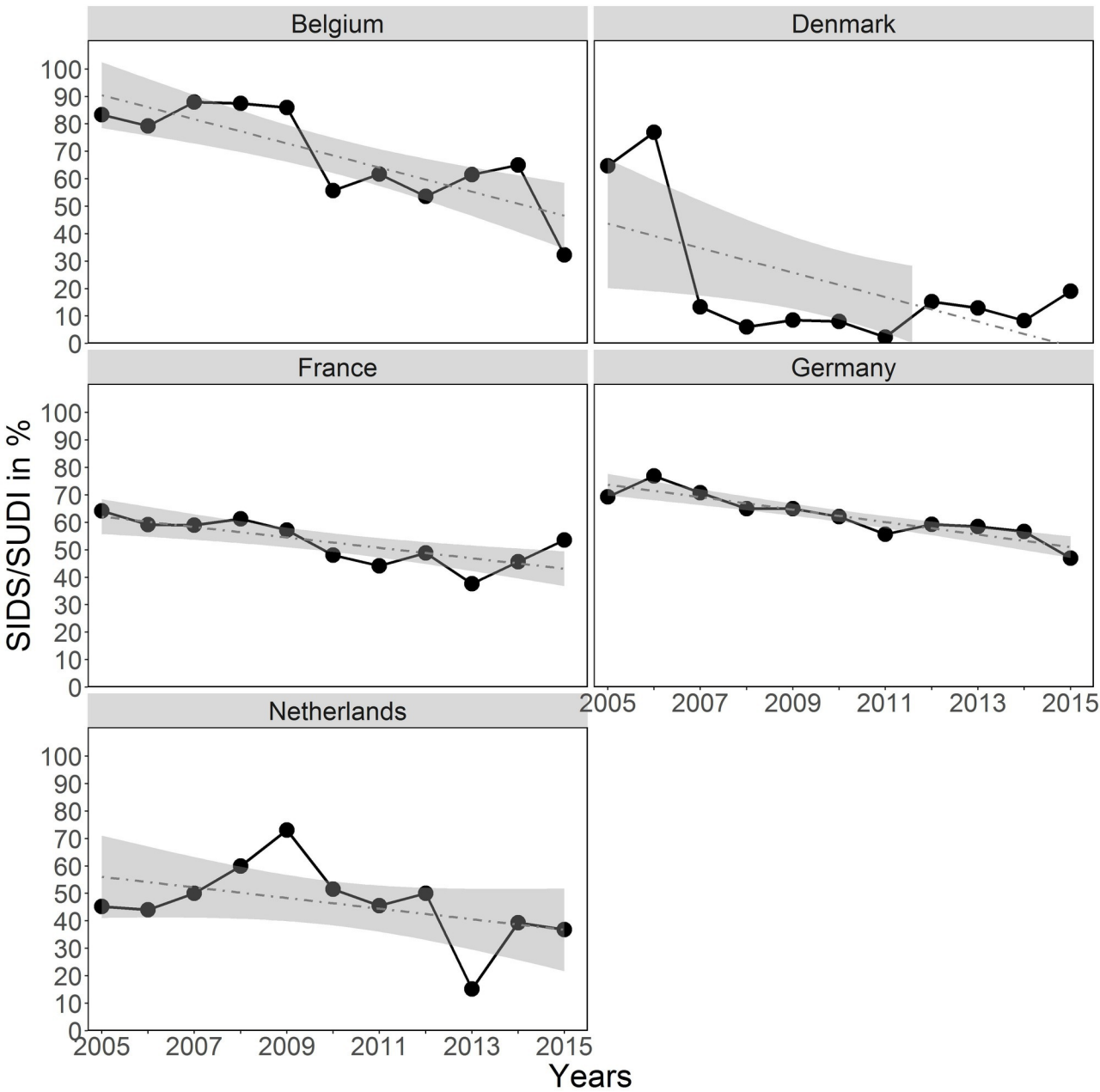
SUDI, sudden unexpected death in infancy

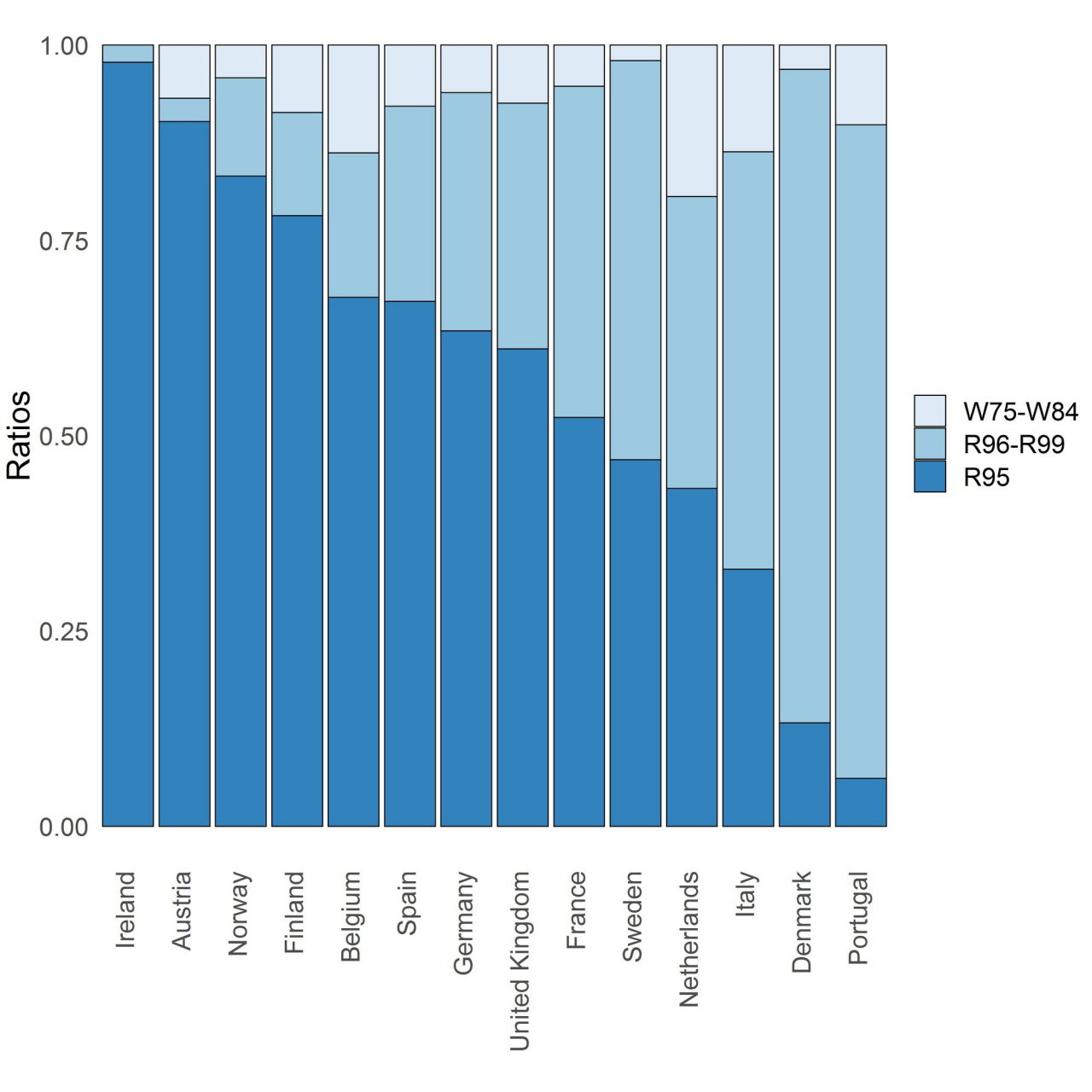


SUDI rate  
(per 100,000 live births)  
2005-2015

- 12.0 - 23.8
- 23.8 - 27.7
- 27.7 - 41.9
- > 41.9









**Table 1 Ratios and rank of infant mortality, and age distribution of the three major leading causes of death in neonates and infants in 14 European countries 2005-2015**

Countries	0-364 days						0-27 days						28-364 days											
	P00-P96*		Q00-Q99**		SUDI***		P00-P96*		Q00-Q99**		SUDI***		P00-P96*		Q00-Q99**		SUDI***							
	% ¶	Rank	% ¶	Rank	% ¶	Rank	% ¶	Rank	% #	% ¶	Rank	% #	% ¶	Rank	% #	% ¶	Rank	% #	% ¶	Rank	% #			
Austria	52.3	1	29.6	2	7.6	3	66,0	1	89.1	28.5	2	67.9	1.4	3	12.8	19.3	3	10.9	32.4	1	32.1	22.7	2	87.2
Belgium	47.3	1	24.7	2	11.8	3	65.3	1	89.7	26.4	2	69.4	2.9	3	16.3	13.9	3	10.3	21.6	2	30.6	28.1	1	83.7
Denmark	49.2	1	20.6	2	20.5	3	53.5	1	96.4	18.8	3	80.8	20.6	2	88.9	15.3	3	3.6	34.5	1	19.2	19.9	2	11.1
Finland	43,0	1	32.1	2	11.1	3	57.8	1	92.0	33.5	2	71.4	2.5	3	15.5	10.9	3	8.0	29.1	2	28.6	29.7	1	84.5
France	50.3	1	21.3	2	14.7	3	65.7	1	88.6	21.6	2	68.9	8,0	3	36.8	17.9	3	11.4	20.6	2	31.1	28.9	1	63.2
Germany	50,0	1	26.8	2	12.0	3	65.2	1	87.6	25.2	2	63.5	4.9	3	27.4	19.0	3	12.4	29.9	1	36.5	26.7	2	72.6
Ireland*****	42.5	2	42.8	1	8.2	3	50.1	1	90.7	44,0	2	79.0	3.1	3	29.1	17.2	3	9.3	39,0	1	21.0	25.1	2	70.9
Italy	56.9	1	24.6	2	3.6	3	72.8	1	90.9	21.5	2	62.0	1.7	3	34.7	17.8	2	9.1	32.2	1	38.0	8,0	4	65.3
The Netherlands	54.3	1	28.7	2	4.6	3	66.4	1	91.0	27.9	2	72.6	1.5	3	24.4	19.2	2	9.0	30.9	1	27.4	13.6	3	75.6
Norway	52.8	1	27.5	2	9.4	3	65.6	1	87.3	27.7	2	70.6	3.6	3	26.9	22.5	3	12.7	27.2	1	29.4	23.1	2	73.1
Portugal*****	57.4	1	23,0	2	7.3	3	59.7	1	98.6	22.3	2	91.7	7.1	3	91.3	15.4	2	1.4	35.7	1	8.3	11.9	3	8.7
Spain	54.7	1	25.4	2	6,0	3	72.3	1	87.8	21.9	2	57.2	1.6	3	18.1	19.9	2	12.2	32.5	1	42.8	14.7	3	81.9
Sweden	42.5	1	26.5	2	15,0	3	57.7	1	88.9	25.2	2	62.4	10.6	3	46.5	13.7	3	11.1	28.9	1	37.6	23.2	2	53.5
United Kingdom	53.5	1	24.3	2	9,0	3	68.9	1	88.8	25.4	2	72.0	2.4	3	18.4	19.3	3	11.2	21.9	2	28.0	23.7	1	81.6
<b>Total</b>	<b>52.2</b>	<b>1</b>	<b>25.0</b>	<b>2</b>	<b>9.7</b>	<b>3</b>	<b>67.1</b>	<b>1</b>	<b>89.2</b>	<b>24.2</b>	<b>2</b>	<b>67.4</b>	<b>4.2</b>	<b>3</b>	<b>30.3</b>	<b>18.4</b>	<b>3</b>	<b>10.8</b>	<b>26.6</b>	<b>1</b>	<b>32.6</b>	<b>22.1</b>	<b>2</b>	<b>69.7</b>

\* P00-P96, Certain conditions originating in the perinatal period

\*\* Q00-Q99, Congenital malformations, deformations and chromosomal abnormalities

\*\*\* SUDI, sudden unexpected death in infancy

\*\*\*\*\* Data were not available for Ireland from 2005 to 2006 and for Portugal in 2005, 2006, 2009, 2012 and 2013

¶ % among infant mortality

# % among 0-364 days by death cause category

**Table 2 SUDI rates per 100,000 live births and SIDS/SUDI ratios in 14 European countries for 2005, 2015, and 2005-2015 trends**

Countries	2005			2015			2005-2015							
	n	Rate *	SIDS/SUDI Ratio (%)	n	Rate *	SIDS/SUDI Ratio (%)	n	SUDI			SIDS/SUDI ratio			
								Rate *	Exp( $\beta$ ) [95% CI] **	P value	%	Exp( $\beta$ ) [95% CI] **	P value	
Austria	32	40.9	93.8	21	24.9	81.0	235	27.1	0.93 [0.89-0.97]	< 0.001	90.2	0.99 [0.95-1.03]	0.626	
Belgium	54	45.1	83.3	65	53.2	32.3	595	43.1	0.99 [0.96-1.01]	0.378	67.7	0.93 [0.91-0.96]	< 0.001	
Denmark	17	26.4	64.7	47	80.7	19.1	514	76.4	1.04 [1.02-1.07]	0.002	13.2	0.87 [0.80-0.96]	0.005	
Finland	21	36.4	90.5	9	16.2	66.7	174	26.9	0.97 [0.92-1.02]	0.203	78.2	0.99 [0.94-1.05]	0.854	
France	385	49.7	64.2	280	36.8	53.6	4,380	50.6	0.99 [0.98-1.00]	0.028	52.4	0.96 [0.95-0.97]	< 0.001	
Germany	430	62.7	69.3	270	36.6	47.0	3,206	42.5	0.94 [0.93-0.95]	< 0.001	63.4	0.96 [0.95-0.98]	< 0.001	
Ireland***	n/a	n/a	n/a	16	24.4	87.5	182	28.2	0.97 [0.92-1.03]	0.296	97.8	1.00 [0.94-1.06]	0.902	
Italy	73	13.2	27.4	56	11.5	28.6	717	12.0	0.99 [0.97-1.01]	0.365	32.9	1.00 [0.96-1.04]	0.990	
The Netherlands	42	22.4	45.2	19	11.1	36.8	356	18.0	1.01 [0.98-1.05]	0.479	43.3	0.94 [0.90-0.99]	0.021	
Norway	20	35.2	100.0	12	20.4	66.7	167	25.5	0.97 [0.92-1.02]	0.210	83.2	0.96 [0.91-1.01]	0.118	
Portugal***	n/a	n/a	n/a	14	16.4	21.4	196	23.2	0.90 [0.85-0.95]	< 0.001	6.1	1.25 [1.04-1.51]	0.017	
Spain	114	24.5	77.2	66	15.8	69.7	997	19.4	0.97 [0.95-0.99]	< 0.001	67.2	0.99 [0.97-1.02]	0.531	
Sweden	33	32.6	69.7	53	46.1	47.2	456	37.4	1.00 [0.97-1.03]	0.970	46.9	1.00 [0.96-1.04]	0.938	
United-Kingdom	335	46.4	56.7	265	34.1	54.3	3,442	40.1	0.97 [0.96-0.98]	< 0.001	61.1	1.00 [0.98-1.01]	0.834	
<b>Total</b>	1,556	40.2	64.9	1,193	29.9	49.7	15,617	34.9	0.98 [0.97-0.98]	< 0.001	56.7	0.97 [0.97-0.98]	< 0.001	
<b>Range</b>		13.2-62.5	27.4-100.0		11.1-80.7	19.1-87.5		12.0-76.4				6.1-97.8		

\* Per 100,000 live births

\*\* Coefficient of a Poisson regression model of the annual change in rate by calendar year; 95% CI: 95% confidence interval

\*\*\* For Ireland, data were not available in 2005 and 2006 and for Portugal in 2005, 2006, 2009, 2012 and 2013; trends were calculated over a 9-year period only for Ireland and a 6-year period for Portugal

SIDS, sudden infant death syndrome

SUDI, sudden unexpected death in infancy

**Table 3 SUDI and subcategory rates per 100,000 live births by sex and sex ratios in 14 European countries 2005-2015**

Countries	SUDI					R95*					R96-R99**					W75-W84***				
	Rate per 100,000 live births			Sex ratio**** [95% CI]	P value	Rate per 100,000 live births			Sex ratio**** [95% CI]	P value	Rate per 100,000 live births			Sex ratio**** [95% CI]	P value	Rate per 100,000 live births			Sex ratio**** [95% CI]	P value
	T	M	F		T	M	F			T	M	F		T	M	F		T	M	F
Austria	27.1	31.4	22.5	1.4 [1.1-1.8]	0.012	22.1	25.9	18.0	1.4 [1.0-2.0]	0.024	0.8	0.3	1.4	0.2 [0.0-1.6]	0.088	1.8	2.2	1.4	1.5 [0.5-4.6]	0.469
Belgium	43.2	51.2	34.8	1.5 [1.2-1.7]	< 0.001	26.4	32.1	20.5	1.6 [1.2-2.0]	< 0.001	9.2	10.5	7.9	1.3 [0.9-1.9]	0.158	5.5	6.0	5.0	1.2 [0.7-2.0]	0.490
Denmark	76.4	81.8	70.8	1.2 [1.0-1.4]	0.103	8.7	9.2	11.8	0.8 [0.4-1.4]	0.409	78.2	81.1	75.2	1.1 [0.9-1.3]	0.434	2.2	3.2	1.1	2.9 [0.8-10.5]	0.100
Finland	26.9	30.3	23.4	1.3 [1.0-1.7]	0.094	20.0	22.5	17.4	1.3 [0.9-1.9]	0.188	3.4	3.3	3.5	1.0 [0.4-2.4]	0.922	2.3	2.2	2.3	1.0 [0.3-3.0]	0.936
France	50.6	58.6	42.2	1.4 [1.3-1.5]	< 0.001	25.4	30.3	20.1	1.5 [1.4-1.7]	< 0.001	22.5	24.8	20.0	1.2 [1.1-1.4]	< 0.001	2.6	3.1	2.0	1.6 [1.2-2.1]	0.003
Germany	42.5	49.0	35.7	1.4 [1.3-1.5]	< 0.001	23.9	28.0	19.6	1.4 [1.3-1.6]	< 0.001	13.2	14.5	11.8	1.2 [1.1-1.4]	0.004	2.4	2.8	2.0	1.4 [1.0-2.0]	0.038
Ireland	28.2	30.9	25.5	1.2 [0.9-1.6]	0.196	27.6	30.0	25.1	1.2 [0.9-1.6]	0.244	0.6	0.9	0.3	2.9 [0.3-27.4]	0.342	0.0	0.0	0.0	-	-
Italy	12.0	13.1	10.9	1.2 [1.0-1.4]	0.017	4.0	4.5	3.4	1.3 [1.0-1.8]	0.048	6.4	6.8	6.0	1.1 [0.9-1.4]	0.277	1.7	1.7	1.6	1.1 [0.7-1.7]	0.766
The Netherlands	18.0	20.5	15.3	1.3 [1.1-1.7]	0.007	7.7	9.5	5.9	1.6 [1.1-2.3]	0.009	6.7	7.0	6.4	1.1 [0.8-1.6]	0.604	3.5	4.2	2.8	1.5 [0.9-2.6]	0.124
Norway	25.5	31.5	19.1	1.6 [1.2-2.3]	0.002	19.8	26.7	12.6	2.1 [1.4-3.2]	< 0.001	3.7	4.3	3.0	1.4 [0.6-3.5]	0.440	1.1	0.4	1.9	0.2 [0.0-1.6]	0.089
Portugal	23.2	25.4	20.9	1.2 [0.9-1.6]	0.173	2.1	4.2	2.1	2.0 [0.6-6.7]	0.242	19.4	21.2	17.5	1.2 [0.9-1.7]	0.215	2.4	2.3	2.4	1.0 [0.4-2.3]	0.911
Spain	19.4	22.4	16.3	1.4 [1.2-1.6]	< 0.001	12.2	13.3	11.1	1.2 [1.0-1.4]	0.038	4.9	6.3	3.5	1.8 [1.3-2.4]	< 0.001	1.5	1.8	1.3	1.4 [0.8-2.3]	0.211
Sweden	37.4	40.5	34.1	1.2 [1.0-1.4]	0.069	16.5	20.2	12.6	1.6 [1.2-2.2]	0.003	19.4	18.2	20.6	0.9 [0.7-1.2]	0.402	0.8	0.8	0.8	0.9 [0.2-3.8]	0.934
United Kingdom	40.1	46.1	33.7	1.4 [1.3-1.5]	< 0.001	24.1	28.3	19.6	1.4 [1.3-1.6]	< 0.001	12.3	14.1	10.3	1.4 [1.2-1.6]	< 0.001	2.8	3.1	2.5	1.2 [0.9-1.6]	0.143
<b>Total</b>	<b>34.9</b>	<b>39.9</b>	<b>29.5</b>	<b>1.4 [1.3-1.4]</b>	<b>&lt; 0.001</b>	<b>18.8</b>	<b>22.2</b>	<b>15.4</b>	<b>1.4 [1.4-1.5]</b>	<b>&lt; 0.001</b>	<b>13.1</b>	<b>14.4</b>	<b>11.7</b>	<b>1.2 [1.2-1.3]</b>	<b>&lt; 0.001</b>	<b>2.3</b>	<b>2.7</b>	<b>2.0</b>	<b>1.3 [1.2-1.5]</b>	<b>&lt; 0.001</b>

\* R95, sudden infant death syndrome

\*\* R96-R99, unknown/unattended/unspecified death

\*\*\* W75-W84, accidental threats to breathing

\*\*\*\* Sex ratio, confidence interval and p value were computed as rate ratio Wald

T, total; M, male; F, female

SUDI, sudden unexpected death in infancy

**Table 4 Numbers, ratios, rates per 100,000 live births and trends of SUDI and subcategories in 14 European countries 2005-2015**

Countries	R95*					R96-R99**					W75-W84***				
	n	%	Rate ****	Exp( $\beta$ ) [95% CI] *****	P value	n	%	Rate ****	Exp( $\beta$ ) [95% CI] *****	P value	n	%	Rate ****	Exp( $\beta$ ) [95% CI] *****	P value
Austria	212	90.2	24.4	0.92 [0.88-0.96]	< 0.001	7	3	0.8	1.17 [0.91-1.50]	0.223	16	6.8	1.8	0.97 [0.83-1.13]	0.689
Belgium	403	67.7	29.2	0.92 [0.89-0.95]	< 0.001	110	18.5	8.0	1.34 [1.24-1.45]	< 0.001	82	13.8	5.9	0.98 [0.92-1.05]	0.651
Denmark	68	13.2	10.1	0.95 [0.88-1.03]	0.201	430	83.7	63.9	1.06 [1.03-1.09]	< 0.001	16	3.1	2.4	1.02 [0.88-1.19]	0.781
Finland	136	78.2	21.0	0.96 [0.91-1.02]	0.191	23	13.2	3.6	1.03 [0.90-1.17]	0.704	15	8.6	2.3	0.93 [0.79-1.10]	0.387
France	2,293	52.4	26.5	0.95 [0.94-0.97]	< 0.001	1,857	42.4	21.5	1.04 [1.02-1.05]	< 0.001	230	5.3	2.7	0.98 [0.94-1.02]	0.269
Germany	2,033	63.4	27.0	0.91 [0.90-0.92]	< 0.001	979	30.5	13.0	1.02 [1.00-1.04]	0.062	194	6.1	2.6	0.93 [0.89-0.97]	0.002
Ireland	178	97.8	27.6	0.97 [0.91-1.02]	0.247	4	2.2	0.6	1.14 [0.77-1.69]	0.510	0	0.0	0.0	-	-
Italy	236	32.9	4.0	0.99 [0.95-1.03]	0.612	383	53.4	6.4	1.00 [0.97-1.04]	0.856	98	13.7	1.6	0.94 [0.88-1.00]	0.044
The Netherlands	154	43.3	7.8	0.95 [0.91-1.00]	0.066	133	37.4	6.7	1.08 [1.02-1.14]	0.005	69	19.4	3.5	1.02 [0.94-1.10]	0.668
Norway	139	83.2	21.2	0.93 [0.88-0.98]	0.006	21	12.6	3.2	1.32 [1.11-1.55]	0.001	7	4.2	1.1	1.01 [0.80-1.28]	0.915
Portugal	12	6.1	1.4	1.10 [0.91-1.34]	0.321	164	83.7	19.4	0.86 [0.80-0.91]	< 0.001	20	10.2	2.4	1.13 [0.95-1.34]	0.161
Spain	670	67.2	13.1	0.96 [0.93-0.98]	< 0.001	249	25.0	4.9	0.98 [0.94-1.02]	0.417	78	7.8	1.5	0.97 [0.91-1.05]	0.451
Sweden	214	46.9	17.5	1.00 [0.96-1.04]	0.917	233	51.1	19.1	1.00 [0.96-1.04]	0.920	9	2.0	0.7	1.08 [0.88-1.34]	0.458
United Kingdom	2,104	61.1	24.5	0.97 [0.96-0.98]	< 0.001	1,082	31.4	12.6	0.97 [0.95-0.99]	0.005	256	7.4	3.0	0.97 [0.94-1.01]	0.165
<b>Total</b>	<b>8,852</b>	<b>56.7</b>	<b>19.8</b>	<b>0.95 [0.94-0.95]</b>	<b>&lt; 0.001</b>	<b>5,675</b>	<b>36.3</b>	<b>12.7</b>	<b>1.02 [1.01-1.03]</b>	<b>&lt; 0.001</b>	<b>1,090</b>	<b>7.0</b>	<b>2.4</b>	<b>0.97 [0.95-0.99]</b>	<b>0.001</b>
Range	6.1-97.8 1.4-27.6					2.2-83.7 0.6-63.9					0.0-19.4 0.0-5.9				

\* R95, sudden infant death syndrome

\*\* R96-R99, unknown/unattended/unspecified cause

\*\*\* W75-W84, accidental threats to breathing

\*\*\*\* Per 100,000 live births

\*\*\*\*\* Coefficient of a Poisson regression model of the annual rate by calendar year; 95% CI: 95% confidence interval

SUDI, sudden unexpected death in infancy