BMJ Open

International comparisons of drowning mortality: intent-specific versus all-intents-combined

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-021501
Article Type:	Research
Date Submitted by the Author:	06-Jan-2018
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Keywords:	drowning, mortality, international comparisons

International comparisons of drowning mortality: intent-specific *versus* all-intents-combined

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ABSTRACT

Objective To compare the rankings of drowning mortality rates of the Organisation for Economic Co-operation and Development (OECD) countries according to intent-specific *versus* all-intents-combined.

Design A population-based cross-sectional study.

Setting 32 OECD countries.

Participants Population died from drowning

Main outcome measures Rankings of unintentional intent, intentional self-harm, assault, undetermined intent, and all-intent-combined drowning mortality rates (deaths per 100,000 population).

Results The proportions of various intents of drowning death were as follows: from 26.2% in Belgium to 96.8% in Chile for unintentional intent; 0.7% in Mexico to 57.4% in Belgium for intentional self-harm; 0.0% in nine countries to 4.9% in Mexico for assault; and 0.0% in Israel and Turkey to 38.3% in Austria for undetermined intent. Countries with the highest drowning mortality rates (deaths per 100000 population) were Estonia (3.53), Japan (3.49), and Greece (2.40) for unintentional intent; Ireland (0.96), Belgium (0.96), and Korea (0.89) for intentional self-harm; Austria (0.57), Korea (0.56), and Hungary (0.44) for undetermined intent; and Japan (4.35), Estonia (3.70), and Korea (2.73) for all-intents-combined. Korea ranked 12th and 3rd for unintentional intent and all-intents-combined, respectively. By contrast, Belgium ranked 2nd and 15th for intentional self-harm and all-intents-combined, respectively.

Conclusions The all-intents-combined approach in addition to intent-specific approach can provide a more complete picture of the drowning problem of a country.

Strengths and limitations of this study

- This study is the first study comparing drowning mortality rates according to intent-specific versus all-intent-combined, which can provide a more complete picture of drowning problem of a county.
- We combined mortality data for three years to ensure the statistical stability for comparisons.
- The criteria of classifying undetermined intent in each participating country was not available.

INTRODUCTION

An international comparison of injury mortality rates is crucial to identify the unique features of the injury problem of a given country. An international comparison of unintentional drowning mortality rates indicated that drowning rate rankings of different countries differed according to age groups; the countries with the highest drowning rates were Kyrgyzstan for 0–4 years, Thailand for 5–14 years, Guyana for 15–24 years, Belarus for 25–44 years, Lithuania for 45–64 years, and Japan for ≥65 years.[1] However, several studies have indicated country and regional variations in the determination of intent (manner of death), such as unintentional (accidents), intentional self-harm (suicides), assault (homicides), and events of undetermined intent, which could hinder valid international comparisons of injury mortality rates.[2–6]

To improve the comparability between countries and across years within a single country, some scholars have proposed considering all-intent-combined versus intent-specific injury deaths to reveal a more comprehensive picture of the injury problem.[7–10] Theory and evidence supporting the all-intents-combined approach indicate that passive protection strategies through modification of products (smart gun or adding unpleasant odours and colours in pesticides), environmental interventions (fence on the roofs of high buildings and locking of used pesticides), and lethal means restriction (gun control and banning the use of lethal pesticides) are highly effective in preventing not only unintentional injuries but also intentional injuries.[11–15] The all-intents-combined approach has been used for the early identification of emerging drug-related poisoning problems in the United States and the drowning problem in Finland.[16-21] However, no study thus far has used the

all-intents-combined approach to examine international variations in drowning mortality. In this study, we compared the rankings of intent-specific and all-intents-combined drowning mortality of countries of the Organisation for Economic Co-operation and Development (OECD).

METHODS

Drowning mortality data of the OECD countries were extracted from the World Health Organization Cause of Death Query Online.[22] To ensure statistical stability in calculating the mortality rates, we combined data for latest available three years for international comparisons. The International Classification of Diseases Tenth Revision (ICD-10) codes for drowning mortality of different intents are ICD-10 codes W65-W74 for unintentional intent (accident), ICD-10 code X71 for intentional self-harm (suicide), ICD-10 code X92 for assault (homicide), and ICD-10 code Y21 for undetermined intent. We first computed the proportion of each intent for each country. We then calculated the undetermined intent/intentional self-harm ratio and all-intents-combined/ unintentional intent ratio for each country. Next, age-adjusted mortality rates (deaths per 100000 population) were calculated using the US 2000 age structure 0–14, 25–24, 25–44, 45–64, 65–74, and >75 years as standard. Rankings of the drowning rates of a country for each intent and all-intents-combined were illustrated using a bar chart.

RESULTS

The number and proportion of each intent for the drowning mortality of different countries are

presented in Table 1 and Figure 1. The percentage of unintentional intent ranged from 26.2% in Belgium to 96.8% in Chile. The proportion of intentional self-harm ranged from 0.7% in Mexico to 57.4% in Belgium, indicating a considerably large variation. The percentage of assault was less than 1.0% in most countries except Mexico (4.9%) and Slovenia (1.5%). We also found a large variation in undetermined intent, from 0.0% in Israel and Turkey to 38.3% in Austria. Of the 32 OECD countries included in the study, 10 had an undetermined intent proportion of less than 3% and 8 had a proportion of more than 15%. The undetermined intent/intentional self-harm ratio (an indicator of underreported suicide) was highest in Mexico (12.35, 593/48) and Poland (7.53, 444/59). The all-intents-combined/unintentional intent ratio was highest in Belgium (3.82, 687/180) and Austria (3.46, 446/129).

Countries with the highest drowning mortality rate (deaths per 100000 population) were Estonia (3.53), Japan (3.49), and Greece (2.40) for unintentional intent (Figure 2); Ireland (0.96), Belgium (0.96), and Korea (0.89) for intentional self-harm (Figure 3); Austria (0.57), Korea (0.56), and Hungary (0.44) for undetermined intent (Figure 4); and Japan (4.35), Estonia (3.70), and Korea (2.73) for all-intents-combined (Figure 5). Korea ranked 12th and 3rd for unintentional intent and all-intents-combined, respectively. By contrast, Belgium ranked 2nd and 15th for intentional self-harm and all-intents-combined, respectively.

DISCUSSION

The findings of this study, which are consistent with those of previous studies,[2–6] indicate a large

variation in the practice of classifying the undetermined intent of drowning deaths across countries; this variation hinders valid international comparisons of intent-specific (unintentional and intentional self-harm) drowning mortality rates. Korea and Belgium exhibited the largest variations in ranking when ranked according to the intent-specific approach and the all-intents-combined approach.

According to a study involving eight European countries, a legal inquiry is compulsory for every injury death in each participating country, and the inquiry is most commonly executed by legal authorities. However, differences in the classification practices (such as the efficiency of communication between the medical and legal authorities involved in suicide registration, the percentage of bodies of injury death performing forensic autopsies, level of medical training of the coders, and availability of inquiry results and forensic autopsy results to the final cause-of-death decision-maker) in different countries result in variations in the proportion of deaths classified as undetermined intent. The undetermined intent/suicide ratio was highest in Portugal during 2000–2004 (0.78) and lowest in Austria during 2003–2007 (0.07).[2] In this study, we found eight countries (Austria, Czech Republic, Hungary, Japan, Mexico, Poland, Slovenia, and UK) with an undetermined intent/suicide ratio of more than 1; this could adversely affect the comparability of intentional self-harm drowning mortality rates across countries.

With regard to the determination of intent (manner of death) of drowning death, 'unintentional intent' could be the assigned intent when witnesses were present during the drowning incident (e.g. children swimming or young people surfing in recreational water environments). By contrast, the

intent 'intentional self-harm' could be assigned if witnesses were present when someone intentionally and voluntarily jumped off a bridge into a river. However, determining the intent of drowning for a body found in water is difficult. According to a study conducted by Lunetta et al, of 1707 bodies that were found in water and were autopsied at the Department of Forensic Medicine, University of Helsinki from 1976 to 2000, 276 (16.2%) cases were assigned undetermined intent. Of 757 cases initially thought to be accidents by police investigators, pathologists involved with the autopsies agreed in 79.4% of the cases, whereas for suicide, homicide, and undetermined intent, the pathologists agreed in only 76.9%, 39.5%, and 18.7% of the cases, respectively.[23]

Because determining the intent of injury is difficult and because accumulated evidence suggests that environmental interventions could prevent not only unintentional injuries but also intentional injuries, counting injury deaths by using the all-intents-combined approach to identify all injury deaths with the same mechanism is recommended.[7-10] For example, in the United States, poisoning (n = 31116) was the second leading injury mechanism followed by motor vehicular accidents (n = 37985) in 2008, when the count was restricted to only unintentional intent. However, when we the all-intents-combined approach was used, poisoning (n = 41080) became the first leading injury mechanism and superseded motor vehicular accidents (n = 37985) in 2008.[20] According to the findings of this study (Table 1), 12348 drowning deaths were identified using the all-intents-combined approach, which suggests that the use of this approach could identify 20% more drowning deaths (n = 2108) than did the use of only the unintentional intent approach (n = 10240).

Environmental interventions, such as the provision of effective lifeguard supervision and rescue services, and the establishment of different recreation zones for different recreational activities by using lines, buoys, and markers can prevent unintentional drowning.[24] Because many intentional self-harm drownings were executed by jumping off a bridge, a systematic review suggested that restricting access to these means by installing physical barriers can avert suicides at hot spots (such as Grafton Bridge, Auckland, New Zealand; Clifton Suspension Bridge, Bristol, United Kingdom; Ellington Bridge, Washington DC, United States) without substitution effects.[25]

Strengths and limitations of this study

The strength of this study is that it is the first to compare both intent-specific and all-intents-combined drowning mortality across countries. However, several limitations should be considered while interpreting the findings of this study. First, we did not include water transport accidents (ICD-10 codes V90-V94) in this study because of the small number of deaths resulting from these accidents in most countries. Second, unlike unintentional drowning (ICD-10 codes W65-W74), which provides detailed information on the body of water (bathtub, swimming pool, or natural water body) and the mechanism of drowning (while in water versus following fall into water), no such information are available in intentional self-harm (ICD-10 code X71), assault (ICD-10 code X92), and undetermined intent (ICD-10 code Y21). Therefore, we could not further analyse the body of water and mechanisms of drowning involved in intentional drowning. Third, we could not determine whether the considerably large variations in intentional self-harm drowning

mortality rates across countries were caused by actual differences in suicide rates or by differences in classifying undetermined intent.

CONCLUSIONS

The rankings of a country with regard to drowning mortality rates differ depending on whether the all-intents-combined approach or the intent-specific approach is used. We suggest that presenting an international comparison of drowning mortality using both approaches provides a more complete picture of the injury problem of each participating country.

Acknowledgement The authors thank Ms. Pai-Huan Lin for data analysis.

Contributors WHH collected data and performed analysis and drafted and revised the manuscript. CHW participated the interpretation of results and drafted and revised the manuscript. THL initiated the idea and participated the interpretation of results and drafted and revised the manuscript and supervised the study and is the guarantor.

Funding None

Competing interests The authors have no competing interests to declare.

Ethics approval This study was approved by the Institutional Review Boards of Chi-Mei Medical Center (10406-003) and TzuChi Hospital (104-67-B).

Data sharing: No additional data available.

Transparency statement: The corresponding author confirms that the manuscript is an honest, accurate, and transparent account of the study being reported; no crucial aspects of the study have been omitted; and all discrepancies are disclosed.

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Table 1. The number and proportion of each intent in drowning mortality in each OECD country

	(1) All-intents-combined		(2) Unintentional		(3) Intentional self-harm		(4) Assault		(5) Undetermined intent			
Country, data year	No.	%	No.	%	No.	%	No.	%	No.	%	(5)/(3)	(1)/(2)
Australia, 2012-14	793	100.0	591	74.5	156	19.7	5	0.6	41	5.2	0.26	1.34
Austria, 2012-14	446	100.0	129	28.9	146	32.7	0	0.0	171	38.3	1.17	3.46
Belgium, 2012-14	687	100.0	180	26.2	394	57.4	7	1.0	106	15.4	0.27	3.82
Canada, 2010-12	1241	100.0	840	67.7	301	24.3	9	0.7	91	7.3	0.30	1.48
Chile, 2012-14	1022	100.0	989	96.8	28	2.7	5	0.5	0	0.0	0.00	1.03
Czech Republic, 2013-15	627	100.0	484	77.2	63	10.0	2	0.3	78	12.4	1.24	1.30
Denmark, 2012-14	205	100.0	97	47.3	94	45.9	1	0.5	13	6.3	0.14	2.11
Estonia, 2012-14	161	100.0	153	95.0	5	3.1	0	0.0	3	1.9	0.60	1.05
Finland, 2012-14	510	100.0	332	65.1	117	22.9	3	0.6	58	11.4	0.50	1.54
France, 2011-13	4147	100.0	2818	68.0	1277	30.8	11	0.3	41	1.0	0.03	1.47
Germany, 2012-14	2295	100.0	1271	55.4	752	32.8	6	0.3	266	11.6	0.35	1.81
Greece, 2014	363	100.0	349	96.1	10	2.8	0	0.0	4	1.1	0.40	1.04
Hungary, 2013-15	651	100.0	372	57.1	127	19.5	3	0.5	149	22.9	1.17	1.75
Ireland, 2011-13	348	100.0	159	45.7	133	38.2	1	0.3	55	15.8	0.41	2.19
Israel, 2012-14	155	100.0	148	95.5	7	4.5	0	0.0	0	0.0	0.00	1.05
Italy, 2010-12	1668	100.0	1124	67.4	534	32.0	8	0.5	2	0.1	0.00	1.48
Japan, 2012-14	27383	100.0	22940	83.8	2166	7.9	10	0.0	2267	8.3	1.05	1.19
Korea, 2011-13	4337	100.0	1980	45.7	1441	33.2	14	0.3	902	20.8	0.63	2.19
Mexico, 2012-14	6970	100.0	5990	85.9	48	0.7	339	4.9	593	8.5	12.35	1.16
Netherlands, 2013-15	585	100.0	244	41.7	327	55.9	2	0.3	12	2.1	0.04	2.40
New Zealand, 2010-12	211	100.0	175	82.9	29	13.7	2	0.9	5	2.4	0.17	1.21
Norway, 2012-14	265	100.0	171	64.5	89	33.6	0	0.0	5	1.9	0.06	1.55
Poland, 2012-14	3005	100.0	2502	83.3	59	2.0	0	0.0	444	14.8	7.53	1.20

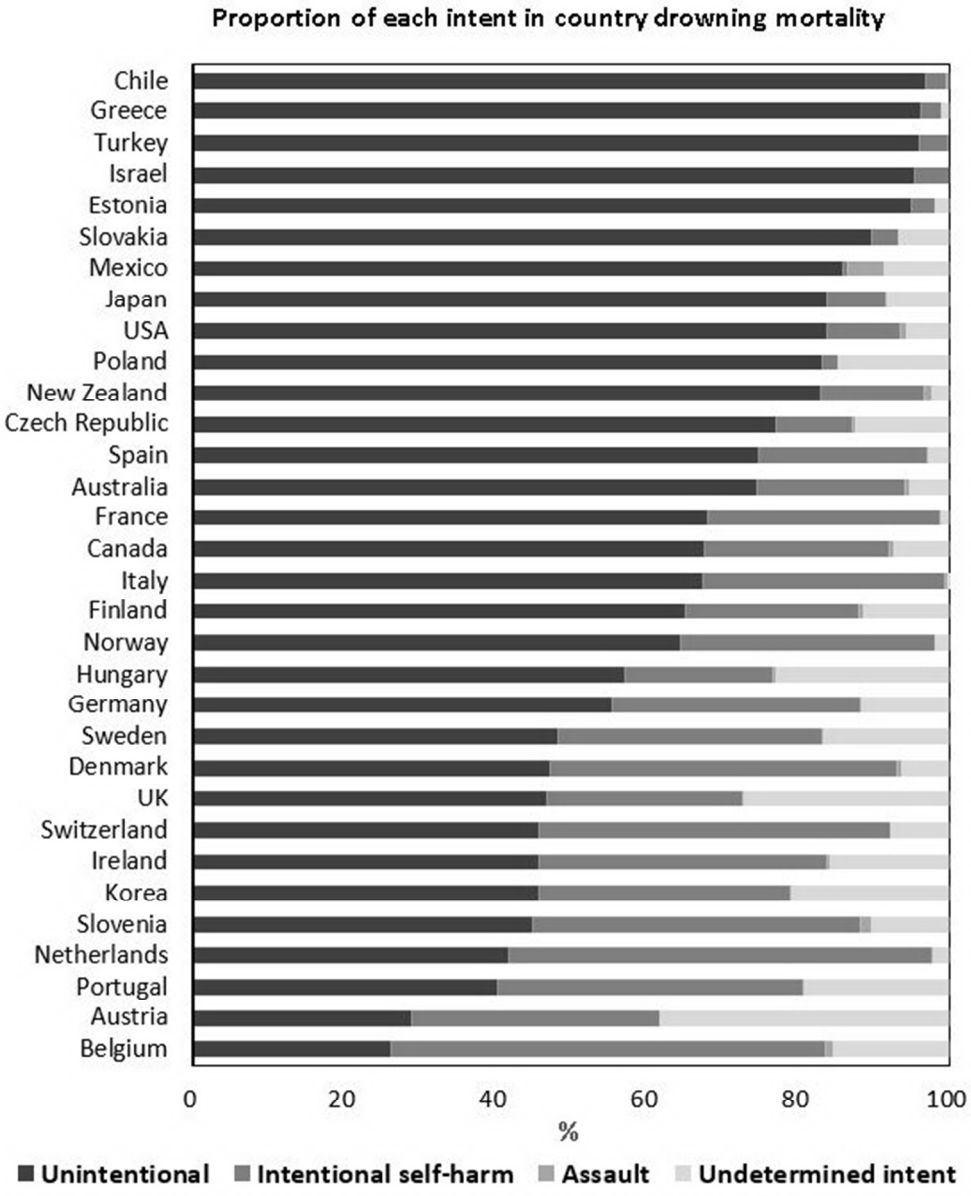

Figure 1. Proportion of intents in drowning mortality in each OECD country.

164x199mm (96 x 96 DPI)

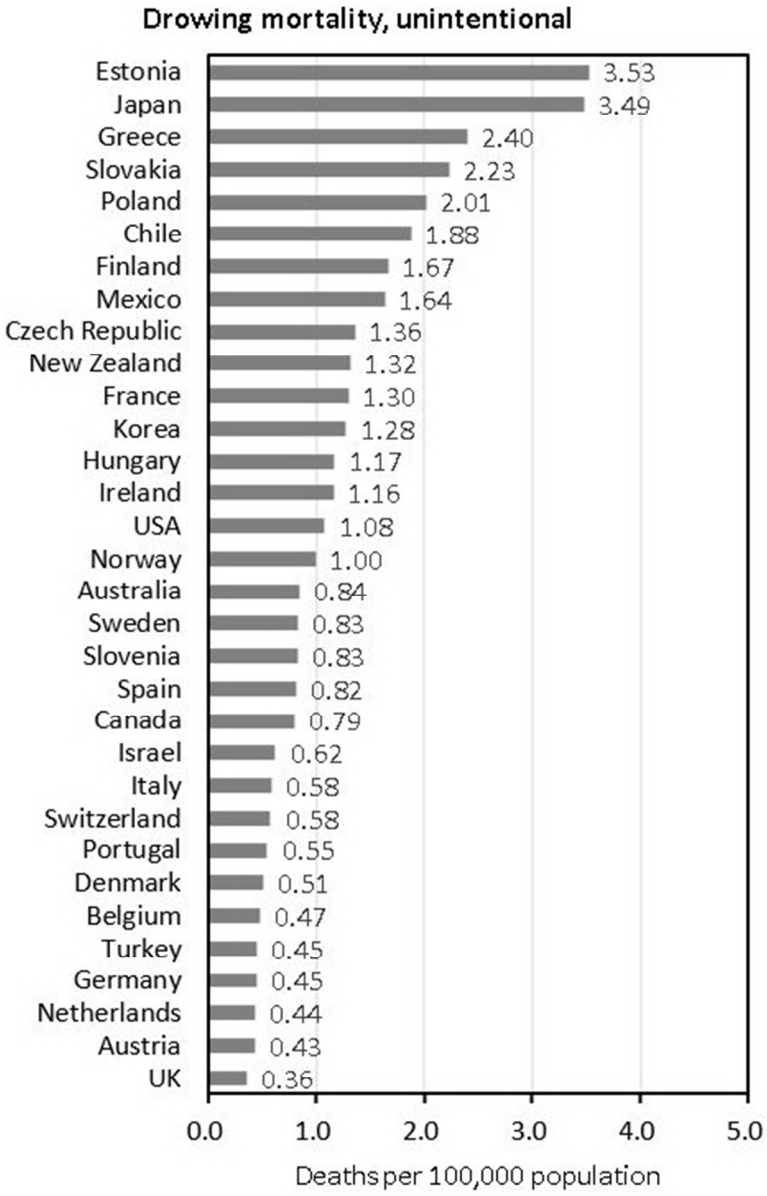

Figure 2 Unintentional drowning mortality in each OECD country.

129x193mm (96 x 96 DPI)

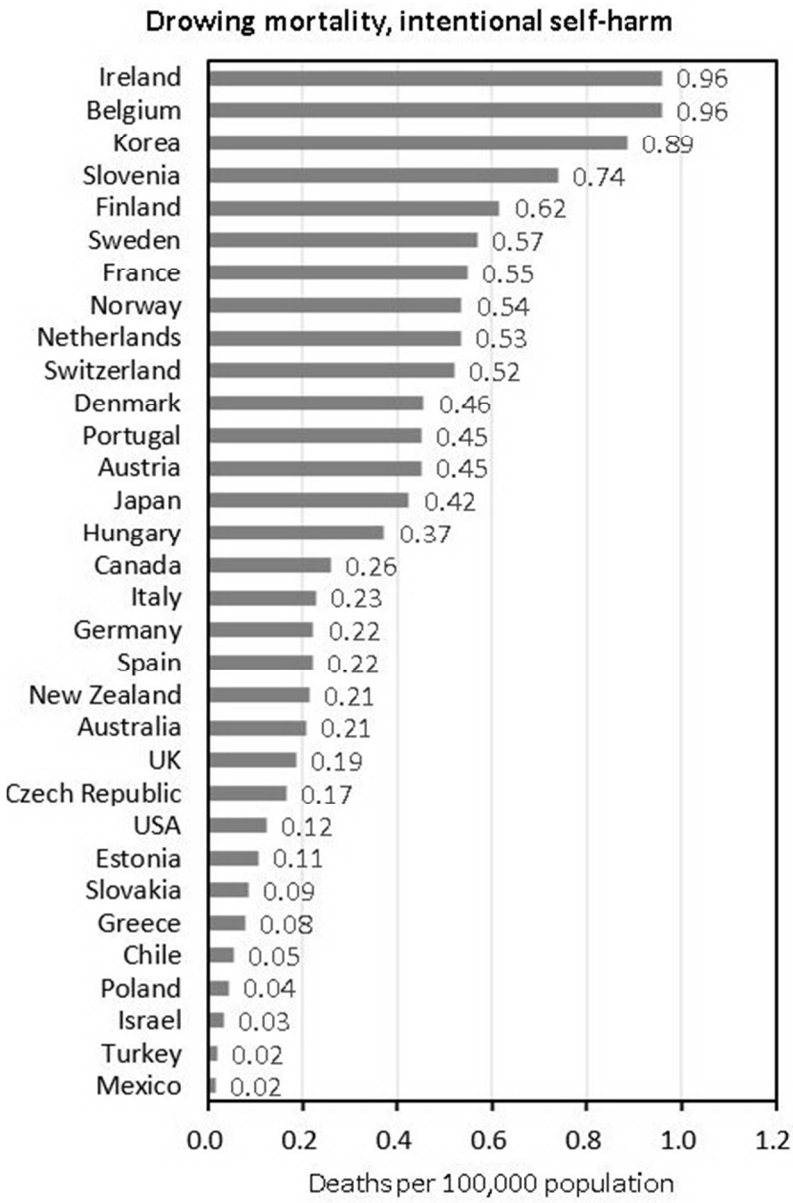

Figure 3 Intentional self-harm (suicide) drowning mortality in each OECD country.

128x192mm (96 x 96 DPI)

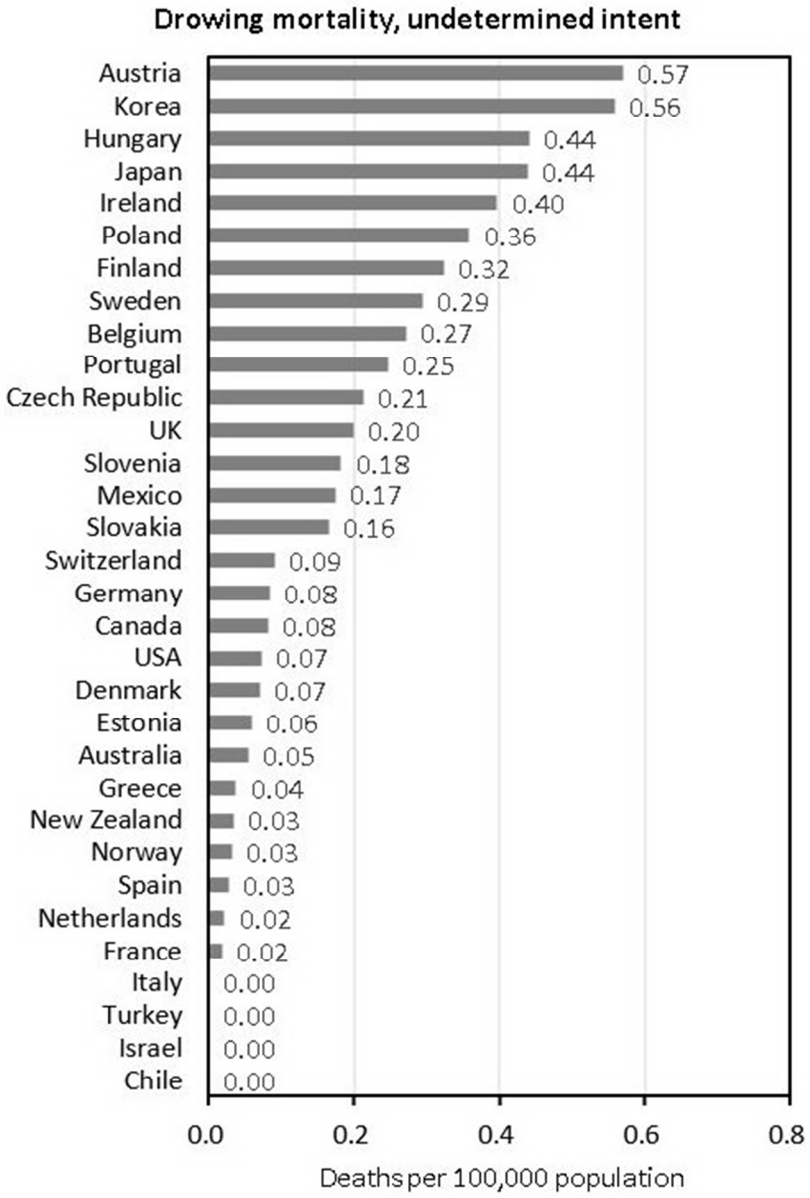

Figure 4 Undetermined intent drowning mortality in each OECD country.

136x193mm (96 x 96 DPI)

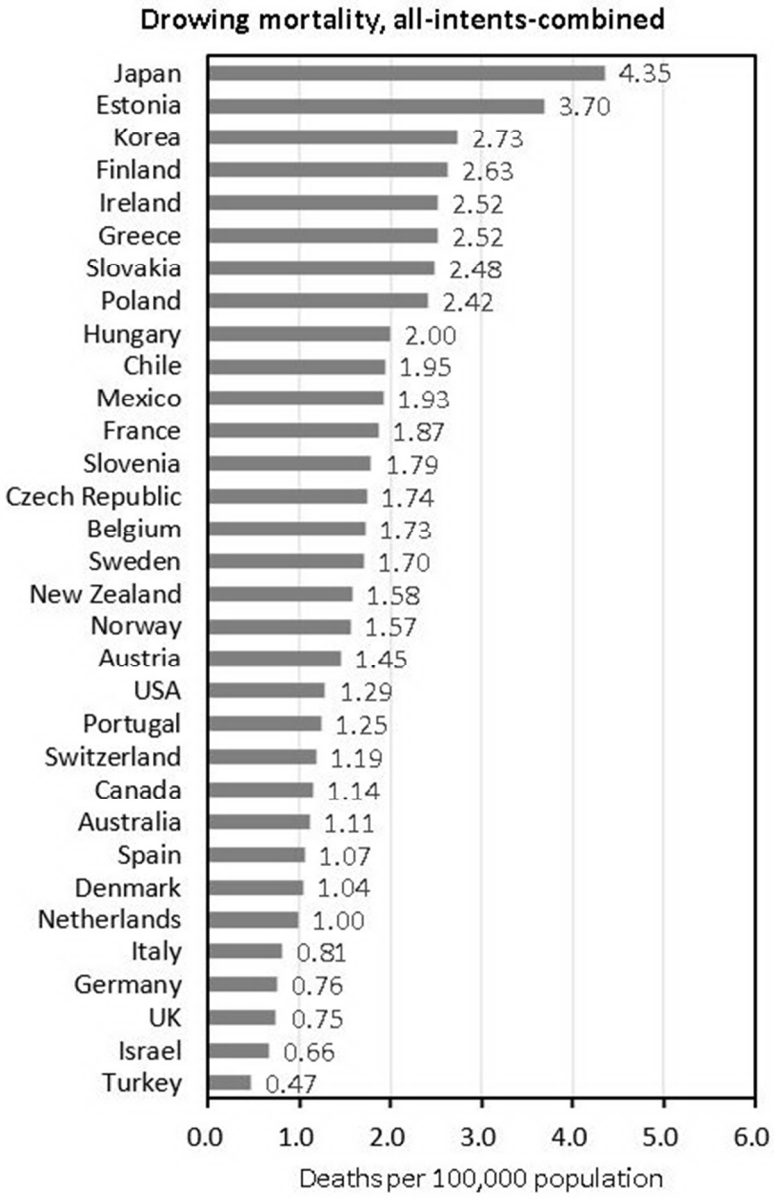

Figure 5 All-intents-combined drowning mortality in each OECD country.

129x193mm (96 x 96 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	10
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	NA
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	No
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	NA
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	No

		(*b*) Report category boundaries when continuous variables were categorized	No
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	No
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	No
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9
Generalisability	21	Discuss the generalisability (external validity) of the study results	9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-021501.R1
Article Type:	Research
Date Submitted by the Author:	27-Mar-2018
Complete List of Authors:	Hsieh, Wanhua; Tzu Chi University, Department of Public Health Wang, Chien-Hsing ; Buddhist Tzu Chi General Hospital, Department of Surgery and Trauma Center Lu, Tsung-Hsueh; Institute of Public Health, National Cheng Kung University
Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Public health
Keywords:	drowning, mortality, international comparisons

Drowning mortality by intent: a population-based cross-sectional study of 32 OECD countries, 2012–2014

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ABSTRACT

Objective To compare the drowning mortality rates and proportion of deaths of each intent among all drowning deaths of the Organisation for Economic Co-operation and Development (OECD) countries, 2012-2014.

Design A population-based cross-sectional study.

Setting 32 OECD countries.

Participants Population died from drowning

Main outcome measures Drowning mortality rates (deaths per 100,000 population) and proportion (%) of deaths of each intent (i.e., unintentional intent, intentional self-harm, assault, undetermined intent, and all-intent-combined) among all drowning deaths.

Results Countries with the highest drowning mortality rates (deaths per 100000 population) were Estonia (3.53), Japan (3.49), and Greece (2.40) for unintentional intent; Ireland (0.96), Belgium (0.96), and Korea (0.89) for intentional self-harm; Austria (0.57), Korea (0.56), and Hungary (0.44) for undetermined intent; and Japan (4.35), Estonia (3.70), and Korea (2.73) for all-intents-combined. Korea ranked 12th and 3rd for unintentional intent and all-intents-combined, respectively. By contrast, Belgium ranked 2nd and 15th for intentional self-harm and all-intents-combined, respectively. The proportion of deaths of each intent among all drowning deaths in each country varied greatly: from 26.2% in Belgium to 96.8% in Chile for unintentional intent; 0.7% in Mexico to 57.4% in Belgium for intentional self-harm; 0.0% in nine countries to 4.9% in Mexico for assault; and 0.0% in Israel and Turkey to 38.3% in Austria for undetermined intent.

Conclusions A large variation in the practice of classifying the undetermined intent of drowning deaths across countries was noted and this variation hinders valid international comparisons of intent-specific (unintentional and intentional self-harm) drowning mortality rates.

Strengths and limitations of this study

- This study is the first study comparing drowning mortality rates according to intent-specific versus all-intent-combined, which can provide a more complete picture of drowning problem of a county.
- We combined mortality data for three years to ensure the statistical stability for comparisons.
- The criteria of classifying undetermined intent in each participating country was not available.

INTRODUCTION

An international comparison of injury mortality rates is crucial to identify the unique features of the injury problem of a given country. An international comparison of unintentional drowning mortality rates indicated that drowning rate rankings of different countries differed according to age groups; the countries with the highest drowning rates were Kyrgyzstan for 0–4 years, Thailand for 5–14 years, Guyana for 15–24 years, Belarus for 25–44 years, Lithuania for 45–64 years, and Japan for ≥65 years.[1] However, several studies have indicated country and regional variations in the determination of intent (manner of death), such as unintentional (accidents), intentional self-harm (suicides), assault (homicides), and events of undetermined intent, which could hinder valid international comparisons of injury mortality rates.[2–6]

To improve the comparability between countries and across years within a single country, some scholars have proposed considering all-intent-combined versus intent-specific injury deaths to reveal a more comprehensive picture of the injury problem.[7–10] Theory and evidence supporting the all-intents-combined approach indicate that passive protection strategies through modification of products (smart gun or adding unpleasant odours and colours in pesticides), environmental interventions (fence on the roofs of high buildings and locking of used pesticides), and lethal means restriction (gun control and banning the use of lethal pesticides) are highly effective in preventing not only unintentional injuries but also intentional injuries.[11–15] The all-intents-combined approach has been used for the early identification of emerging drug-related poisoning problems in the United States and the drowning problem in Finland.[16-21] However, no study thus far has used the

all-intents-combined approach to examine international variations in drowning mortality. In this study, we compared the drowning mortality rates and proportion of deaths of each intent among all drowning deaths of the Organisation for Economic Co-operation and Development (OECD) countries.

METHODS

Study design and setting

This study is a population-based descriptive cross-sectional study of 32 OECD countries.

Data source

The population and drowning mortality data of 32 OECD countries were extracted from the World Health Organization Cause of Death Query Online.[22] To ensure statistical stability in calculating the drowning mortality rates, we combined available data from the latest 3 years. Both numerator (drowning deaths) and denominator (number of population) were combined for three years. The latest available year of mortality data differed across countries. For example, as of April 30, 2017, the latest 3 years were 2013–2015 for 5 countries and 2012–2014 for 16 countries.

Measures

The International Classification of Diseases Tenth Revision (ICD-10) codes for drowning mortality of different intents are ICD-10 codes W65-W74 for unintentional intent (accident), ICD-10 code X71 for intentional self-harm (suicide), ICD-10 code X92 for assault (homicide), and ICD-10 code Y21 for undetermined intent.

Statistical analyses

We first calculated the age-standardized mortality rates (deaths per 100000 population) of each intent for each country using the US 2000 age structure 0–14, 25–24, 25–44, 45–64, 65–74, and >75 years as standard. We used bar charts to represent the variations and rankings in drowning mortality rates by intent across countries.

We then computed the proportion of deaths of each intent among all drowning deaths for each country grouped by region. The classification of country by region was based on the Global Burden of Disease study.[23] To demonstrate the extent of variations in death certification practices we calculated undetermined intent/intentional self-harm ratio and all-intents-combined/ unintentional intent ratio for each country. The proportion of each intent of each country was illustrated by stacked bar chart.

Patient and Public Involvement

This study used secondary administrative data, so no patients involved in the development of the research question and outcome measures informed by patients' priorities, experience, and preferences; in the design of this study; in the recruitment to and conduct of the study.

RESULTS

Intent-specific mortality rates

Countries with the highest drowning mortality rate (deaths per 100000 population) were Estonia (3.53), Japan (3.49), and Greece (2.40) for unintentional intent (Figure 1); Ireland (0.96), Belgium

(0.96), and Korea (0.89) for intentional self-harm (Figure 2); Austria (0.57), Korea (0.56), and Hungary (0.44) for undetermined intent (Figure 3); and Japan (4.35), Estonia (3.70), and South Korea (2.73) for all-intents-combined (Figure 4). South Korea ranked 12th and 3rd for unintentional intent and all-intents-combined, respectively. By contrast, Belgium ranked 2nd and 15th for intentional self-harm and all-intents-combined, respectively.

Proportion of drowning deaths by intent

The number and proportion of each intent among drowning deaths for each country by region are presented in Table 1 and Figure 5. The percentage of unintentional intent ranged from 26.2% in Belgium to 96.8% in Chile. The proportion of intentional self-harm ranged from 0.7% in Mexico to 57.4% in Belgium, indicating a considerably large variation. The percentage of assault was less than 1.0% in most countries except Mexico (4.9%) and Slovenia (1.5%). We also found a large variation in undetermined intent, from 0.0% in Israel and Turkey to 38.3% in Austria.

Of the 32 OECD countries included in the study, 10 had an undetermined intent proportion of less than 3% and 8 had a proportion of more than 15%. The undetermined intent/intentional self-harm ratio (an indicator of underreported suicide) was highest in Mexico (12.35, 593/48) and Poland (7.53, 444/59). Four out of five Central Europe countries had undetermined intent/ intentional self-harm ratio larger than 1, suggesting relatively high proportion in reporting undetermined intent in Central European countries. On the other hand, the all-intents-combined/unintentional intent ratio was highest in Belgium (3.82, 687/180) and Austria (3.46, 446/129). Of 11 countries with all-intents-combined/ unintentional intent ratio larger than 2, 8

of them were in Western Europe countries.

DISCUSSION

The findings of this study indicate different rankings of drowning mortality rates by intent, which might be due to large variations in proportion in reporting undetermined intent and intentional self-harm among all drowning deaths across countries. This study suggests that the drowning related death certification practices associate with region of the countries. Countries in Central Europe had higher proportion in reporting undetermined intent and countries in Western Europe had higher proportion in reporting intentional self-harm.

According to a previous study involving eight European countries on certification practices, a legal inquiry is compulsory for every injury death in each participating country, and the inquiry is most commonly executed by legal authorities. However, differences in the classification practices (such as the efficiency of communication between the medical and legal authorities involved in suicide registration, the percentage of bodies of injury death performing forensic autopsies, level of medical training of the coders, and availability of inquiry results and forensic autopsy results to the final cause-of-death decision-maker) in different countries result in variations in the proportion of deaths classified as undetermined intent. In that study, the undetermined intent/suicide ratio was highest in Portugal during 2000–2004 (0.78) and lowest in Austria during 2003–2007 (0.07).[2]

In this study, we found 8 countries (Japan, Austria, UK, Czech Republic, Hungary, Poland, Slovakia, and Mexico) with an undetermined intent/suicide ratio of more than 1. Four out of five

countries in Central Europe had undetermined intent/suicide ratio of more than 1, which indicated similar certification practices among medical examiners coroners in this region. We also found 8 out of 11 countries with high all-intents-combined/unintentional intent ratio were countries in Western Europe region. One possible explanation was the high proportion in intentional self-harm drowning deaths in this region.

With regard to the determination of intent (manner of death) of drowning death, 'unintentional intent' could be the assigned intent when witnesses were present during the drowning incident (e.g. children swimming or young people surfing in recreational water environments). By contrast, the intent 'intentional self-harm' could be assigned if witnesses were present when someone intentionally and voluntarily jumped off a bridge into a river. However, determining the intent of drowning for a body found in water is difficult. According to a study conducted by Lunetta et al, of 1707 bodies that were found in water and were autopsied at the Department of Forensic Medicine, University of Helsinki from 1976 to 2000, 276 (16.2%) cases were assigned undetermined intent. Of 757 cases initially thought to be accidents by police investigators, pathologists involved with the autopsies agreed in 79.4% of the cases, whereas for suicide, homicide, and undetermined intent, the pathologists agreed in only 76.9%, 39.5%, and 18.7% of the cases, respectively.[24]

Because determining the intent of injury is difficult and because accumulated evidence suggests that environmental interventions could prevent not only unintentional injuries but also intentional injuries, counting injury deaths by using the all-intents-combined approach to identify all injury deaths with the same mechanism is recommended.[7-10] For example, in the United States,

poisoning (n = 31116) was the second leading injury mechanism followed by motor vehicular accidents (n = 37985) in 2008, when the count was restricted to only unintentional intent. However, when we the all-intents-combined approach was used, poisoning (n = 41080) became the first leading injury mechanism and superseded motor vehicular accidents (n = 37985) in 2008.[20] According to the findings of this study (Table 1), 12348 drowning deaths were identified using the all-intents-combined approach, which suggests that the use of this approach could identify 20% more drowning deaths (n = 2108) than did the use of only the unintentional intent approach (n = 10240).

Strengths and limitations of this study

The strength of this study is that it is the first to compare both intent-specific and all-intents-combined drowning mortality across countries. However, several limitations should be considered while interpreting the findings of this study. First, we did not include water transport accidents (ICD-10 codes V90-V94) in this study because of the small number of deaths resulting from these accidents in most countries. Second, unlike unintentional drowning (ICD-10 codes W65-W74), which provides detailed information on the body of water (bathtub, swimming pool, or natural water body) and the mechanism of drowning (while in water versus following fall into water), no such information are available in intentional self-harm (ICD-10 code X71), assault (ICD-10 code X92), and undetermined intent (ICD-10 code Y21). Therefore, we could not further analyse the body of water and mechanisms of drowning involved in intentional drowning. Third, we

could not determine whether the considerably large variations in intentional self-harm drowning mortality rates across countries were caused by actual differences in suicide rates or by differences in classifying undetermined intent.

CONCLUSIONS

The rankings of a country with regard to drowning mortality rates differ depending on whether the all-intents-combined approach or the intent-specific approach is used. The findings of this study indicate a large variation in the practice of classifying the undetermined intent of drowning deaths across countries and this variation hinders valid international comparisons of intent-specific (unintentional and intentional self-harm) drowning mortality rates.

Acknowledgement The authors thank Ms. Pai-Huan Lin for data analysis.

Contributors WHH collected data and performed analysis and drafted and revised the manuscript. CHW participated the interpretation of results and drafted and revised the manuscript. THL initiated the idea and participated the interpretation of results and drafted and revised the manuscript and supervised the study and is the guarantor.

Funding None

Competing interests The authors have no competing interests to declare.

Ethics approval This study was approved by the Institutional Review Boards of Chi-Mei Medical Center (10406-003) and TzuChi Hospital (104-67-B).

Data sharing: Please contact corresponding author.

Transparency statement: The corresponding author confirms that the manuscript is an honest, accurate, and transparent account of the study being reported; no crucial aspects of the study have been omitted; and all discrepancies are disclosed.

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Table 1. The number and proportion of each intent in drowning mortality in each OECD country

Region	(1) All-intents-combined		(2) Unintentional		(3) Intentional self-harm		(4) Assault		(5) Undetermined intent			
Country, data year	No.	%	No.	%	No.	%	No.	%	No.	%	(5)/(3)	(1)/(2)
High-income North America												
Canada, 2010-12	1241	100.0	840	67.7	301	24.3	9	0.7	91	7.3	0.30	1.48
USA, 2012-14	12348	100.0	10340	83.7	1200	9.7	109	0.9	699	5.7	0.58	1.19
Australasia												
Australia, 2012-14	793	100.0	591	74.5	156	19.7	5	0.6	41	5.2	0.26	1.34
New Zealand, 2010-12	211	100.0	175	82.9	29	13.7	2	0.9	5	2.4	0.17	1.21
High-income Asia Pacific												
Japan, 2012-14	27383	100.0	22940	83.8	2166	7.9	10	0.0	2267	8.3	1.05	1.19
South Korea, 2011-13	4337	100.0	1980	45.7	1441	33.2	14	0.3	902	20.8	0.63	2.19
Western Europe												
Austria, 2012-14	446	100.0	129	28.9	146	32.7	0	0.0	171	38.3	1.17	3.46
Belgium, 2012-14	687	100.0	180	26.2	394	57.4	7	1.0	106	15.4	0.27	3.82
Denmark, 2012-14	205	100.0	97	47.3	94	45.9	1	0.5	13	6.3	0.14	2.11
Finland, 2012-14	510	100.0	332	65.1	117	22.9	3	0.6	58	11.4	0.50	1.54
France, 2011-13	4147	100.0	2818	68.0	1277	30.8	11	0.3	41	1.0	0.03	1.47
Germany, 2012-14	2295	100.0	1271	55.4	752	32.8	6	0.3	266	11.6	0.35	1.81
Greece, 2014	363	100.0	349	96.1	10	2.8	0	0.0	4	1.1	0.40	1.04
Ireland, 2011-13	348	100.0	159	45.7	133	38.2	1	0.3	55	15.8	0.41	2.19
Israel, 2012-14	155	100.0	148	95.5	7	4.5	0	0.0	0	0.0	0.00	1.05
Italy, 2010-12	1668	100.0	1124	67.4	534	32.0	8	0.5	2	0.1	0.00	1.48
Netherlands, 2013-15	585	100.0	244	41.7	327	55.9	2	0.3	12	2.1	0.04	2.40
Norway, 2012-14	265	100.0	171	64.5	89	33.6	0	0.0	5	1.9	0.06	1.55
Portugal, 2011-13	472	100.0	190	40.3	191	40.5	1	0.2	90	19.1	0.47	2.48

Spain, 2012-14	1730	100.0	1294	74.8	385	22.3	4	0.2	47	2.7	0.12	1.34
Sweden, 2013-15	594	100.0	287	48.3	207	34.8	1	0.2	99	16.7	0.48	2.07
Switzerland, 2011-13	337	100.0	154	45.7	157	46.6	0	0.0	26	7.7	0.17	2.19
UK, 2011-13	1529	100.0	714	46.7	398	26.0	2	0.1	415	27.1	1.04	2.14
Eastern Europe												
Estonia, 2012-14	161	100.0	153	95.0	5	3.1	0	0.0	3	1.9	0.60	1.05
Central Europe												
Czech Republic, 2013-15	627	100.0	484	77.2	63	10.0	2	0.3	78	12.4	1.24	1.30
Hungary, 2013-15	651	100.0	372	57.1	127	19.5	3	0.5	149	22.9	1.17	1.75
Poland, 2012-14	3005	100.0	2502	83.3	59	2.0	0	0.0	444	14.8	7.53	1.20
Slovakia, 2012-14	434	100.0	389	89.6	16	3.7	0	0.0	29	6.7	1.81	1.12
Slovenia, 2013-15	136	100.0	61	44.9	59	43.4	2	1.5	14	10.3	0.24	2.23
Latin America												
Chile, 2012-14	1022	100.0	989	96.8	28	2.7	5	0.5	0	0.0	0.00	1.03
Mexico, 2012-14	6970	100.0	5990	85.9	48	0.7	339	4.9	593	8.5	12.35	1.16
Middle East												
Turkey, 2011-13	1061	100.0	1018	95.9	41	3.9	2	0.2	0	0.0	0.00	1.04

Data source: World Health Organization Cause of Death Query Online (http://apps.who.int/healthinfo/statistics/mortality/causeofdeath_query/)

Figure legends

Figure 1 Unintentional drowning mortality in each OECD country.

Figure 2 Intentional self-harm (suicide) drowning mortality in each OECD country.

Figure 3 Undetermined intent drowning mortality in each OECD country.

Figure 4 All-intents-combined drowning mortality in each OECD country.

Figure 5. Proportion of deaths of each intent among all drowning deaths in each OECD country.

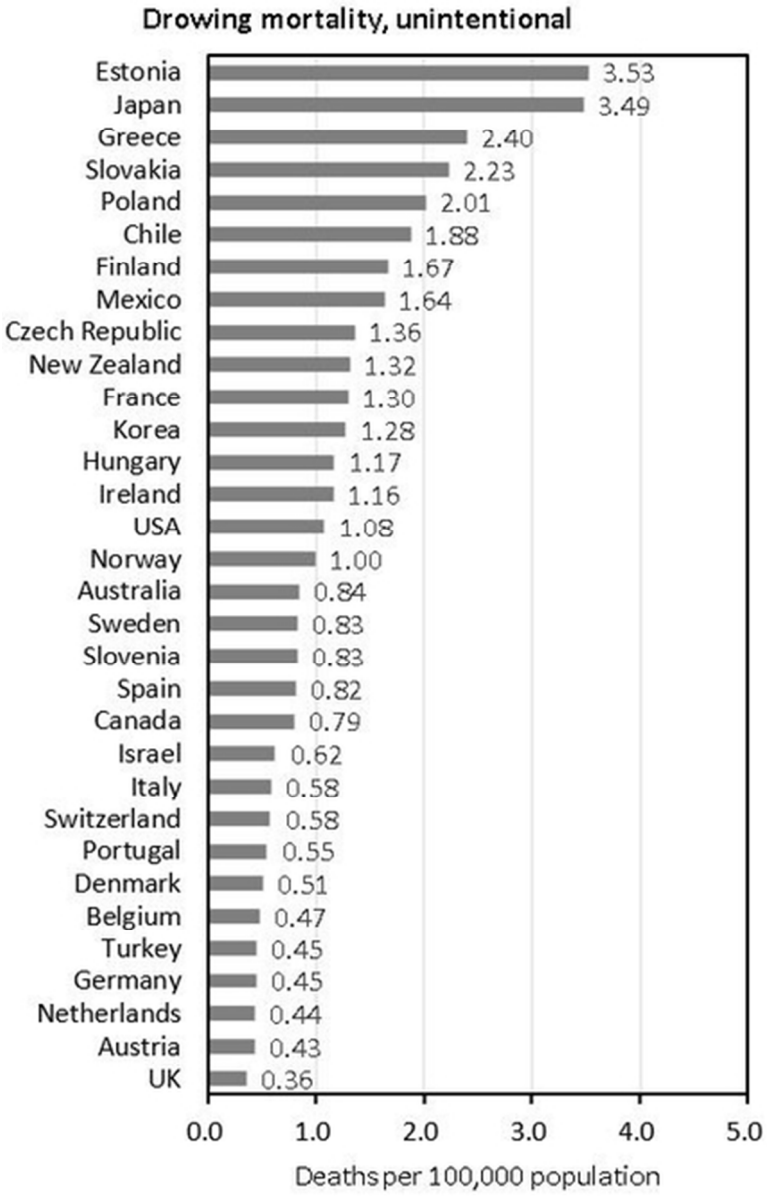


Figure 1 Unintentional drowning mortality in each OECD country.

37x56mm (300 x 300 DPI)

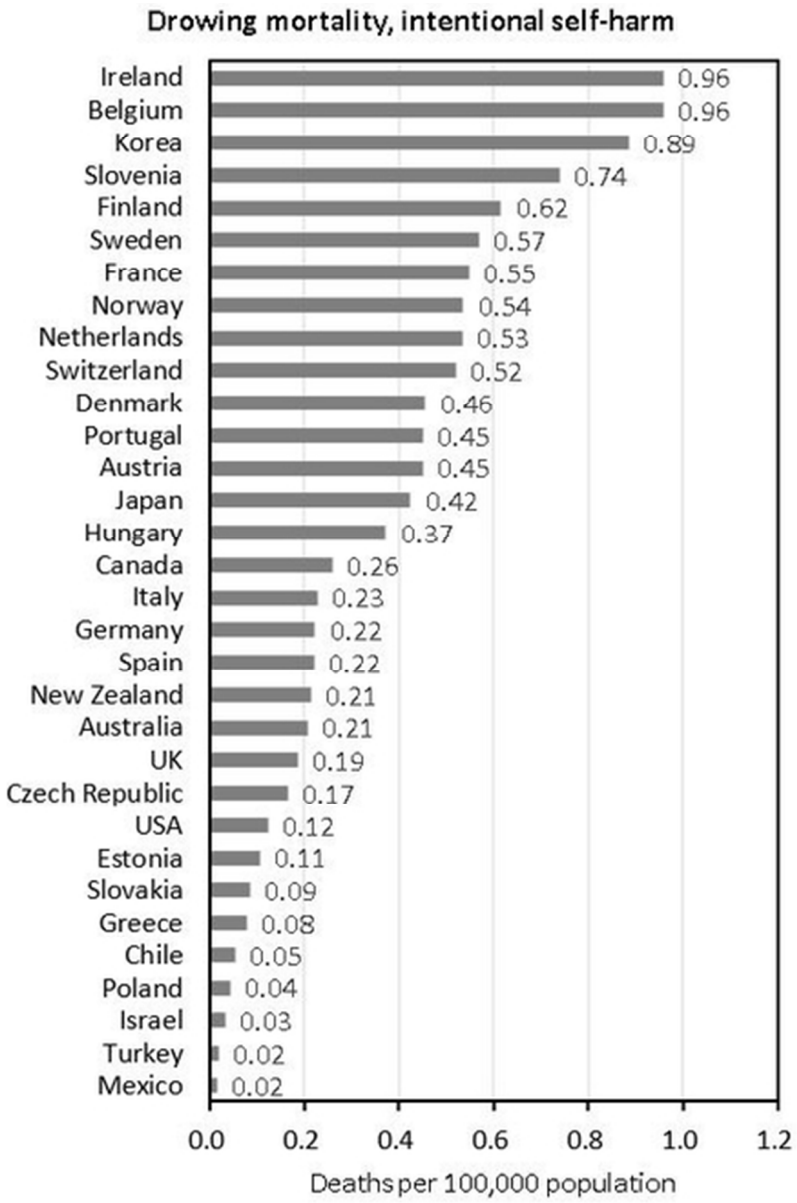


Figure 2 Intentional self-harm (suicide) drowning mortality in each OECD country.

36x55mm (300 x 300 DPI)

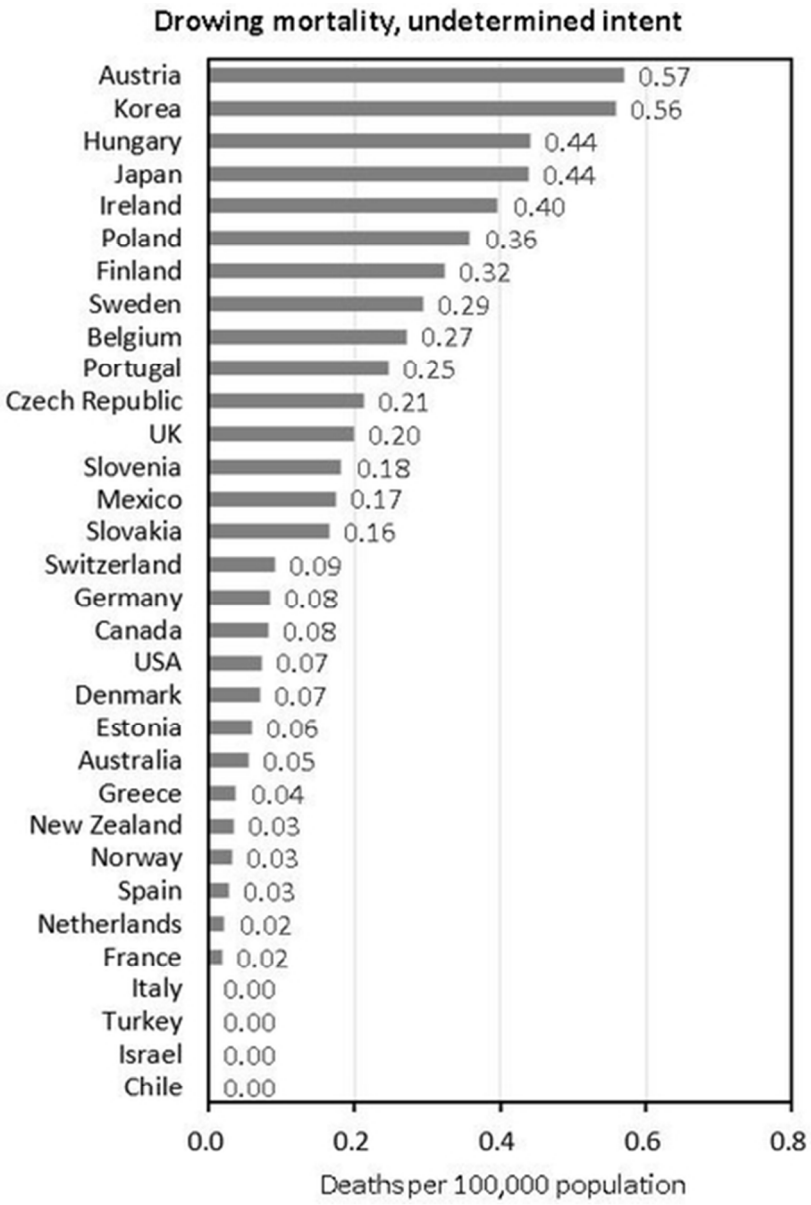


Figure 3 Undetermined intent drowning mortality in each OECD country.

36x53mm (300 x 300 DPI)

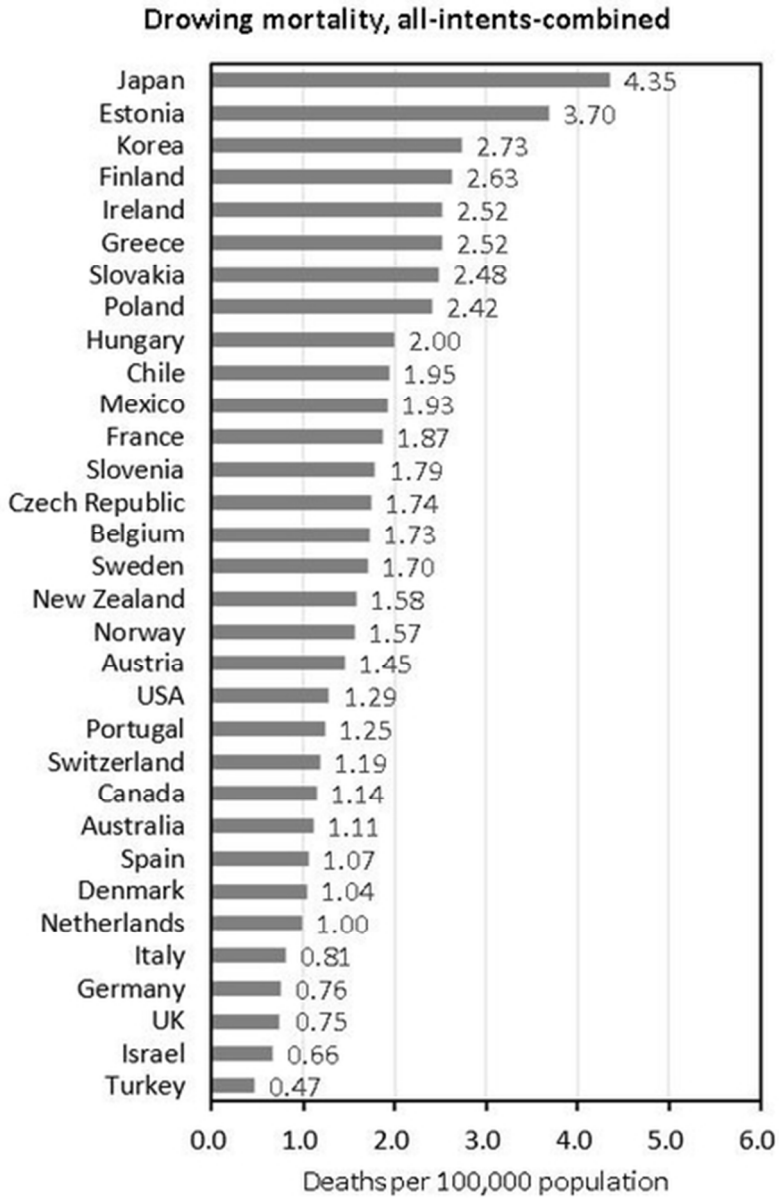
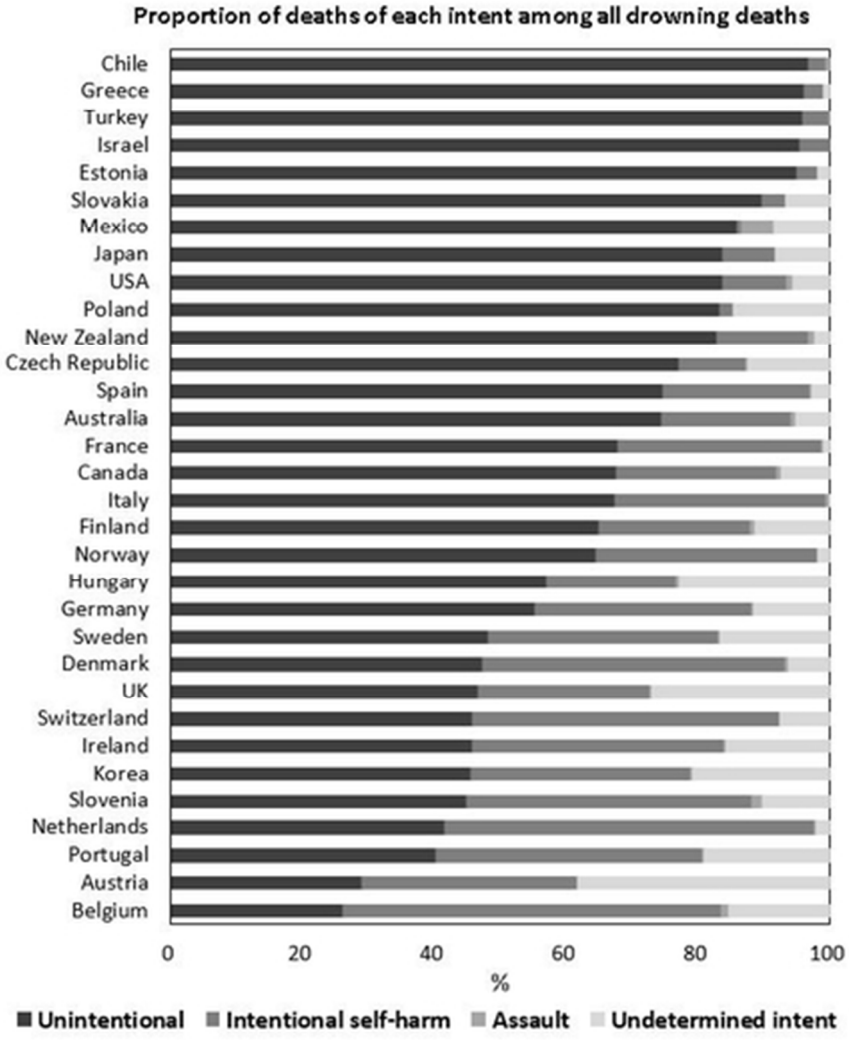


Figure 4 All-intents-combined drowning mortality in each OECD country.

37x56mm (300 x 300 DPI)



36x44mm (300 x 300 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	10
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	NA
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	No
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	NA
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	No

		(*b*) Report category boundaries when continuous variables were categorized	No
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	No
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	No
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9
Generalisability	21	Discuss the generalisability (external validity) of the study results	9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

Drowning mortality by intent: a population-based cross-sectional study of 32 OECD countries, 2012–2014

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-021501.R2
Article Type:	Research
Date Submitted by the Author:	04-Jun-2018
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Primary Subject Heading:	Epidemiology
Secondary Subject Heading:	Public health
Keywords:	drowning, mortality, international comparisons

Drowning mortality by intent: a population-based cross-sectional study of 32 OECD countries, 2012–2014

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ABSTRACT

Objective To compare the drowning mortality rates and proportion of deaths of each intent among all drowning deaths in Organisation for Economic Co-operation and Development (OECD) countries in 2012–2014.

Design A population-based cross-sectional study.

Setting 32 OECD countries.

Participants Individuals in OECD countries who died from drowning.

Main outcome measures Drowning mortality rates (deaths per 100,000 population) and proportion (%) of deaths of each intent (i.e., unintentional intent, intentional self-harm, assault, undetermined intent, and all intents combined) among all drowning deaths.

Results Countries with the highest drowning mortality rates (deaths per 100,000 population) were Estonia (3.53), Japan (3.49), and Greece (2.40) for unintentional intent; Ireland (0.96), Belgium (0.96), and Korea (0.89) for intentional self-harm; Austria (0.57), Korea (0.56), and Hungary (0.44) for undetermined intent; and Japan (4.35), Estonia (3.70), and Korea (2.73) for all intents combined. Korea ranked 12th and third for unintentional intent and all intents combined, respectively. By contrast, Belgium ranked second and 15th for intentional self-harm and all intents combined, respectively. The proportion of deaths of each intent among all drowning deaths in each country varied greatly: from 26.2% in Belgium to 96.8% in Chile for unintentional intent; 0.7% in Mexico to 57.4% in Belgium for intentional self-harm; 0.0% in nine countries to 4.9% in Mexico for assault; and 0.0% in Israel and Turkey to 38.3% in Austria for undetermined intent.

Conclusions A large variation in the practice of classifying undetermined intent in drowning deaths across countries was noted and this variation hinders valid international comparisons of intent-specific (unintentional and intentional self-harm) drowning mortality rates.

Strengths and limitations of this study

- This study is the first study comparing drowning mortality rates according to intent-specific versus all intents combined, which can provide a more complete picture of drowning problems within a county.
- We combined mortality data for 3 years to ensure the statistical stability of comparisons.
- The criteria for classifying undetermined intent in each participating country was not available.

INTRODUCTION

An international comparison of injury mortality rates is crucial to identify the unique features of injury problems within a given country. An international comparison of unintentional drowning mortality rates indicated that drowning rate rankings of different countries differed according to age groups; the countries with the highest drowning rates were Kyrgyzstan for ages 0–4 years, Thailand for ages 5–14 years, Guyana for ages 15–24 years, Belarus for ages 25–44 years, Lithuania for ages 45–64 years, and Japan for ages 65 years or more.[1] However, several studies have indicated country and regional variations in the determination of intent (manner of death), such as unintentional (accidents), intentional self-harm (suicides), assault (homicides), and events of undetermined intent, which could hinder valid international comparisons of injury mortality rates.[2–6]

To improve the comparability between countries and across years within a single country, some scholars have proposed considering all intents combined versus intent-specific injury deaths to reveal a more comprehensive picture of the injury problem.[7–10] Theory and evidence supporting the all-intents-combined approach indicate that passive protection strategies through modification of products (e.g. smart guns or adding unpleasant odours and colours to pesticides), environmental interventions (e.g. fences on the roofs of high buildings and securing used pesticides), and lethal means restriction (e.g. gun control and banning the use of lethal pesticides) are highly effective in preventing not only unintentional injuries but also intentional injuries.[11–15] The all-intents-combined approach has been used for the early identification of emerging drug-related poisoning problems in the United States and drowning problems in Finland.[16–21] However, no study thus far has used the

all-intents-combined approach to examine international variations in drowning mortality. In this study, we compared the drowning mortality rates and proportion of deaths of each intent among all drowning deaths within Organisation for Economic Co-operation and Development (OECD) countries.

METHODS

Study design and setting

This study was a population-based descriptive cross-sectional study of 32 OECD countries.

Data source

The population and drowning mortality data of 32 OECD countries were extracted from the World Health Organization Cause of Death Query Online.[22] To ensure statistical stability in calculating the drowning mortality rates, we combined available data from the most recently available 3 years. Both numerator (drowning deaths) and denominator (population size) were combined for each 3-year period. The latest available year of mortality data differed across countries. For example, as of April 30, 2017, the latest 3 years of data were 2013–2015 for 5 countries and 2012–2014 for 16 countries.

Measures

The International Classification of Diseases Tenth Revision (ICD-10) codes for drowning mortality of different intents are ICD-10 codes W65–W74 for unintentional intent (accident), ICD-10 code X71 for intentional self-harm (suicide), ICD-10 code X92 for assault (homicide), and ICD-10 code

Y21 for undetermined intent.

Statistical analyses

We first calculated the age-standardized mortality rates (deaths per 100,000 population) of each intent for each country using the US 2000 age structure (0–14, 25–24, 25–44, 45–64, 65–74, and greater than or equal to 75 years) as standard. We used bar charts to represent the variations and rankings in drowning mortality rates by intent across countries.

We then computed the proportion of deaths of each intent among all drowning deaths for each country grouped by region. The classification of country by region was based on the Global Burden of Disease Study.[23] To demonstrate the extent of variations in death certification practices, we calculated an undetermined intent versus intentional self-harm ratio and an all intents combined versus unintentional intent ratio for each country. The proportion of each intent for each country was illustrated by stacked bar charts.

Patient and Public Involvement

This study used secondary administrative data. As such, no patients were involved in the development of the research questions. Outcome measures were informed by patients' priorities, experience, and preferences. These conditions applied to the design of this study, in the recruitment for the study, and in the conduct of the study.

RESULTS

Intent-specific mortality rates

Countries with the highest drowning mortality rates (deaths per 100,000 population) were Estonia (3.53), Japan (3.49), and Greece (2.40) for accidental (Figure 1); Ireland (0.96), Belgium (0.96), and Korea (0.89) for intentional self-harm (Figure 2); Austria (0.57), Korea (0.56), and Hungary (0.44) for undetermined intent (Figure 3); and Japan (4.35), Estonia (3.70), and South Korea (2.73) for all intents combined (Figure 4). South Korea ranked 12th and third for unintentional intent and all intents combined, respectively. By contrast, Belgium ranked second and 15th for intentional self-harm and all intents combined, respectively.

Proportion of drowning deaths by intent

The numbers and proportions of each intent among drowning deaths for each country by region are presented in Table 1 and Figure 5. The percentage of unintentional intent ranged from 26.2% in Belgium to 96.8% in Chile. The proportion of intentional self-harm ranged from 0.7% in Mexico to 57.4% in Belgium, indicating a considerably large variation. The percentage of assault was less than 1.0% in most countries, except in Mexico (4.9%) and Slovenia (1.5%). We also found a large variation in undetermined intent, from 0.0% in Israel and Turkey to 38.3% in Austria.

Of the 32 OECD countries included in the study, 10 had undetermined intent proportions lower than 3% and eight had proportions greater than 15%. The undetermined intent versus intentional self-harm ratio (an indicator of underreported suicide) was highest in Mexico (12.35, 593/48) and Poland (7.53, 444/59). Four out of five Central European countries had undetermined intent versus intentional self-harm ratios larger than 1, suggesting relatively a high proportion of reported undetermined intent in Central European countries. By contrast, the all intents combined versus

unintentional intent ratio was highest in Belgium (3.82, 687/180) and Austria (3.46, 446/129). Of 11 countries with all intents combined versus unintentional intent ratios larger than 2, eight were Western European countries.

DISCUSSION

The findings of this study indicate different rankings of drowning mortality rates by intent, which might have been caused by large variations in the proportions of reported undetermined intent and intentional self-harm among all drowning deaths across countries. This study suggests variability in the drowning-related death certification practices associated with specific regions. For example, countries in Central Europe had higher proportions of reporting undetermined intent and countries in Western Europe had higher proportions of reporting intentional self-harm.

According to a previous study involving the certification practices of eight European countries, a legal inquiry is compulsory for every injury death in each participating country, and the inquiry is most commonly executed by legal authorities. However, differences in the classification practices (e.g. the efficiency of communication between the medical and legal authorities involved in suicide registration, percentage of injury deaths where forensic autopsies are performed, level of medical training of the coders, and availability of inquiry results and forensic autopsy results to the final cause-of-death decision-maker) in different countries result in variations in the proportion of deaths classified as undetermined intent. In that study, the undetermined intent versus suicide ratio was highest in Portugal during 2000–2004 (0.78) and lowest in Austria during 2003–2007 (0.07).[2]

In this study, we found eight countries (Japan, Austria, UK, Czech Republic, Hungary, Poland, Slovakia, and Mexico) with an undetermined intent versus suicide ratio greater than 1. Four out of five countries in Central Europe had undetermined intent versus suicide ratios greater than 1, which indicated similar certification practices among medical examiners and coroners in this region. We also found that eight out of the 11 countries with high all intents combined versus unintentional intent ratios were in Western Europe. One possible explanation for this was the high proportion in intentional self-harm drowning deaths in this region.

Regarding the determination of intent (manner of death) in drowning deaths, 'unintentional intent' could be the assigned intent when witnesses were present during the drowning incident (e.g. children swimming or young people surfing in recreational water environments). By contrast, the intent 'intentional self-harm' could be assigned if witnesses were present when someone intentionally and voluntarily jumped off a bridge into a river. However, determining the intent of drowning for a body found in water is difficult. According to a study conducted by Lunetta et al, of 1707 bodies that were found in water and were autopsied at the Department of Forensic Medicine, University of Helsinki, from 1976 to 2000, 276 cases (16.2%) were assigned undetermined intent. Of 757 cases initially thought to be accidents by police investigators, pathologists involved with the autopsies agreed in 79.4% of the cases, whereas for suicide, homicide, and undetermined intent, the pathologists agreed in only 76.9%, 39.5%, and 18.7% of the cases, respectively.[24]

Because determining the intent of injury is difficult and because accumulated evidence suggests that environmental interventions could prevent not only unintentional injuries but also

intentional injuries, counting injury deaths by using the all-intents-combined approach to identify all injury deaths with the same mechanism is recommended.[7–10] For example, in the United States, poisoning (n = 31116) was the second leading injury mechanism followed by motor vehicular accidents (n = 37985) in 2008 when the count was restricted to only unintentional intent. However, when the all-intents-combined approach was used, poisoning (n = 41080) became the first leading injury mechanism and superseded motor vehicular accidents (n = 37985) in 2008.[20] According to the findings of this study (Table 1), 12348 drowning deaths were identified using the all-intents-combined approach, which suggests that the use of this approach could identify 20% more drowning deaths (n = 2108) than did the use of only the unintentional intent approach (n = 10240).

Strengths and limitations of this study

The strength of this study is that it is the first to compare both intent-specific and all-intents-combined drowning mortality across countries. However, several limitations should be considered while interpreting the findings of this study. First, we did not include water transport accidents (ICD-10 codes V90–V94) in this study because of the small number of deaths resulting from these accidents in most countries. Second, unlike reports of unintentional drowning (ICD-10 codes W65–W74), which provide detailed information on the body of water (i.e. bathtub, swimming pool, or natural water body) and the mechanism of drowning (i.e. while in water versus following fall into water), reports of intentional self-harm (ICD-10 code X71), assault (ICD-10 code

X92), and undetermined intent (ICD-10 code Y21) provide no such information. Therefore, we could not further analyse the bodies of water and mechanisms of drowning involved in intentional drowning. Third, we could not determine whether the considerably large variations in intentional self-harm drowning mortality rates across countries were caused by actual differences in suicide rates or by differences in classifying undetermined intent.

CONCLUSIONS

The rankings of a country with regard to drowning mortality rates differ depending on whether the all-intents-combined approach or the intent-specific approach is used. The findings of this study indicate a large variation in the practice of classifying the undetermined intent of drowning deaths across countries; this variation hinders valid international comparisons of intent-specific (unintentional and intentional self-harm) drowning mortality rates.

Acknowledgement The authors thank Ms. Pai-Huan Lin for data analysis.

Contributors WHH collected data, performed analysis, and drafted and revised the manuscript. CHW participated the interpretation of results and drafted and revised the manuscript. THL initiated the idea, participated in the interpretation of results, drafted and revised the manuscript, supervised the study, and is the guarantor.

Funding None

Competing interests The authors have no competing interests to declare.

Ethics approval This study was approved by the Institutional Review Boards of the Chi-Mei Medical Center (10406-003) and the Tzu Chi Hospital (104-67-B).

Data sharing: Please contact corresponding author.

Transparency statement: The corresponding author confirms that the manuscript is an honest, accurate, and transparent account of the study being reported; no crucial aspects of the study have been omitted; and all discrepancies are disclosed.

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Table 1. The number and proportion of each intent in drowning mortality in each OECD country

Region	(1) All-intents-combined		(2) Unintentional		(3) Intentional self-harm		(4) Assault		(5) Undetermined intent			
Country, data year	No.	%	No.	%	No.	%	No.	%	No.	%	(5)/(3)	(1)/(2)
High-income North America												
Canada, 2010-12	1241	100.0	840	67.7	301	24.3	9	0.7	91	7.3	0.30	1.48
USA, 2012-14	12348	100.0	10340	83.7	1200	9.7	109	0.9	699	5.7	0.58	1.19
Australasia												
Australia, 2012-14	793	100.0	591	74.5	156	19.7	5	0.6	41	5.2	0.26	1.34
New Zealand, 2010-12	211	100.0	175	82.9	29	13.7	2	0.9	5	2.4	0.17	1.21
High-income Asia Pacific												
Japan, 2012-14	27383	100.0	22940	83.8	2166	7.9	10	0.0	2267	8.3	1.05	1.19
South Korea, 2011-13	4337	100.0	1980	45.7	1441	33.2	14	0.3	902	20.8	0.63	2.19
Western Europe												
Austria, 2012-14	446	100.0	129	28.9	146	32.7	0	0.0	171	38.3	1.17	3.46
Belgium, 2012-14	687	100.0	180	26.2	394	57.4	7	1.0	106	15.4	0.27	3.82
Denmark, 2012-14	205	100.0	97	47.3	94	45.9	1	0.5	13	6.3	0.14	2.11
Finland, 2012-14	510	100.0	332	65.1	117	22.9	3	0.6	58	11.4	0.50	1.54
France, 2011-13	4147	100.0	2818	68.0	1277	30.8	11	0.3	41	1.0	0.03	1.47
Germany, 2012-14	2295	100.0	1271	55.4	752	32.8	6	0.3	266	11.6	0.35	1.81
Greece, 2014	363	100.0	349	96.1	10	2.8	0	0.0	4	1.1	0.40	1.04
Ireland, 2011-13	348	100.0	159	45.7	133	38.2	1	0.3	55	15.8	0.41	2.19
Israel, 2012-14	155	100.0	148	95.5	7	4.5	0	0.0	0	0.0	0.00	1.05
Italy, 2010-12	1668	100.0	1124	67.4	534	32.0	8	0.5	2	0.1	0.00	1.48
Netherlands, 2013-15	585	100.0	244	41.7	327	55.9	2	0.3	12	2.1	0.04	2.40
Norway, 2012-14	265	100.0	171	64.5	89	33.6	0	0.0	5	1.9	0.06	1.55
Portugal, 2011-13	472	100.0	190	40.3	191	40.5	1	0.2	90	19.1	0.47	2.48

Spain, 2012-14	1730	100.0	1294	74.8	385	22.3	4	0.2	47	2.7	0.12	1.34
Sweden, 2013-15	594	100.0	287	48.3	207	34.8	1	0.2	99	16.7	0.48	2.07
Switzerland, 2011-13	337	100.0	154	45.7	157	46.6	0	0.0	26	7.7	0.17	2.19
UK, 2011-13	1529	100.0	714	46.7	398	26.0	2	0.1	415	27.1	1.04	2.14
Eastern Europe												
Estonia, 2012-14	161	100.0	153	95.0	5	3.1	0	0.0	3	1.9	0.60	1.05
Central Europe												
Czech Republic, 2013-15	627	100.0	484	77.2	63	10.0	2	0.3	78	12.4	1.24	1.30
Hungary, 2013-15	651	100.0	372	57.1	127	19.5	3	0.5	149	22.9	1.17	1.75
Poland, 2012-14	3005	100.0	2502	83.3	59	2.0	0	0.0	444	14.8	7.53	1.20
Slovakia, 2012-14	434	100.0	389	89.6	16	3.7	0	0.0	29	6.7	1.81	1.12
Slovenia, 2013-15	136	100.0	61	44.9	59	43.4	2	1.5	14	10.3	0.24	2.23
Latin America												
Chile, 2012-14	1022	100.0	989	96.8	28	2.7	5	0.5	0	0.0	0.00	1.03
Mexico, 2012-14	6970	100.0	5990	85.9	48	0.7	339	4.9	593	8.5	12.35	1.16
Middle East												
Turkey, 2011-13	1061	100.0	1018	95.9	41	3.9	2	0.2	0	0.0	0.00	1.04

Data source: World Health Organization Cause of Death Query Online (http://apps.who.int/healthinfo/statistics/mortality/causeofdeath_query/)

Figure legends

Figure 1 Unintentional (accident) drowning mortality in each OECD country.

Figure 2 Intentional self-harm (suicide) drowning mortality in each OECD country.

Figure 3 Undetermined intent drowning mortality in each OECD country.

Figure 4 All intents combined drowning mortality in each OECD country.

Figure 5. Proportion of deaths of each intent among all drowning deaths in each OECD country.

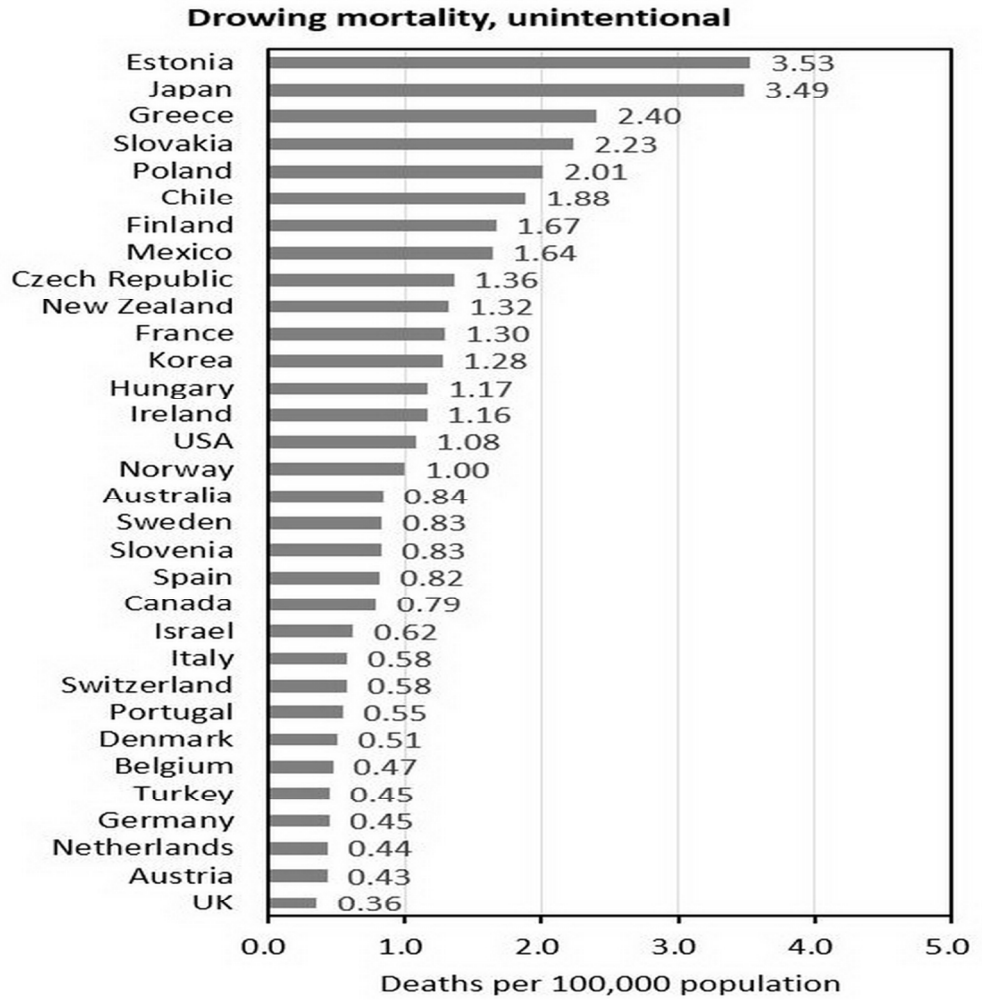

Figure 1 Unintentional (accident) drowning mortality in each OECD country.

90x90mm (300 x 300 DPI)

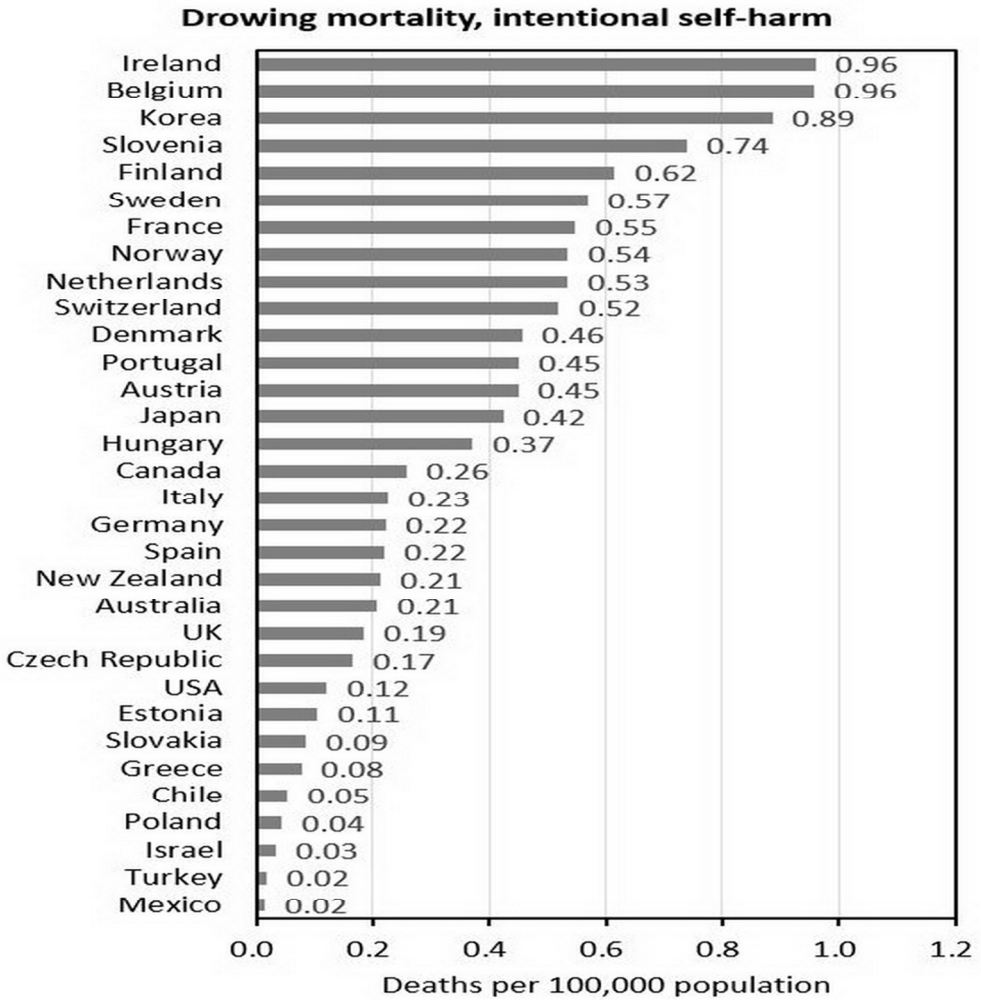

Figure 2 Intentional self-harm (suicide) drowning mortality in each OECD country.

90x90mm (300 x 300 DPI)

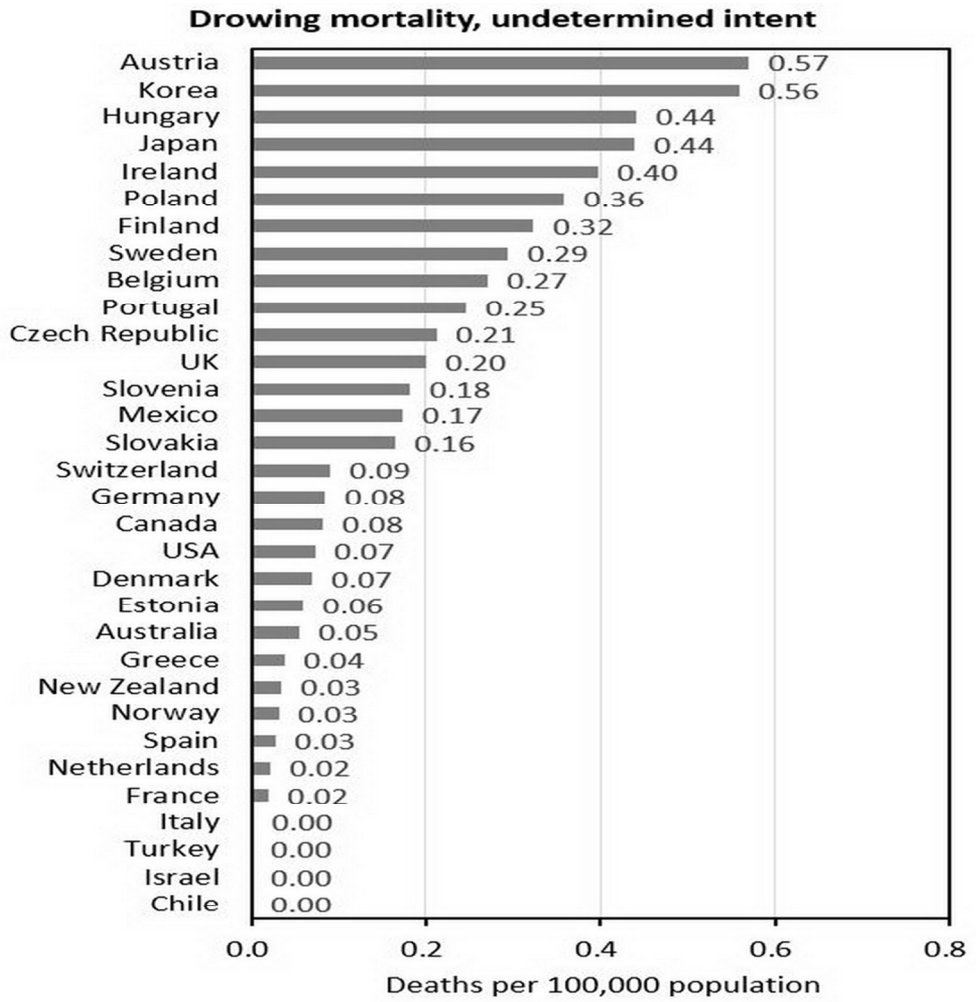

Figure 3 Undetermined intent drowning mortality in each OECD country.

90x90mm (300 x 300 DPI)

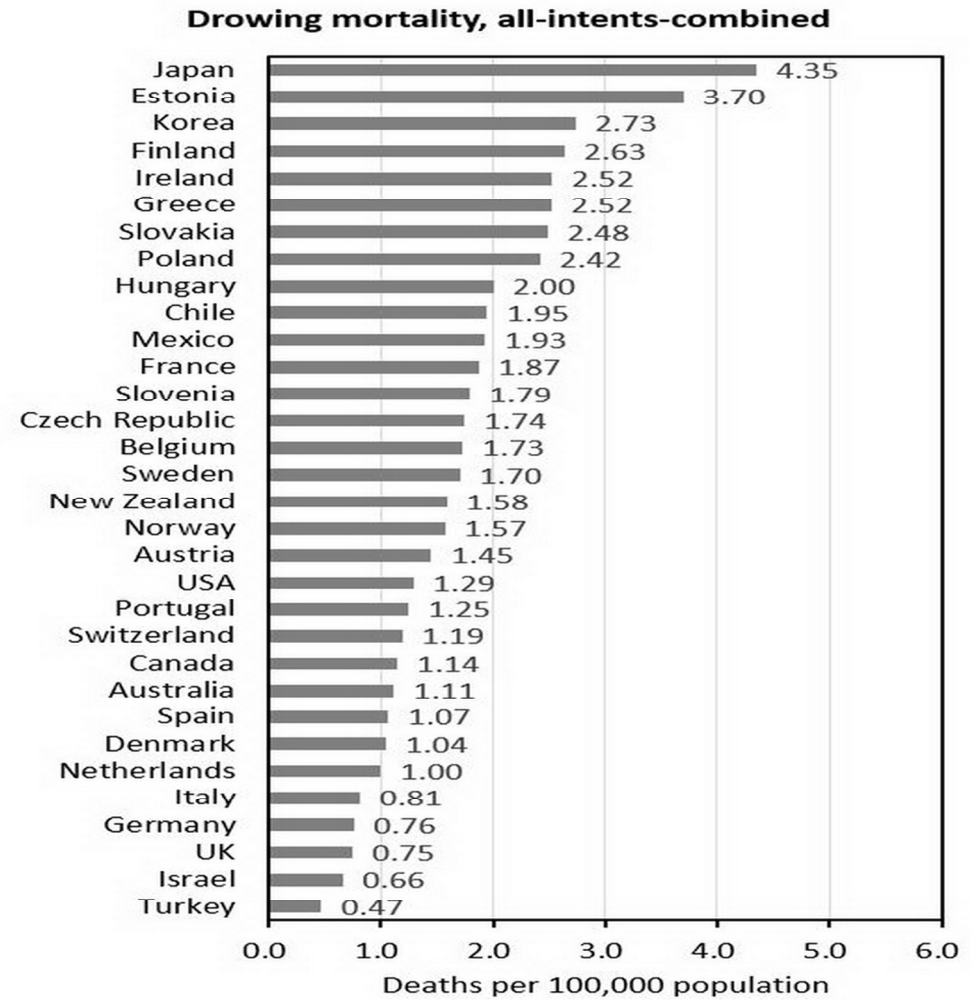

Figure 4 All intents combined drowning mortality in each OECD country.

90x90mm (300 x 300 DPI)

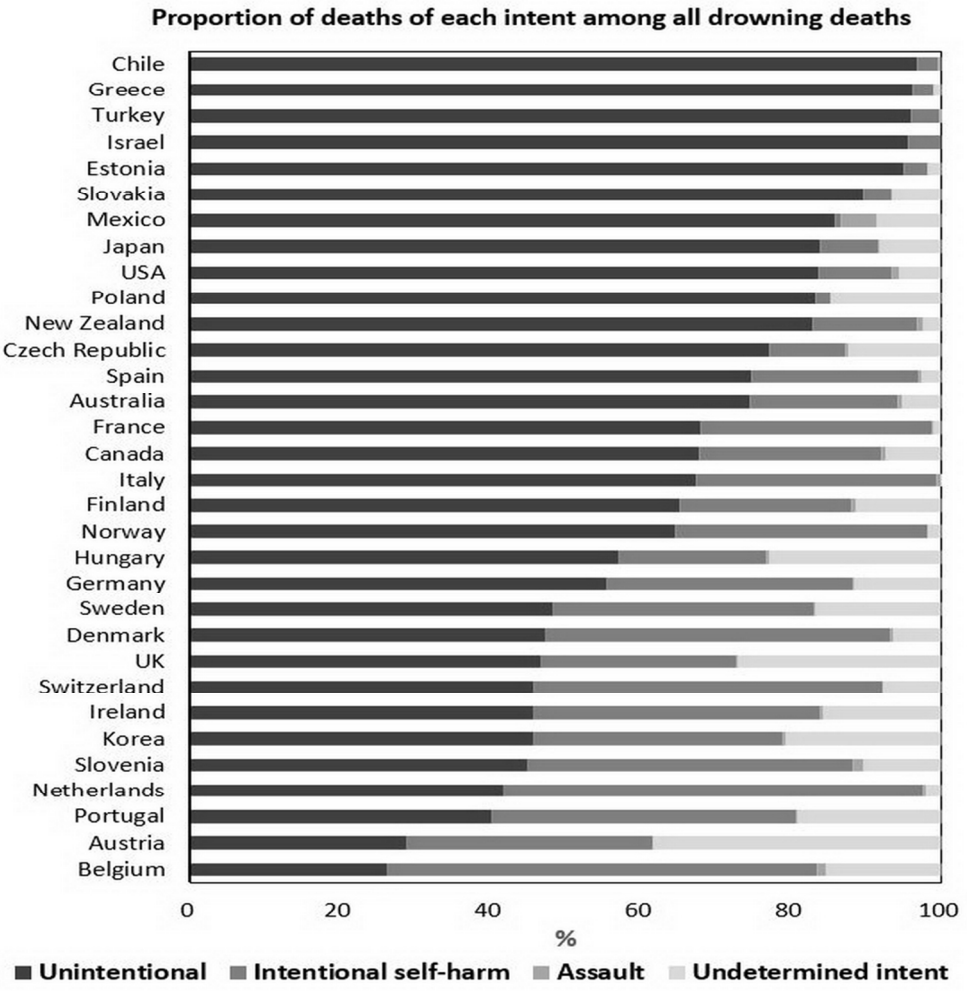

Figure 5. Proportion of deaths of each intent among all drowning deaths in each OECD country.

90x90mm (300 x 300 DPI)

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5
Objectives	3	State specific objectives, including any prespecified hypotheses	6
Methods			
Study design	4	Present key elements of study design early in the paper	6
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	6
Bias	9	Describe any efforts to address potential sources of bias	10
Study size	10	Explain how the study size was arrived at	NA
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	6
		(*b*) Describe any methods used to examine subgroups and interactions	NA
		(*c*) Explain how missing data were addressed	10
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	NA
		(*e*) Describe any sensitivity analyses	NA
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	NA
		(b) Give reasons for non-participation at each stage	NA
		(c) Consider use of a flow diagram	No
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	NA
		(b) Indicate number of participants with missing data for each variable of interest	NA
Outcome data	15*	Report numbers of outcome events or summary measures	7
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	No

		(*b*) Report category boundaries when continuous variables were categorized	No
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	No
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	No
Discussion			
Key results	18	Summarise key results with reference to study objectives	8
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	10
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	9
Generalisability	21	Discuss the generalisability (external validity) of the study results	9
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	NA

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.