BMJ Open

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-027909
Article Type:	Research
Date Submitted by the Author:	13-Nov-2018
Complete List of Authors:	Gianino, Maria Michela; University of Torino, Dept. Public Health and Pediatrics Lenzi, Jacopo; Alma Mater Studiorum - University of Bologna, Department of Biomedical and Neuromotor Sciences Bonaudo, Marco; Università degli Studi di Torino, Department of Public Health Sciences and Pediatrics Fantini, Maria Pia; University of Bologna, Department of Biomedical and Neuromotor Sciences Siliquini, Roberta; University of Turin, Department of Public Health Sciences and Pediatrics Ricciardi, W; Universita Cattolica del Sacro Cuore Sede di Roma, Istituto di Sanità Pubblica; Fondazione Policlinico Universitario 'Agostino Gemelli' IRCCS Damiani, Gianfranco; Universita Cattolica del Sacro Cuore Sede di Roma, Istituto di Sanità Pubblica; Fondazione Policlinico Universitario 'Agostino Gemelli' IRCCS
Keywords:	Community child health < PAEDIATRICS, International health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, PUBLIC HEALTH

Amenable mortality in children in 34 OECD countries: evidence from a 15–year time trend analysis

Authors:

Maria Michela Gianino[a], Jacopo Lenzi[b], Marco Bonaudo[a], Maria Pia Fantini[b], Roberta Siliquini[a], Walter Ricciardi[cd], Gianfranco Damiani[cd].

Maria Michela Gianino, Professor

a) Department of Public Health Sciences and Pediatrics, Università di Torino

Via Santena 5 bis - 10126 Turin (Italy)

Tel #: +39(0)116705839 - Fax #: +39(0)116705889

mariola.gianino@unito.it

Jacopo Lenzi, PhD

b) Department of Biomedical and Neuromotor Sciences, Alma Mater Studiorum - Università di Bologna

Via Ugo Foscolo 7 - 40123 Bologna (Italy)

Tel #: +39(0)512094836

jacopo.lenzi2@unibo.it

Marco Bonaudo, MSN

a) Department of Public Health Sciences and Pediatrics, Università di Torino

Via Santena 5 bis - 10126 Turin (Italy)

Tel #: +39(0)116705839 - Fax #: +39(0)116705889

marco.bonaudo@unito.it

Maria Pia Fantini, MD, Professor

b) Department of Biomedical and Neuromotor Sciences, Alma Mater Studiorum - Università di Bologna

Via Ugo Foscolo 7 - 40123 Bologna (Italy)

Tel #: +39(0)512094836

mariapia.fantini@unibo.it

Roberta Siliquini, Professor

a) Department of Public Health Sciences and Pediatrics, Università di Torino

Via Santena 5 bis - 10126 Turin (Italy)

Tel #: +39(0)116705812

roberta.siliquini@unito.it

Walter Ricciardi, MD, Professor

c) Fondazione Policlinico Universitario 'Agostino Gemelli' IRCCS, Roma, Italia

Largo Agostino Gemelli 8 - 00168 Roma (Italia)

Tel #: +39(0)630154396

walter.ricciardi@unicatt.it

and

d) Istituto di Sanità Pubblica, Università Cattolica del Sacro Cuore, Roma, Italia

Largo Francesco Vito 1 - 00168 Roma (Italia)

Tel #: +39(0)630154396

walter.ricciardi@unicatt.it

Gianfranco Damiani MD, Professor

c) Fondazione Policlinico Universitario 'Agostino Gemelli' IRCCS, Roma, Italia

Largo Agostino Gemelli 8 - 00168 Roma (Italia)

Tel #: +39(0)630154396

gianfranco.damiani@policlinicogemelli.it

and

d) Istituto di Sanità Pubblica, Università Cattolica del Sacro Cuore, Roma, Italia

Largo Francesco Vito 1 - 00168 Roma (Italia)

Tel #: +39(0)630154396

gianfranco.damiani@unicatt.it

Corresponding Author:

Marco Bonaudo, MSN

a) Department of Public Health Sciences and Pediatrics, Università di Torino

Via Santena 5 bis - 10126 Turin (Italy)

Tel #: +39(0)116705839 - Fax #: +39(0)116705889

marco.bonaudo@unito.it

Words count paper: 2901

Words count abstract: 236

ABSTRACT

Background. The children mortality burden conditioned by the performance of the health care system has not been well investigated. This study aimed to analyse the trends of amenable mortality rates (AMRs) in children in 34 OECD countries during 2001-2015.

Methods. An observational longitudinal study was performed. Using data from the WHO Mortality Database and Nolte and McKee's list, AMRs were calculated as the annual number of deaths over the population aged ≤14 years/100,000 inhabitants. The rates were stratified by the age groups (<1, 1–4, 5–9, 10–14 years). All data were summarised by presenting the average rates for the years 2001/2005, 2006/2010, and 2011/2015.

Results. There was a significant decline in children's AMRs in the <1 age class in all 34 OECD countries from 2001/2005 to 2006/2010 (from 332.78 to 295.17/100,000; %Δ -11.30%; 95% CI -18.75%, - 3.85%) and from 2006/2010 to 2011/2015 (from 295.17 to 240.22/100,000; %Δ -18.62%; 95% CI -26.53%, -10.70%), and a slow decline in the other age classes. The only cause of death that was significantly reduced was conditions originating in the early neonatal period in the <1 age class. The age-specific distribution of causes of deaths did not vary significantly over the study period.

Conclusion. The trajectories declined in all OECD countries during 2001-2015: fast in the <1 age class and slow in the other age classes. Therefore, policies that affect the determinants on the supply side are required.

Strengths and limitations of this study:

1. This is the first study to analyse trends in child mortality amenable to health care.
2. Thirty-four OECD countries were included in the analyses to provide a thorough depiction of amenable child mortality in high-income economies.
3. Mortality was not disaggregated by ethnicity or socioeconomic characteristics.
4. Making international comparisons is difficult due to variations in birth registration laws and death certification practices.

Key words: Amenable mortality, child, childhood, healthcare, healthcare services, OECD countries

INTRODUCTION

The health of children and adolescents is an important goal for every society, both because they are vulnerable and because diseases can affect their quality of life.

Measures for protecting and improving children's and adolescents' health will yield economic and social benefits beyond improved health outcomes. Indeed, young people have the potential to affect the health of future populations as well as global economic development unless timely and effective strategies are put into place.[1,2]

For the adoption of new strategies and the planning of interventions, information on the leading causes of death is essential. Many studies have analysed the mortality rates and have identified the main causes of death of children in specific countries[3] or areas.[4] Many different factors contribute to child and adolescent mortality.[5] Differences in infant mortality rates are noted when grouped by biological and psychosocial factors, such as sex, race, ethnic origin or disability, in both studies and national or international statistics.[6] An inverse relationship has been shown between socioeconomic status and child mortality for all or specific causes.[7,8] Engagement in behaviours such as smoking, alcohol misuse, drug misuse, poor diet, and physical activity during adolescence increases morbidity and the risk of premature death.[9] The physical environment is another factor associated with child mortality. Indeed, studies have demonstrated that children living in the most disadvantaged urban areas are likely to live close to industrialised and highly populated zones with a greater chance of being exposed to pollution and a greater risk of road accidents. In the landscape described, the mortality burden conditioned by the performance of the health care system has not been well investigated. Although there is no indicator that is able to compressively reflect the performance of the healthcare system, a suitable measurement seems to be the concept of amenable mortality.

Amenable mortality is defined as deaths that, in the light of medical knowledge and technology at the time of death, could be prevented by timely access to good quality health care.[10,11] Amenable

mortality was originally conceptualised by Rutstein et al., who created a list of conditions that were considered either treatable or preventable given the current medical knowledge and technology,[12] and amenable mortality has been used as an indicator of the performance of healthcare systems by the English Department of Health[13] and the Organisation for Economic Cooperation and Development.[14] Over the last few decades, mortality amenable to healthcare has increasingly been used to evaluate the effect of healthcare on health outcomes.[15]

According to the WHO, an estimated 6.3 million children under the age of 15 years died in 2017; 5.4 million of them were under the age of 5 and 2.5 million of them died within the first month of life. More than half of these early child deaths were due to conditions that could be prevented or treated with access to simple, affordable interventions and were, consequently, amenable.[2]

The purpose of this study was to analyse the trends of amenable child mortality rates in 34 OECD countries from 2001-2015 and to evaluate the pattern across age classes.

MATERIALS AND METHODS

This descriptive study was conducted using secondary data from 34 OECD countries during the period from 2001 to 2015. Mexico and Turkey, albeit members of the OECD, were not included in the analysis because these countries are not listed among high-income economies in the World Development Indicators dataset (gross national income per capita ≥$12,056 for fiscal year 2019)[16] and had limited data availability. The mortality and population data came from the World Health Organization (WHO) Mortality Database,[17] which comprises deaths registered in national vital registration systems, with the underlying causes of death coded according to the International Classification of Diseases. If reference populations were not available in the WHO Mortality Database, the data were extracted from UNdata.[18] The country-level data availability is presented in Table S1. The causes of death amenable to health care were selected using the list proposed by Nolte and McKee[15,19] and used by the OECD to generate estimates of amenable mortality for 31 countries[14] (see Table S2 for Nolte and McKee's list). The aggregation of the causes of death

operated in the WHO Mortality Database prevents the use of the list of amenable deaths currently adopted by Eurostat.[20] For each country, the amenable mortality rates were calculated as the annual number of deaths in the population aged 0–14 years per 100,000 inhabitants. The rates were stratified by the age groups adopted in the WHO Mortality Database (<1, 1–4, 5–9, 10–14 years) and by the 33 disease categories defined by Gay et al..[14] Due to the instability in the estimates of the annual amenable mortality rates, especially for small-population countries, all data were summarised by presenting the average rates for the years 2001/2005, 2006/2010 and 2011/2015. The statistical significance of the percentage changes between these time periods was assessed by building 95% confidence intervals with the formula suggested by Hildebrandt et al..[21] Differences in the ranking of age-specific causes of death between time periods were evaluated with the Friedman test.

All data were analysed using the Stata software package, version 15 (StataCorp. 2017. *Stata Statistical Software: Release 15*. College Station, TX: StataCorp LLC).

RESULTS

All-cause childhood amenable mortality rates

The results of the trend analyses conducted over the five-year periods 2001/2005, 2006/2010 and 2011/2015 are presented in Table 1 and Table 2.

As shown in Table 1, the amenable mortality rate of the OECD population with <1 year dropped significantly from 2001/2005 to 2006/2010 (from 332.78 to 295.17 per 100,000; %Δ -11.30%; 95% CI -18.75%, -3.85%) and from 2006/2010 to 2011/2015 (from 295.17 to 240.22 per 100,000; %Δ -18.62%; 95% CI -26.53%, -10.70%).

Contrary to the OECD rate of children <1 year, in the population ≥1 year the overall OECD rate did not decrease significantly (Table 1 and Table 2). From 2001/2005 to 2006/2010 and from 2006/2010 to 2011/2015, the mortality rates decreased by 13.37% and 13.02%, respectively, for the 1-4 age group; 11.94% and 11.26%, respectively, for the 5-9 age group; and 13.53% and 13.08%, respectively, for the 10-14 age group.

Following these reductions, the 2011/2015 overall amenable mortality rate in children <1 year was 240.22 per 100,000. In children aged 1-4, the rate dropped to 4.73 per 100,000 and reached the lowest value between 5 and 9 years (2.02 per 100,000). Between 10 and 14 years of age, the rate was 2.16 per 100,000.

Table 1. Yearly Amenable Mortality Rates (Per 100,000) for Ages <1 and 1–4 Years in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015 (See Table S1 for Country-Level Data Availability).

Country	<1 Year					1–4 Years				
	Yearly Amenable Mortality Rate			% Change (95% CI)		Yearly Amenable Mortality Rate			% Change (95% CI)	
	2001/2005	2006/2010	2011/2015	2006/10 – 2001/05	2011/15 – 2006/10	2001/2005	2006/2010	2011/2015	2006/10 – 2001/05	2011/15 – 2006/10
CA	343.10	343.46	332.97	.1 (-7.9, 8.1)	-3.1 (-10.7, 4.5)	4.34	4.09	3.98	-5.7 (-39.7, 28.2)	-2.6 (-37.7, 32.5)
US	415.80	382.24	350.87	-8.1 (-10.1, -6.1) *	-8.2 (-10.3, -6.1) *	6.00	5.46	5.13	-8.9 (-17.2, -.6) *	-6.1 (-14.9, 2.8)
CL	478.56	457.40	427.15	-4.4 (-12.2, 3.4)	-6.6 (-14.4, 1.2)	10.11	7.50	5.90	-25.8 (-47.9, -3.8) *	-21.3 (-48.2, 5.6)
IL	291.77	221.77	189.73	-24 (-34.9, -13.1) *	-14.4 (-27.4, -1.5) *	6.89	4.62	3.86	-32.9 (-66, .2)	-16.5 (-61.6, 28.6)
JP	150.76	121.39	97.24	-19.5 (-25.3, -13.7) *	-19.9 (-26.5, -13.3) *	8.78	7.84	7.15	-10.7 (-23.6, 2.2)	-8.7 (-23, 5.5)
KR	334.41	235.84	198.16	-29.5 (-35, -24) *	-16 (-23.5, -8.4) *	8.50	6.69	4.59	-21.3 (-38.9, -3.8) *	-31.5 (-50.3, -12.6) *
DK	285.08	191.17	220.19	-32.9 (-48.2, -17.7) *	15.2 (-13.3, 43.6)	6.16	3.87	3.11	-37.2 (-86.4, 12)	-19.6 (-94.7, 55.6)
IS	134.24	127.50	85.5	-5 (-114.3, 95)	-32.9 (-119.1, 53.2)	4.74	6.78	2.14	43.2 (-361.8, 143.2)	-68.4 (-181.5, 31.6)
FI	186.77	151.76	109.42	-18.7 (-41.6, 4.1)	-27.9 (-50.9, -4.9) *	4.46	3.25	2.80	-27.2 (-95.6, 41.2)	-14 (-103, 75)
NO	207.32	186.37	149.55	-10.1 (-33.4, 13.1)	-19.8 (-42, 2.5)	5.77	4.56	3.36	-21 (-84.1, 42.2)	-26.4 (-92.8, 40)
SE	178.05	136.44	130.95	-23.4 (-40.2, -6.6) *	-4 (-25.8, 17.8)	4.44	4.03	2.82	-9.2 (-70.6, 52.3)	-30.1 (-80.6, 20.5)
AT	297.83	243.56	198.02	-18.2 (-34, -2.5) *	-18.7 (-35.9, -1.5) *	4.72	4.54	3.62	-3.7 (-73, 65.6)	-20.4 (-81.8, 41.1)
BE	244.36	220.91	198.89	-9.6 (-24.7, 5.5)	-10 (-25.4, 5.4)	5.25	3.82	4.09	-27.3 (-71.3, 16.7)	7.1 (-59.6, 73.7)
FR	237.86	216.89	211.19	-8.8 (-14.9, -2.8) *	-2.6 (-9.3, 4)	3.98	3.73	2.82	-6.2 (-30.3, 17.8)	-24.3 (-45.4, -3.3) *
DE	245.69	223.48	206.37	-9 (-15.3, -2.8) *	-7.7 (-14.3, -1) *	5.31	4.27	4.19	-19.6 (-38.6, -.6) *	-1.9 (-27, 23.3)
LU	218.18	111.42	126.65	-48.9 (-98.7, .8)	13.7 (-106.8, 113.7)	0.88	1.76	1.62	98.8 (-968.1, 198.8)	-7.6 (-412.5, 92.4)
NL	306.18	257.29	234.49	-16 (-26, -5.9) *	-8.9 (-20.9, 3.2)	4.66	4.63	3.03	-.8 (-46.3, 44.8)	-34.6 (-69.4, .3)
CH	274.24	272.00	251.67	-.8 (-20.1, 18.5)	-7.5 (-25.4, 10.5)	4.22	2.95	2.02	-30.2 (-90.2, 29.8)	-31.3 (-100.6, 38)
IE	247.00	198.95	184.09	-19.5 (-38.2, -.7) *	-7.5 (-29.5, 14.6)	6.28	2.53	3.18	-59.7 (-97.1, -22.3) *	25.6 (-100.4, 125.6)
GB	346.07	305.01	256.65	-11.9 (-16.9, -6.8) *	-15.9 (-20.8, -10.9) *	6.33	5.65	4.96	-10.7 (-29.7, 8.4)	-12.2 (-31.4, 6.9)
GR	305.19	218.33	222.92	-28.5 (-40.3, -16.6) *	2.1 (-16.4, 20.6)	5.54	5.36	4.62	-3.4 (-59.2, 52.5)	-13.8 (-65.2, 37.7)
IT	299.93	256.16	224.78	-14.6 (-20.7, -8.5) *	-12.2 (-19, -5.5) *	4.96	4.05	4.15	-18.4 (-41.2, 4.5)	2.4 (-27.3, 32.2)
PT	300.62	219.72	219.56	-26.9 (-39.2, -14.6) *	-.1 (-19.2, 19)	8.41	3.92	4.19	-53.4 (-80.4, -26.4) *	6.9 (-66.3, 80.1)
ES	272.67	231.74	204.24	-15 (-21.9, -8.1) *	-11.9 (-19.6, -4.2) *	6.23	5.13	3.59	-17.6 (-40.6, 5.3)	-30 (-51.6, -8.4) *
CZ	259.40	209.92	166.61	-19.1 (-33.5, -4.7) *	-20.6 (-35.9, -5.4) *	4.74	4.43	3.24	-6.7 (-68, 54.7)	-26.9 (-76.7, 23)
EE	394.90	262.22	139.38	-33.6 (-60.7, -6.5) *	-46.8 (-75.4, -18.3) *	6.91	4.89	7.25	-29.3 (-140.4, 70.7)	48.4 (-174, 148.4)
HU	530.50	406.91	348.94	-23.3 (-33.4, -13.2) *	-14.2 (-27, -1.5) *	7.03	6.18	5.80	-12.2 (-60.5, 36.1)	-6 (-60.7, 48.6)
LV	561.36	440.42	324.98	-21.5 (-42.6, -.5) *	-26.2 (-49.2, -3.2) *	7.23	6.54	3.42	-9.5 (-115.5, 90.5)	-47.8 (-122.7, 27.2)
LT	412.34	342.21	225.15	-17 (-38.6, 4.6)	-34.2 (-54.3, -14.1) *	7.14	5.92	5.34	-17.2 (-98.9, 64.5)	-9.7 (-107.2, 87.7)
PL	488.86	400.92	315.70	-18 (-23.5, -12.4) *	-21.3 (-27.2, -15.3) *	7.81	8.35	6.69	6.9 (-20.1, 33.9)	-19.9 (-40.6, .8)
SK	432.24	373.71	345.44	-13.5 (-29.7, 2.6)	-7.6 (-25.5, 10.4)	13.09	11.08	9.26	-15.3 (-61.5, 30.8)	-16.4 (-65.1, 32.2)
SI	270.48	203.78	143.64	-24.7 (-55.9, 6.5)	-29.5 (-62.2, 3.2)	5.01	3.69	3.87	-26.3 (-141.4, 73.7)	4.8 (-161, 104.8)
AU	290.88	261.16	212.74	-10.2 (-19.4, -1) *	-18.5 (-27.1, -9.9) *	5.13	4.43	3.40	-13.6 (-47.3, 20)	-23.3 (-55.2, 8.6)
NZ	317.89	286.41	294.76	-9.9 (-28.6, 8.8)	2.9 (-18.4, 24.2)	5.14	4.98	6.23	-3.1 (-81.6, 75.5)	24.9 (-69.4, 119.3)
All	*332.78*	*295.17*	*240.22*	*-11.30 (-18.75, -3.85) **	*-18.62 (-26.53, -10.70) **	*6.27*	*5.43*	*4.73*	*-13.37 (-40.12, 13.39)*	*-13.02 (-43.46, 17.42)*

* Percentage decrease is statistically significant (P<0.05).

Table 2. Yearly Amenable Mortality Rates (Per 100,000) for Ages 5–9 and 10–14 Years in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015 (See Table S1 for Country-Level Data Availability).

Country	5–9 Years					10–14 Years				
	Yearly Amenable Mortality Rate			% Change (95% CI)		Yearly Amenable Mortality Rate			% Change (95% CI)	
	2001/2005	2006/2010	2011/2015	2006/10 – 2001/05	2011/15 – 2006/10	2001/2005	2006/2010	2011/2015	2006/10 – 2001/05	2011/15 – 2006/10
CA	1.92	2.11	1.38	9.7 (-39.8, 59.2)	-34.6 (-67.4, -1.8) *	1.80	1.80	1.91	.3 (-45.4, 45.9)	5.7 (-43, 54.4)
US	2.58	2.38	2.23	-7.6 (-19.1, 3.9)	-6.4 (-18.4, 5.6)	3.06	2.76	2.52	-9.6 (-19.9, .6)	-8.9 (-19.8, 2)
CL	3.69	3.17	2.94	-14.1 (-49.6, 21.4)	-7.2 (-48.8, 34.4)	3.72	3.16	3.11	-15 (-48.8, 18.8)	-1.4 (-43.8, 41)
IL	1.73	2.05	2.10	18.2 (-75.1, 111.5)	2.6 (-70.9, 76.2)	2.54	2.04	1.73	-19.8 (-79.8, 40.1)	-14.8 (-81.9, 52.4)
JP	2.67	2.50	2.40	-6.2 (-27.4, 15.1)	-3.9 (-26.8, 19)	2.55	2.17	2.20	-14.8 (-34.7, 5.1)	1.2 (-23.7, 26.1)
KR	3.42	2.39	1.86	-30.1 (-50.9, -9.4) *	-22 (-51.6, 7.5)	3.58	2.55	1.99	-28.9 (-48.4, -9.3) *	-21.7 (-47.8, 4.3)
DK	1.78	1.32	1.21	-25.8 (-116.5, 64.9)	-8.4 (-132.4, 91.6)	2.10	1.78	0.72	-15.6 (-106.8, 75.6)	-59.7 (-119.8, .4)
IS	2.00	2.08	0.94	4.2 (-112.8, 104.2)	-54.9 (-118.9, 9)	1.71	1.98	1.23	15.9 (-116.5, 115.9)	-37.8 (-118.6, 43)
FI	0.00	0.94	1.80	N/A	92.2 (-939.2, 192.2)	1.75	4.48	2.81	156.1 (-783, 256.1)	-37.2 (-238.1, 62.8)
NO	2.73	2.20	1.62	-19.4 (-101.6, 62.7)	-26.3 (-111.9, 59.3)	2.14	1.53	1.49	-28.8 (-112.5, 54.9)	-2.6 (-127.2, 97.4)
SE	1.45	1.56	1.53	8.2 (-100.9, 108.2)	-2.1 (-98.2, 94)	2.56	1.80	1.83	-29.7 (-86.2, 26.7)	1.6 (-90.3, 93.4)
AT	2.35	1.36	1.53	-42.1 (-101.4, 17.2)	12.7 (-116.1, 112.7)	2.03	2.18	1.62	7.8 (-86.9, 102.6)	-25.9 (-97.9, 46.2)
BE	2.02	2.13	1.52	5.5 (-77.9, 88.9)	-28.7 (-88.6, 31.2)	2.41	1.96	1.53	-18.6 (-80.2, 43)	-22.1 (-88.6, 44.3)
FR	1.89	1.52	1.25	-19.7 (-47.7, 8.3)	-17.5 (-48.8, 13.8)	1.96	1.59	1.41	-18.8 (-46.4, 8.9)	-11.5 (-43.9, 20.8)
DE	2.33	1.80	1.83	-22.9 (-47, 1.2)	1.6 (-33.1, 36.2)	2.55	2.09	1.78	-18 (-41.1, 5.1)	-15.1 (-42.3, 12.1)
LU	1.38	1.69	1.98	22.6 (-487, 122.6)	17.4 (-423.1, 117.4)	2.88	1.98	0.64	-31.1 (-261.7, 68.9)	-67.5 (-231.9, 32.5)
NL	2.14	1.76	1.43	-17.8 (-69.7, 34.1)	-18.8 (-76.2, 38.6)	2.89	2.12	1.85	-26.6 (-67.9, 14.8)	-12.7 (-67.2, 41.8)
CH	1.52	1.82	1.37	19.8 (-109.7, 119.8)	-24.5 (-109.3, 60.2)	2.24	1.23	1.58	-45.2 (-103.5, 13.2)	27.9 (-120.1, 127.9)
IE	3.03	1.86	1.29	-38.7 (-104.6, 27.1)	-30.4 (-118.1, 57.3)	2.98	2.12	1.96	-28.7 (-103.4, 45.9)	-7.8 (-112.1, 92.2)
GB	2.98	2.59	2.13	-13.1 (-37.5, 11.2)	-17.8 (-42.7, 7)	3.18	2.76	2.35	-13 (-35.9, 9.9)	-14.8 (-39.5, 9.9)
GR	3.13	2.54	2.18	-18.8 (-77.5, 39.9)	-14.2 (-81.6, 53.1)	3.55	2.63	2.79	-25.7 (-76.1, 24.7)	6 (-71.2, 83.2)
IT	2.36	2.08	1.86	-11.8 (-43.2, 19.7)	-10.6 (-44, 22.8)	2.84	2.29	2.19	-19.3 (-45.8, 7.3)	-4.2 (-37.7, 29.2)
PT	3.23	1.67	1.67	-48.2 (-89.4, -7) *	.1 (-92.8, 93)	4.53	2.66	1.87	-41.2 (-78.8, -3.6) *	-29.7 (-85.5, 26.1)
ES	3.04	2.45	2.02	-19.3 (-49.1, 10.5)	-17.5 (-49.4, 14.4)	3.40	2.64	2.14	-22.3 (-49.6, 5)	-18.9 (-50.2, 12.4)
CZ	2.15	2.26	2.27	5.2 (-84.8, 95.3)	.7 (-82.6, 84)	2.67	2.25	1.87	-15.7 (-79.5, 48)	-17 (-90.8, 56.8)
EE	3.32	3.50	1.40	5.7 (-191.8, 105.7)	-60.2 (-154.3, 34)	4.61	1.84	1.79	-60 (-141.2, 21.2)	-3 (-253.9, 97)
HU	3.34	2.36	2.44	-29.4 (-81.9, 23.1)	3.3 (-80.6, 87.3)	3.58	3.50	2.92	-2.3 (-62.7, 58)	-16.5 (-74.2, 41.2)
LV	4.53	4.62	3.53	1.9 (-129.9, 101.9)	-23.4 (-130.1, 76.6)	3.65	4.06	1.32	11 (-128.4, 111)	-67.4 (-133.5, -1.3) *
LT	3.82	3.35	2.78	-12.2 (-110.1, 85.6)	-16.9 (-126.8, 83.1)	3.08	4.14	1.21	34.2 (-98.2, 134.2)	-70.7 (-118.1, -23.2) *
PL	2.99	3.14	2.97	4.9 (-32.2, 41.9)	-5.3 (-40, 29.4)	3.03	3.52	3.30	16.1 (-20.2, 52.4)	-6.1 (-37.7, 25.5)
SK	3.27	4.34	3.19	32.7 (-78.9, 132.7)	-26.5 (-91.2, 38.2)	3.70	4.23	3.35	14.4 (-71.3, 100.1)	-20.9 (-87.9, 46.2)
SI	1.67	2.20	1.64	31.6 (-242, 131.6)	-25.6 (-180.2, 74.4)	2.61	1.24	1.74	-52.4 (-153.7, 47.6)	40.3 (-291.8, 140.3)
AU	2.14	1.81	1.76	-15.6 (-61.1, 30)	-2.5 (-56.6, 51.6)	2.24	2.13	1.80	-4.8 (-52.7, 43.1)	-15.6 (-60.3, 29.1)
NZ	2.11	2.01	1.37	-5 (-112.6, 95)	-32 (-118.6, 54.6)	3.04	2.71	2.96	-10.6 (-94.3, 73.1)	9.1 (-95.1, 109.1)
All	*2.59*	*2.28*	*2.02*	*-11.94 (-49.31, 25.43)*	*-11.26 (-53.86, 31.34)*	*2.87*	*2.48*	*2.16*	*-13.53 (-47.69, 20.63)*	*-13.08 (-52.82, 26.65)*

* Percentage decrease is statistically significant (P<0.05).

Cause-specific childhood mortality rates

Examining the distribution of cause-specific mortality rates across multiple age groups and study periods, we found no statistically significant variations in the OECD countries studied. The only exception was a significant decrease in deaths in the first year of life for conditions originating in the early neonatal period (2001/2005 - 2006/2010: from 266.3 to 239.8 per 100,000, %Δ -9.9% [95% CI -18.4%, -1.5%]; 2006/2010 - 2011/2015: from 239.8 to 193.8 per 100,000, %Δ -19.2% [95% CI -27.9%, -10.4%]) (Table S3).

Despite this variation, globally, for the years 2001/2005, 2006/2010 and 2011/2015, there were no significant differences in the age-specific percentage distribution of causes of death (<1 years: Friedman test 0.955, P 0.372, 1-4 years: Friedman test 0.864, P 0.607; 5-9 years: Friedman test 0.470, P 0.740; 10-14 years: Friedman test 1.773, P 0.398) The three leading causes of death by age groups over the 15-year study period were the following: conditions originating in the early neonatal period, congenital cardiovascular anomalies, and pneumonia for <1 year; congenital cardiovascular anomalies, leukaemia, and respiratory diseases (excl. pneumonia/flu) for all other age groups (Table 3).

Table 3. Percentage Distribution of the Causes of Death Amenable to Healthcare in 34 OECD Countries, Years 2001/2005, 2006/2010 and 2011/2015.

Cause of Death	<1 Year Rank (%)			1–4 Years Rank (%)			5–9 Years Rank (%)			10–14 Years Rank (%)		
	2001/05	2006/10	2011/15	2001/05	2006/10	2011/15	2001/05	2006/10	2011/15	2001/05	2006/10	2011/15
Tuberculosis	#16 (0.01)	#18 (0.01)	#19 (0.00)	#15 (0.27)	#16 (0.24)	#16 (0.24)	#17 (0.31)	#18 (0.28)	#21 (0.11)	#19 (0.35)	#20 (0.17)	#20 (0.22)
Septicaemia	#4 (1.50)	#4 (1.39)	#4 (1.04)	#5 (7.57)	#5 (8.18)	#6 (6.88)	#7 (5.15)	#7 (5.67)	#7 (5.26)	#7 (4.17)	#7 (4.92)	#7 (4.29)
Pneumonia	#3 (1.82)	#3 (1.53)	#3 (1.30)	#4 (12.35)	#4 (12.20)	#4 (12.24)	#4 (8.58)	#4 (7.90)	#5 (9.12)	#6 (7.59)	#6 (6.73)	#6 (7.27)
Influenza	#13 (0.08)	#13 (0.08)	#13 (0.09)	#10 (2.16)	#10 (1.92)	#10 (2.39)	#9 (1.66)	#8 (2.54)	#8 (2.97)	#11 (1.15)	#9 (2.15)	#9 (1.77)
Intestinal infections other than typhoid, diphtheria (0–14 yrs)	#7 (0.27)	#5 (0.60)	#5 (0.72)	#9 (2.45)	#9 (3.05)	#8 (3.98)	#13 (0.87)	#12 (1.25)	#10 (2.00)	#16 (0.54)	#15 (0.62)	#13 (1.00)
Diphtheria, Tetanus, Poliomyelitis	#24 (0.00)	#25 (0.00)	#25 (0.00)	#28 (0.01)	#30 (0.00)	#30 (0.00)	#26 (0.03)	#26 (0.03)	#26 (0.02)	#30 (0.02)	#32 (0.00)	#30 (0.00)
Whooping cough (0–14 yrs)	#11 (0.11)	#12 (0.10)	#10 (0.19)	#26 (0.02)	#27 (0.01)	#22 (0.05)	#30 (0.00)	#31 (0.00)	#26 (0.02)	#30 (0.02)	#30 (0.03)	#30 (0.00)
Measles (1–14 yrs)	#29 (0.00)	#30 (0.00)	#25 (0.00)	#21 (0.15)	#30 (0.00)	#23 (0.02)	#19 (0.27)	#29 (0.01)	#28 (0.00)	#24 (0.11)	#27 (0.07)	#27 (0.04)
Colorectal cancer	#22 (0.00)	#22 (0.00)	#19 (0.00)	#25 (0.03)	#23 (0.03)	#23 (0.02)	#24 (0.06)	#22 (0.07)	#25 (0.07)	#18 (0.36)	#18 (0.24)	#17 (0.39)
Malignant neoplasm of skin	#24 (0.00)	#26 (0.00)	#23 (0.00)	#26 (0.02)	#25 (0.02)	#28 (0.01)	#26 (0.03)	#24 (0.06)	#23 (0.09)	#27 (0.04)	#26 (0.09)	#23 (0.10)
Breast cancer	#23 (0.00)	#23 (0.00)	#23 (0.00)	#29 (0.00)	#27 (0.01)	#23 (0.02)	#25 (0.04)	#26 (0.03)	#28 (0.00)	#32 (0.01)	#29 (0.04)	#30 (0.00)
Cervical cancer and uterine cancer	#24 (0.00)	#26 (0.00)	#25 (0.00)	#29 (0.00)	#26 (0.02)	#23 (0.02)	#30 (0.00)	#29 (0.01)	#28 (0.00)	#29 (0.03)	#31 (0.01)	#27 (0.04)
Neoplasm of the testis	#24 (0.00)	#23 (0.00)	#25 (0.00)	#23 (0.05)	#21 (0.05)	#23 (0.02)	#26 (0.03)	#26 (0.03)	#23 (0.09)	#23 (0.13)	#25 (0.11)	#21 (0.14)
Hodgkin's disease	#29 (0.00)	#26 (0.00)	#25 (0.00)	#24 (0.04)	#27 (0.01)	#28 (0.01)	#16 (0.35)	#17 (0.31)	#15 (0.31)	#13 (0.83)	#13 (0.92)	#15 (0.57)
Leukaemia	#8 (0.21)	#8 (0.26)	#8 (0.24)	#3 (14.55)	#3 (13.99)	#2 (14.99)	#1 (31.72)	#1 (28.35)	#1 (27.31)	#1 (31.3)	#1 (30.01)	#1 (30.24)
Thyroid disorders	#17 (0.01)	#21 (0.01)	#22 (0.00)	#22 (0.10)	#21 (0.05)	#21 (0.07)	#23 (0.10)	#24 (0.06)	#21 (0.11)	#24 (0.11)	#24 (0.12)	#24 (0.08)
Diabetes mellitus	#21 (0.01)	#15 (0.02)	#17 (0.01)	#13 (0.42)	#13 (0.38)	#14 (0.31)	#12 (0.97)	#13 (0.86)	#13 (0.81)	#8 (2.49)	#8 (2.31)	#8 (1.97)
Epilepsy	#9 (0.17)	#9 (0.17)	#9 (0.23)	#7 (5.16)	#7 (5.50)	#5 (7.20)	#5 (7.81)	#5 (7.86)	#4 (10.37)	#5 (7.73)	#5 (7.89)	#4 (10.36)
Rheumatic heart diseases	#15 (0.02)	#17 (0.01)	#18 (0.01)	#18 (0.21)	#15 (0.25)	#20 (0.12)	#17 (0.31)	#20 (0.15)	#18 (0.20)	#17 (0.46)	#17 (0.34)	#18 (0.28)
Ischemic heart diseases: 50% of deaths	#14 (0.04)	#14 (0.04)	#14 (0.03)	#16 (0.25)	#17 (0.22)	#15 (0.28)	#15 (0.38)	#15 (0.40)	#16 (0.24)	#15 (0.63)	#16 (0.59)	#14 (0.59)
Cerebrovascular diseases	#6 (0.51)	#6 (0.60)	#6 (0.38)	#8 (3.86)	#8 (4.13)	#9 (3.38)	#6 (6.87)	#6 (7.13)	#6 (6.69)	#4 (8.12)	#4 (8.99)	#5 (9.08)
Hypertensive diseases	#19 (0.01)	#16 (0.01)	#15 (0.01)	#20 (0.17)	#20 (0.13)	#18 (0.19)	#21 (0.19)	#19 (0.21)	#18 (0.20)	#21 (0.22)	#19 (0.18)	#24 (0.08)
Nephritis and nephrosis	#5 (0.54)	#7 (0.49)	#7 (0.25)	#11 (1.41)	#11 (1.48)	#12 (1.12)	#10 (1.60)	#10 (1.69)	#11 (1.72)	#9 (1.79)	#10 (1.91)	#12 (1.24)
Benign prostatic hyperplasia	#29 (0.00)	#30 (0.00)	#25 (0.00)	#29 (0.00)	#30 (0.00)	#30 (0.00)	#30 (0.00)	#31 (0.00)	#28 (0.00)	#33 (0.00)	#32 (0.00)	#30 (0.00)
All respiratory diseases, excl. pneumonia/influenza (1–14 yrs)	#29 (0.00)	#30 (0.00)	#25 (0.00)	#2 (15.6)	#2 (16.79)	#3 (14.25)	#3 (12.91)	#2 (16.28)	#2 (13.87)	#3 (13.66)	#2 (15.28)	#2 (13.66)
Peptic ulcer	#17 (0.01)	#19 (0.01)	#19 (0.00)	#19 (0.19)	#19 (0.17)	#16 (0.24)	#22 (0.16)	#21 (0.13)	#18 (0.20)	#20 (0.24)	#20 (0.17)	#19 (0.26)
Appendicitis	#20 (0.01)	#19 (0.01)	#16 (0.01)	#14 (0.3)	#17 (0.22)	#19 (0.18)	#14 (0.78)	#14 (0.75)	#14 (0.46)	#14 (0.79)	#14 (0.75)	#16 (0.53)
Abdominal hernia	#10 (0.17)	#10 (0.13)	#12 (0.11)	#17 (0.24)	#14 (0.36)	#13 (0.33)	#20 (0.21)	#16 (0.33)	#17 (0.22)	#22 (0.20)	#22 (0.15)	#21 (0.14)
Cholelithiasis and cholecystitis	#24 (0.00)	#26 (0.00)	#25 (0.00)	#29 (0.00)	#23 (0.03)	#30 (0.00)	#26 (0.03)	#22 (0.07)	#28 (0.00)	#27 (0.04)	#28 (0.05)	#27 (0.04)
Maternal deaths	#29 (0.00)	#30 (0.00)	#25 (0.00)	#29 (0.00)	#30 (0.00)	#30 (0.00)	#30 (0.00)	#31 (0.00)	#28 (0.00)	#26 (0.08)	#23 (0.13)	#26 (0.06)
Conditions originating in the early neonatal period	#1 (80.02)	#1 (81.25)	#1 (80.69)	#6 (5.59)	#6 (5.6)	#7 (5.06)	#8 (2.25)	#9 (2.48)	#9 (2.80)	#10 (1.57)	#11 (1.78)	#10 (1.52)

Congenital cardiovascular anomalies	#2 (14.38)	#2 (13.15)	#2 (14.55)	#1 (25.67)	#1 (23.63)	#1 (25.21)	#2 (14.91)	#3 (13.67)	#3 (13.12)	#2 (14.13)	#3 (12.17)	#3 (12.62)
Misadventures to patients during surgical and medical care	#12 (0.09)	#11 (0.11)	#11 (0.11)	#12 (1.17)	#12 (1.33)	#11 (1.18)	#11 (1.41)	#11 (1.37)	#12 (1.61)	#12 (1.08)	#12 (1.08)	#11 (1.40)
Total number of deaths	*190 169.5*	*175 008*	*105 210.5*	*14 437.5*	*12 738*	*8491.5*	*7704.5*	*6706*	*4541*	*9109*	*7578.5*	*4921*

Country-specific childhood amenable mortality rates

The amenable mortality rate for the population aged <1 year dropped significantly over the study period in 24 countries (United States, Israel, Japan, South Korea, Czech Republic, Estonia, France, Germany, Italy, Greece, Latvia, Lithuania, Hungary, Denmark, Finland, Sweden, Poland, Spain, Netherland, Austria, Portugal, Ireland, United Kingdom and Australia). In addition to the decrease in conditions originating in early neonatal period mortality, other causes contributed to a significant reduction in mortality: septicaemia, pneumonia and nephritis/nephrosis played roles in the United States, septicaemia played a role in Poland, and congenital cardiovascular anomalies played roles in Japan and Spain (Table S4).

Although the overall OECD rate did not decrease significantly in the population aged ≥1 years, some country-specific data exhibited significant trends (Tables 1). In 8 countries (Chile, United States, South Korea, France, Germany, Ireland, Portugal and Spain), there was a significant decrease in the mortality rate of children aged 1 to 4 (Table 1); the decline in pneumonia played an important role in Chile and the United States, respiratory diseases in South Korea, Ireland and Portugal, and congenital cardiovascular anomalies in Chile, United States, South Korea and Ireland (Table S5).

In 3 countries (Canada, South Korea and Portugal), a significant decrease in the mortality rate of children aged 5 to 9 (Table 2) was observed, driven by a significant decrease in deaths from leukaemia, pneumonia and respiratory pathologies, respectively (Table S6). In 4 countries (South Korea, Latvia, Lithuania and Portugal) there was a significant decrease in the mortality rate of children aged 10 to 14 (Table 2). For this age group, no specific condition contributed to this trend in a predominant way (Table S7).

DISCUSSION

In this observational longitudinal study, we found a significant decline in childhood amenable mortality rates for the <1 age group in all 34 OECD countries between 2001/2005 and 2011/2015, and a slow decline in the other age groups. These results confirm the trend shown by previous studies

conducted on six OECD countries that were selected to provide a variety of forms of health care delivery between 1956 and 1980,[22] and these results highlight that policies to reduce amenable mortality rates are still needed, even in settings where the quality of medical services and resources is high.

These results were affected by the fact that the only cause of death that was significantly reduced was conditions originating in the early neonatal period in the <1-year class. Surprisingly, the decline was not more pronounced among countries with higher mortality in 2001, indicating that continued gains occurred both in low-mortality and high-mortality countries. The most representative countries were Japan and Finland, which showed a remarkable improvement in their performance, despite starting from low values in 2001/2005, and countries such as Hungary and the US, which showed high amenable mortality rates in 2001/2005.

The strong decline in the amenable rate for conditions originating in the early neonatal period suggests that substantial progress has been made in the improvement of timely and effective healthcare, on those factors that the literature considers important for amenable mortality and referring to a national policy on providing access to healthcare services[23] and cooperation between healthcare professionals, on the implementation of a perinatal audit[24] or the presence and content of clinical practice guidelines for antenatal and perinatal care, and/or on barriers to the adherence of these guidelines.[25] The 4 most representative countries mentioned above may again be taken as examples. In Japan, the marked decrease in amenable mortality to 54.2 since 2001 was likely achieved through improvements in access to medical care, permitting a significant decline in home births and an increase in the number of births in hospitals and/or clinics (hospital births). Prompt and appropriate medical care in cases of perinatal problems, guaranteed through the introduction of effective medical care and innovative treatments, appears to be another important factor contributing to improvements in outcomes for children.[26] A system organised by the level of the care that promises all children access to the appropriate level of the care may have improved the outcome in Finland,[27] so changes may also result from national programmes, such as the National Fetal and Infant Mortality Review

Program (NFIMR) in the US. The decrease of mortality in Hungary may be due to the introduction of evidence-based protocols on routine and essential new-born care to the hospital and trained delivery room and nursery staff members on the protocols.[28]

Our results on country-specific childhood amenable mortality rates showed that the reductions in the age classes' mortality rates were not evenly distributed across OECD countries. There was not a single cause for which the age classes' mortality rates declined in the countries studied, and the success in reducing mortality rates was not consistent for all causes. These achievements corroborate another of our results, highlighting that the causal distribution of the age classes' mortality rates did not vary over the period examined and that the conditions originating in the early neonatal period, namely, congenital cardiovascular anomalies, pneumonia, leukaemia, and all respiratory diseases (excl. pneumonia/influenza), are always positioned in high ranks. Because these are the main causes related to chronic disorders and pathologies that require acute care delivered quickly, our results suggest that the models of care for children must be revised. Wolf[29] highlights that the presence of children with chronic disorders requires substantial changes from a hospital-centric model to a model in which primary care and secondary care providers and public health services work closely together. Community-based delivery improves access and represents the first contact between patients and clinicians. Although an international debate is open on the best pattern of paediatric primary care among a paediatrician-based system, a combined system or a system based on GPs/FDs,[30] some authors highlight the importance of primary care paediatricians, especially to diagnose diseases such as cancer. Symptom interpretation is crucial because it influences the time interval from the first symptom presentation to diagnosis, but it can be difficult because the numbers are small and children with cancer present vague and non-specific symptoms.[31] Primary care paediatricians who look after children are likely to have more professional training and competencies than a general practitioner (GP).[29]

The mortality rates for pneumonia were high for the <1-year age group, especially in 3 states: Poland, Slovakia and Chile. There may be several reasons for these high rates. In Chile, the healthcare system

replicates class inequalities. Studies have identified and tracked several important inequalities in the burden of infant mortality for infectious diseases by socioeconomic level in Chile, and they have shown that this gap is discriminatory because disadvantaged households underutilise health care services (due to social or economic exclusion).[32] The mortality trend for pneumonia in Poland might be partly explained by differences in timely antimicrobial treatment together with the only recommendation for the vaccines against invasive infections caused by *S. pneumonia*, which means that they are not refunded by the Ministry of Health.[33] The Slovak social health insurance system formally covers all residents and has a benefit package that all insurance companies must provide for their insured. In theory, the insurance system is thus designed to provide everybody with the same benefit package, regardless of their health status, ability to pay or place of residence. In practice, coverage varies across the country, mainly because the supply of human resources is not adequate in all regions and districts, and sometimes providers are simply not available. If providers are available, they also tend to cluster in regional capitals. The Slovak Republic has one of the largest disparities in doctor supply between urban and rural areas among EU countries. In addition, there are large variations in the availability of specialists and GPs in each region. Deprived areas tend to have fewer doctors and other health professionals, especially areas with a large Roma population, a group that suffers from a poor health status and has limited access to care.[34]

Our study has the same limitations as all studies that use secondary data. It is undeniable that international variations in birth registration laws and practices and the process of death certification have the potential to bias the international comparisons of child mortality. Additionally, international comparisons of mortality rates are confounded by the various ways in which countries classify preterm infants near the threshold of viability.[35–37] Considering these issues, our study analyses the trend of amenable mortality rates, and a comparison analysis was not performed.

Although much of the literature assessing the contribution of health care to health focuses on mortality data, data on children may be of limited value because the number of deaths is small, making

interpretation difficult. However, we believe that the problem of low numbers is mitigated by the fact that our study analysed the rates and trajectory of multiple countries over the 15-year time period.

Finally, our analysis did not account for mortality disparities within countries that were attributable to ethnicity, race or socioeconomic characteristics, geographic residence, or race/ethnicity since our data sources did not collect demographic or social information. Evidence from the US, for example, also showed higher levels of amenable mortality among people disadvantaged in terms of race or socioeconomic status.[38,39] Considering that the perinatal mortality of the US has a prevailing effect on premature births and that striking racial disparities persist, with African Americans exhibiting higher rates of preterm delivery than any other major racial/ethnic group,[40] potentially large variations within populations may be concealed.

Some preliminary conclusions can be drawn from this study. Over the 15-year period from 2001 to 2015, the under-1-year-old amenable mortality rate progressively declined in 24 OECD countries. Second, OECD countries had success in reducing mortality from conditions originating in the early neonatal period. These are tremendous successes of the public health system.

Finally, the low decline in amenable mortality rates for children ≥1 year, the variance in amenable mortality rates across countries and the insufficient success in reducing mortality from all causes suggest that the heath system must increase its efforts to improve health outcomes for children.

DECLARATIONS

Ethics approval and consent to participate

Not applicable

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Acknowledgements

Not applicable.

Author Contributions

MMG and GD formulated the research goals and supervised the research activity; MMG, GD, JL defined the design of the methodology; MMG wrote the article; RS, WR and MPF revised the article; MB collected the data and managed the database; JL utilised statistical techniques to analyse the study data.

All authors have read and approved the manuscript.

REFERENCES

1 Blum RW, Nelson-Mmari K. The health of young people in a global context. *J Adolesc Health Off Publ Soc Adolesc Med* 2004;**35**:402–18. doi:10.1016/j.jadohealth.2003.10.007

2 WHO. Children: reducing mortality. http://www.who.int/news-room/fact-sheets/detail/children-reducing-mortality (accessed 3 Oct 2018).

3 Fraser J, Sidebotham P, Frederick J, *et al.* Learning from child death review in the USA, England, Australia, and New Zealand. *Lancet Lond Engl* 2014;**384**:894–903. doi:10.1016/S0140-6736(13)61089-2

4 Kyu HH, Stein CE, Pinto CB, *et al.* Causes of death among children aged 5–14 years in the WHO European Region: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet Child Adolesc Health* 2018;**2**:321–37. doi:10.1016/S2352-4642(18)30095-6

5 Sidebotham P, Fraser J, Covington T, *et al.* Understanding why children die in high-income countries. *The Lancet* 2014;**384**:915–27. doi:10.1016/S0140-6736(14)60581-X

6 Alio AP, Richman AR, Clayton HB, *et al.* An ecological approach to understanding black-white disparities in perinatal mortality. *Matern Child Health J* 2010;**14**:557–66. doi:10.1007/s10995-009-0495-9

7 Gakidou E, Cowling K, Lozano R, *et al.* Increased educational attainment and its effect on child mortality in 175 countries between 1970 and 2009: a systematic analysis. *Lancet Lond Engl* 2010;**376**:959–74. doi:10.1016/S0140-6736(10)61257-3

8 Lightfoot TJ, Johnston WT, Simpson J, *et al.* Survival from childhood acute lymphoblastic leukaemia: the impact of social inequality in the United Kingdom. *Eur J Cancer* 2012;**48**:263–9. doi:10.1016/j.ejca.2011.10.007

9 Gore FM, Bloem PJN, Patton GC, *et al.* Global burden of disease in young people aged 10-24 years: a systematic analysis. *Lancet Lond Engl* 2011;**377**:2093–102. doi:10.1016/S0140-6736(11)60512-6

10 Lavergne MR, McGrail K. What, If Anything, Does Amenable Mortality Tell Us about Regional Health System Performance? *Healthc Policy* 2013;**8**:79-90a.

11 Office for National Statistics. *Definitions of avoidable mortality*. London: ONS: 2011. http://www.networks.nhs.uk/nhs-networks/east-of-england-respiratory-programme/news/ons-consultation-on-avoidable-mortality-closes-12-april.

12 Rutstein DD, Berenberg W, Chalmers TC, *et al.* Measuring the quality of medical care. A clinical method. *N Engl J Med* 1976;**294**:582–8. doi:10.1056/NEJM197603112941104

13 Department of Health. The NHS Outcomes Framework 2011/12. 2010.https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/213789/dh_123138.pdf

14 Gay JG, Paris V, Devaux M, *et al.* Mortality Amenable to Health Care in 31 OECD Countries: estimates and methodological Issues. Published Online First: 31 January 2011. doi:https://doi.org/10.1787/5kgj35f9f8s2-en

15 Nolte E, McKee CM. Measuring the health of nations: updating an earlier analysis. *Health Aff Proj Hope* 2008;**27**:58–71. doi:10.1377/hlthaff.27.1.58

16 World Bank. World Development Indicators | DataBank. 2018.http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators (accessed 3 Oct 2018).

17 World Health Organization. WHO Mortality Database. 2018.http://www.who.int/healthinfo/mortality_data/en/ (accessed 3 Oct 2018).

18 United Nations. Demographic Statistics Database. 2018.http://data.un.org/Data.aspx?d=POP&f=tableCode%3A22 (accessed 3 Oct 2018).

19 Nolte E, McKee M. *Does health care save lives? Avoidable mortality revisited.* The Nuffield Trust 2004. http://researchonline.lshtm.ac.uk/15535/ (accessed 3 Oct 2018).

20 Eurostat. Amenable and preventable deaths of residents. https://ec.europa.eu/eurostat/web/products-datasets/-/hlth_cd_apr (accessed 3 Oct 2018).

21 Hildebrandt M, Bender R, Gehrmann U, *et al.* Calculating confidence intervals for impact numbers. *BMC Med Res Methodol* 2006;**6**:32. doi:10.1186/1471-2288-6-32

22 Charlton JR, Velez R. Some international comparisons of mortality amenable to medical intervention. *Br Med J Clin Res Ed* 1986;**292**:295–301.

23 Kamarudeen S. Amenable mortality as an indicator of healthcare quality - a literature review. *Health Stat Q* 2010;:66–80. doi:10.1057/hsq.2010.16

24 de Jonge A, Baron R, Westerneng M, *et al.* Perinatal mortality rate in the Netherlands compared to other European countries: a secondary analysis of Euro-PERISTAT data. *Midwifery* 2013;**29**:1011–8. doi:10.1016/j.midw.2013.02.005

25 Richardus JH, Graafmans WC, Verloove-Vanhorick SP, *et al.* Differences in perinatal mortality and suboptimal care between 10 European regions: results of an international audit. *BJOG Int J Obstet Gynaecol* 2003;**110**:97–105.

26 Maeda K. Progress of Perinatal Medicine in Japan. *J Health Med Inform* 2013;**s11**. doi:10.4172/2157-7420.S11-002

27 Viisainen K, Gissler M, Hemminki E. Birth outcomes by level of obstetric care in Finland: a catchment area based analysis. *J Epidemiol Community Health* 1994;**48**:400–5. doi:10.1136/jech.48.4.400

28 Kuchna D, Hovsepyan A, Leonard S. Preventing Newborn Deaths In Romania And Hungary. *Health Aff (Millwood)* 2017;**36**:1160–1160. doi:10.1377/hlthaff.2017.0382

29 Wolfe I, Thompson M, Gill P, *et al.* Health services for children in western Europe. *Lancet Lond Engl* 2013;**381**:1224–34. doi:10.1016/S0140-6736(12)62085-6

30 Katz M, Rubino A, Collier J, *et al.* Demography of pediatric primary care in Europe: delivery of care and training. *Pediatrics* 2002;**109**:788–96.

31 Feltbower RG, Lewis IJ, Picton S, *et al.* Diagnosing childhood cancer in primary care – a realistic expectation? *Br J Cancer* 2004;**90**:1882–4. doi:10.1038/sj.bjc.6601733

32 Hertel-Fernandez AW, Giusti AE, Sotelo JM. The Chilean infant mortality decline: improvement for whom? Socioeconomic and geographic inequalities in infant mortality, 1990-2005. *Bull World Health Organ* 2007;**85**:798–804.

33 Gajewska M, Lewtak K, Scheres J, *et al.* Trends in Hospitalization of Children with Bacterial Pneumonia in Poland. *Cent Eur J Public Health* 2016;**24**:188–92. doi:10.21101/cejph.a4164

34 OECD. State of Health in the EU Slovak Republic: Country Health Profile 2017 - European Observatory on Health Systems and Policies. 2017.

35 Kramer MS, Platt RW, Yang H, *et al.* Registration artifacts in international comparisons of infant mortality. *Paediatr Perinat Epidemiol* 2002;**16**:16–22. doi:10.1046/j.1365-3016.2002.00390.x

36 Joseph KS, Liu S, Rouleau J, *et al.* Influence of definition based versus pragmatic birth registration on international comparisons of perinatal and infant mortality: population based retrospective study. *The BMJ* 2012;**344**. doi:10.1136/bmj.e746

37 Mohangoo AD, Blondel B, Gissler M, *et al.* International Comparisons of Fetal and Neonatal Mortality Rates in High-Income Countries: Should Exclusion Thresholds Be Based on Birth Weight or Gestational Age? *PLOS ONE* 2013;**8**:e64869. doi:10.1371/journal.pone.0064869

38 Schwartz E, Kofie VY, Rivo M, *et al.* Black/white comparisons of deaths preventable by medical intervention: United States and the District of Columbia 1980-1986. *Int J Epidemiol* 1990;**19**:591–8. doi:10.1093/ije/19.3.591

39 Macinko J, Elo IT. Black–white differences in avoidable mortality in the USA, 1980–2005. *J Epidemiol Community Health* 2009;**63**:715–21. doi:10.1136/jech.2008.081141

40 Riddell CA, Harper S, Kaufman JS. Trends in Differences in US Mortality Rates Between Black and White Infants. *JAMA Pediatr* 2017;**171**:911–3. doi:10.1001/jamapediatrics.2017.1365

WHAT IS ALREADY KNOWN ON THIS SUBJECT

Many different factors contributing to child and adolescent mortality have been studied, including: biological and psychosocial factors, such as sex, race, ethnic origin or disability, socioeconomic status, engagement in behaviours such as smoking, alcohol misuse, drug misuse, poor diet, and physical activity during adolescence and the physical environment. Whereas the mortality burden is conditioned by the performance of the health care system has not been well investigated.

WHAT THIS STUDY ADDS

Over the 15-year period from 2001 to 2015, the under-1-year-old amenable mortality rate progressively declined in 24 OECD countries. OECD countries had success in reducing mortality from conditions originating in the early neonatal period. These are tremendous successes of the public health system. The low decline in amenable mortality rates for children ≥1 year, the variance in amenable mortality rates across countries and the insufficient success in reducing mortality from all causes suggest that the heath system must increase its efforts to improve health outcomes for children.

Table S1. Data Availability for the 34 OECD Countries (0 “Not Available”/1 “Available”).

Country	Year															Total
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Canada	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	13
Chile	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
United States of America	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	12
Israel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Japan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Republic of Korea	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Austria	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Belgium	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Czech Republic	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Denmark	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Estonia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Finland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
France	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	14
Germany	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Greece	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Hungary	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Iceland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Ireland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	14
Italy	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Latvia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Lithuania	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Luxembourg	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Netherlands	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Norway	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Poland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Portugal	1	1	1	0	0	0	1	1	1	1	1	1	1	1	0	11
Slovakia	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	13
Slovenia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Spain	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Sweden	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Switzerland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
United Kingdom	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Australia	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	14
New Zealand	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	13
All OECD countries	*34*	*34*	*34*	*33*	*32*	*33*	*34*	*34*	*34*	*34*	*32*	*34*	*33*	*31*	*28*	*494*

*Notes:*Causes of death are coded according to the ICD-9 (Austria 2001;Greece 2001/2013; Ireland 2001/2006; Italy 2001/2002; Portugal 2001) or ICD-10 (all other country-years). Reference populations for some country-years were retrieved from UNdata if not available in the WHO Mortality Database (Canada 2006/2013; Chile 2001/2015; United States of America 2008/2010, 2012, 2015; Finland 2015; Ireland 2010, 2014; Switzerland 2014/2015).

Table S2. Nolte and McKee's list of causes of death considered amenable to health care.

Disease category	Age	Diseases	ICD-9 codes	ICD-10 codes
Infectious diseases	0-74	Tuberculosis	010-8, 137	A15-9, B90
	0-74	Septicemia	038	A40-1
	0-74	Pneumonia	480-6	J12-8
	0-74	Influenza	487	J10-1
	0-14	Intestinal infections (other than typhoid, diphtheria)	001-9	A00-9
	0-74	Diphtheria, Tetanus, Poliomyelitis	032, 037, 045	A35-6, A80
	0-14	Whooping cough	033	A37
	1-14	Measles	055	B05
Cancers	0-74	Colorectal cancer	153-4	C18-21
	0-74	Malignant neoplasm of skin	173	C44
	0-74	Breast cancer	174	C50
	0-44	Cervical cancer and uterine cancer	179, 180, 182	C53-5
	0-74	Neoplasm of the testis	186	C62
	0-74	Hodgkin's disease	201	C81
	0-44	Leukemia	204-8	C91-5
Endocrine, nutritional and metabolic diseases	0-74	Thyroid disorders	240-6	E00-7
	0-49	Diabetes mellitus	250	E10-4
Diseases of the nervous system	0-74	Epilepsy	345	G40-1
Diseases of the circulatory system	0-74	Rheumatic heart diseases	393-8	I05-9
	0-74	Ischemic heart diseases: 50% of deaths	410-4	I20-5
	0-74	Cerebrovascular diseases	430-8	I60-9
	0-74	Hypertensive diseases	401-5	I10-3, I15
Diseases of the genitourinary system	0-74	Nephritis and nephrosis	580-9	N00-7, N17-9, N25-7
	0-74	Benign prostatic hyperplasia	600	N40
Diseases of the respiratory system	1-14	All respiratory diseases (excl. pneumonia/influenza)	460-79, 488-519	J00-9, J20-99
Diseases of the digestive system	0-74	Peptic ulcer	531-3	K25-7
	0-74	Appendicitis	540-3	K35-8
	0-74	Abdominal hernia	550-3	K40-6
	0-74	Cholelithiasis and cholecystitis	574-5	K80-1
Perinatal mortality	0-74	Maternal deaths	630-76	O00-99
	0-74	Conditions originating in the early neonatal period	760-79	P00-96
	0-74	Congenital cardiovascular anomalies	745-7	Q20-8
External causes	0-74	Misadventures to patients during surgical and medical care	E870-6, E878-9	Y60-9, Y83-4

Source: Nolte and McKee 2008; Gay et al. 2011.

S3. Yearly Amenable Mortality rates (Per 100,000) of Conditions originating in early neonatal period for Age <1 in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015

Country	Rate 2001/2005	Rate 2006/2010	Rate 2011/2015	% Change 2006/10 – 2001/05	% Change 2011/15 – 2006/10
Canada	293.1 (285, 301.5)	297.1 (289.2, 305.1)	290.8 (280.9, 301)	1.3 (-7.4, 10.1)	-2.1 (-10.3, 6.1)
Chile	329.3 (319.2, 339.7)	341.9 (331.7, 352.3)	324.2 (314.3, 334.4)	3.8 (-6.2, 13.8)	-5.2 (-14.3, 3.9)
United States of America	349.6 (347, 352.2)	322.1 (319.7, 324.5)	295.6 (291.9, 299.5)	**-7.9 (-10, -5.7) ***	**-8.2 (-10.5, -5.9) ***
Israel	229.6 (218.5, 241.1)	174.4 (165.2, 184)	142.4 (134.6, 150.7)	**-24 (-36.3, -11.7) ***	**-18.3 (-32.5, -4.2) ***
Japan	83.6 (81.2, 86)	68.1 (65.9, 70.3)	54.2 (52.2, 56.2)	**-18.5 (-26.4, -10.7) ***	**-20.4 (-29.2, -11.6) ***
Republic of Korea	262 (255.6, 268.5)	186.9 (181.2, 192.7)	160.1 (154.9, 165.5)	**-28.7 (-34.9, -22.4) ***	**-14.3 (-22.9, -5.7) ***
Austria	250.9 (235.3, 267.2)	203.5 (189.5, 218.3)	162.4 (150.1, 175.5)	**-18.9 (-36, -1.8) ***	**-20.2 (-38.8, -1.6) ***
Belgium	193.2 (182, 205)	182.4 (172, 193.4)	162.9 (153.1, 173.2)	-5.6 (-23.1, 11.9)	-10.7 (-27.5, 6.1)
Czech Republic	209.9 (197, 223.4)	167 (156.6, 178)	136 (126.4, 146.1)	**-20.4 (-36.3, -4.6) ***	**-18.6 (-36, -1.1) ***
Denmark	231.3 (215, 248.5)	160.1 (146.6, 174.6)	190.5 (174.9, 207)	-30.8 (-48.1, -13.4) *	18.9 (-12.9, 50.8)
Estonia	290.7 (251.3, 334.7)	188.6 (159.2, 221.8)	109.8 (86.8, 137.1)	**-35.1 (-66.2, -4) ***	**-41.8 (-77.5, -6) ***
Finland	142 (128.4, 156.6)	117.4 (105.4, 130.4)	84.4 (74.2, 95.5)	-17.3 (-43.8, 9.2)	28.2 (-54.3, -2.1) *
France	190.6 (186.2, 195)	175.2 (171, 179.4)	177.1 (172.4, 181.9)	-8.1 (-14.9, -1.3) *	1.1 (-6.5, 8.7)
Germany	195 (190.4, 199.6)	182.5 (178, 187.1)	170.3 (166, 174.7)	-6.4 (-13.5, .8)	-6.7 (-14.1, .8)
Greece	209 (196.8, 221.9)	155.4 (145.3, 165.9)	164.9 (153.7, 176.6)	-25.7 (-40.4, -10.9) *	6.1 (-16.4, 28.7)
Hungary	432.5 (414, 451.7)	334.2 (318, 350.9)	278.4 (263.1, 294.2)	**-22.7 (-34, -11.5) ***	**-16.7 (-30.5, -2.9) ***
Iceland	119.9 (77.5, 176.9)	102 (65.3, 151.8)	67.5 (37.8, 111.3)	-14.9 (-121.4, 85.1)	-33.8 (-129.2, 61.6)
Ireland	189.8 (174.4, 206.3)	154 (141.3, 167.7)	145.1 (131.5, 159.7)	-18.9 (-40.4, 2.7)	-5.8 (-31.2, 19.6)
Italy	232.6 (226.9, 238.4)	203.1 (197.8, 208.4)	177.9 (172.7, 183.1)	**-12.7 (-19.7, -5.7) ***	**-12.4 (-20, -4.8) ***
Latvia	408.7 (370.3, 450)	348.6 (314.9, 384.9)	270.5 (239.3, 304.6)	-14.7 (-41, 11.6)	-22.4 (-49.2, 4.4)
Lithuania	261.4 (236.2, 288.5)	235.8 (212, 261.6)	162.6 (143, 184.2)	-9.8 (-38.6, 19.1)	-31.1 (-56, -6.1) *
Luxembourg	203.1 (152.6, 265.1)	104.2 (69.8, 149.7)	113.3 (78.5, 158.4)	-48.7 (-100.4, 3)	8.7 (-111.7, 108.7)
Netherlands	249.5 (239.8, 259.5)	211.4 (202.1, 221)	199.9 (190.6, 209.5)	-15.3 (-26.5, -4.1) *	-5.4 (-19.1, 8.2)
Norway	166.1 (151.5, 181.8)	158.6 (144.7, 173.6)	123.9 (111.6, 137.2)	-4.5 (-31.7, 22.7)	-21.9 (-45.6, 1.8)
Poland	360.4 (351.7, 369.3)	306.1 (298.4, 313.9)	232.3 (225.4, 239.3)	**-15.1 (-21.7, -8.4) ***	**-24.1 (-30.7, -17.5) ***
Portugal	233.6 (217.6, 250.4)	179.5 (166.7, 193)	181.2 (167.5, 195.6)	-23.2 (-37.6, -8.7) *	.9 (-20.4, 22.3)
Slovakia	301.7 (281, 323.6)	256.6 (238.2, 275.9)	240.2 (217.4, 264.7)	-15 (-34.1, 4.2)	-6.4 (-28.3, 15.5)
Slovenia	203.7 (175, 235.7)	168.8 (144.7, 195.9)	122.3 (102.3, 145.1)	-17.1 (-55.7, 21.5)	-27.6 (-64.2, 9.1)
Spain	209.6 (203.5, 215.8)	181.7 (176.4, 187.1)	166.7 (161.4, 172.1)	-13.3 (-21.4, -5.3) *	-8.2 (-17.2, .7)
Sweden	142.5 (132.1, 153.6)	103.8 (95.4, 112.7)	109.4 (101, 118.3)	-27.2 (-45.3, -9.1) *	5.4 (-21.4, 32.2)
Switzerland	217.4 (202.5, 233.1)	233.3 (218.2, 249.3)	207.7 (193.9, 222.3)	7.3 (-15.7, 30.4)	-11 (-29.8, 7.8)
United Kingdom	289.4 (283.8, 295.2)	256.5 (251.5, 261.6)	214.1 (209.6, 218.7)	**-11.4 (-16.9, -5.9) ***	**-16.6 (-22, -11.2) ***
Australia	244 (234.5, 253.9)	218 (210.4, 225.9)	180.6 (173.9, 187.5)	**-10.7 (-20.6, -.7) ***	**-17.2 (-26.7, -7.6) ***
New Zealand	255.5 (237.2, 274.9)	225.8 (209.4, 243.1)	242.9 (220.9, 266.6)	-11.6 (-32.2, 8.9)	7.6 (-17.2, 32.4)
All OECD countries	266.3 (264.9, 267.6)	239.8 (238.6, 241.1)	193.8 (192.5, 195.1)	**-9.9 (-18.4, -1.5) ***	**-19.2 (-27.9, -10.4) ***

Table S4. Percentage Distribution of Causes of Death Amenable to Healthcare for Age <1 Year in 34 OECD Countries, Years 2011/2015.

Cause of Death	Country																																
	CA	CL	US	IL	JP	KR	AT	BE	CZ	DK	EE	FI	FR	DE	GR	HU	IS	IE	IT	LV	LT	LU	NL	NO	PL	PT	SK	SI	ES	SE	CH	GB	AU	NZ
Tuberculosis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Septicemia	0.6	0.4	1.3	1.4	4.3	0.4	0.1	0.8	1.1	0.0	0.0	0.9	0.5	0.6	2.2	0.1	5.3	0.8	1.6	0.3	1.8	0.0	0.5	0.4	0.8	0.9	0.5	0.0	0.6	2.1	0.0	0.6	0.7	0.9
Pneumonia	0.5	2.7	1.1	0.9	3.6	0.7	0.6	0.7	2.7	0.8	2.0	0.9	0.1	0.5	4.0	1.0	0.0	0.0	0.5	1.5	3.8	0.0	0.2	0.9	3.7	0.6	8.9	2.6	0.4	2.4	0.7	1.0	1.0	3.7
Influenza	0.1	0.1	0.1	0.0	0.1	0.0	0.1	0.2	0.2	0.0	0.0	0.3	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.3	0.3	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0
Intestinal infections other than typhoid, diphtheria (0–14 yrs)	0.3	0.1	1.7	1.3	1.3	0.5	0.4	0.1	0.8	0.0	0.0	0.0	0.5	0.3	0.0	0.3	0.0	0.2	0.3	0.0	0.3	0.0	0.3	0.2	0.1	0.0	0.5	0.0	0.3	0.3	0.0	0.3	0.4	0.7
Diphtheria, Tetanus, Poliomyelitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Whooping cough (0–14 yrs)	0.2	0.9	0.1	0.3	0.1	0.0	0.1	0.3	0.0	0.0	0.0	0.3	0.3	0.0	0.1	0.0	0.0	0.2	0.0	0.6	0.6	0.0	0.2	0.0	0.0	0.6	0.2	0.0	0.7	0.3	0.2	0.3	0.2	0.4
Measles (1–14 yrs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Colorectal cancer	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malignant neoplasm of skin	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Breast cancer	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cervical cancer and uterine cancer	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Neoplasm of the testis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hodgkin's disease	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Leukemia	0.2	0.4	0.1	0.2	0.4	0.4	0.1	0.3	0.2	0.0	0.0	0.3	0.2	0.2	0.8	0.4	0.0	0.0	0.3	0.6	0.0	0.0	0.2	0.4	0.2	0.1	0.3	0.0	0.2	0.5	0.1	0.2	0.2	0.6
Thyroid disorders	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diabetes mellitus	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
Epilepsy	0.2	0.2	0.1	0.6	0.1	0.4	0.0	1.0	0.1	0.2	0.0	0.6	0.3	0.3	0.0	0.1	0.0	0.2	0.2	0.0	0.3	0.0	0.4	0.0	0.1	0.0	0.2	0.0	0.6	0.1	0.6	0.3	0.2	0.6
Rheumatic heart diseases	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ischemic heart diseases: 50% of deaths	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Cerebrovascular diseases	0.2	0.1	0.7	0.3	0.5	0.2	0.3	0.1	0.3	0.0	0.0	0.0	0.2	0.2	0.0	0.1	0.0	0.0	0.8	0.0	0.0	0.0	0.2	0.0	0.1	0.4	0.2	0.0	0.2	0.3	0.0	0.4	0.4	0.2
Hypertensive diseases	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nephritis and nephrosis	0.1	0.1	0.6	0.2	0.3	0.2	0.0	0.0	0.1	0.0	0.0	0.9	0.0	0.1	0.0	0.3	0.0	0.2	0.4	0.0	0.0	0.0	0.1	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.1	0.0
Benign prostatic hyperplasia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All respiratory diseases, excl. pneumonia/influenza (1–14 yrs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Peptic ulcer	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Appendicitis	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Abdominal hernia	0.1	0.0	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.6	0.0	0.3	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.3	0.0	0.0	0.1	0.2
Cholelithiasis and cholecystitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maternal deaths	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Perinatal deaths, excl. stillbirths	87.3	75.9	84.3	75.1	55.7	80.8	82.0	81.9	81.6	86.5	78.8	77.1	83.9	82.5	74.0	79.8	78.9	78.8	79.1	83.2	72.2	89.5	85.2	82.9	73.6	82.5	69.5	85.2	81.6	83.5	82.5	83.4	84.9	82.4
Congenital cardiovascular anomalies	9.9	18.9	9.5	19.6	32.9	16.2	15.9	14.2	12.7	11.9	19.2	18.6	13.7	14.8	18.3	17.9	15.8	19.7	16.0	13.1	20.2	10.5	12.2	14.7	21.2	14.6	19.5	12.3	15.3	9.9	15.6	13.0	11.6	10.4
Misadventures to patients during surgical and medical care	0.1	0.0	0.1	0.1	0.3	0.1	0.1	0.5	0.1	0.5	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.0	0.0	0.3	0.3	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.0	0.0

Table S5. Percentage Distribution of Causes of Death Amenable to Healthcare for Ages 1–4 Years in 34 OECD Countries, Years 2011/2015.

Cause of Death	Country																																		
	CA	CL	US	IL	JP	KR	AT	BE	CZ	DK	EE	FI	FR	DE	GR	HU	IS	IE	IT	LV	LT	LU	NL	NO	PL	PT	SK	SI	ES	SE	CH	GB	AU	NZ
Tuberculosis	0.0	0.3	0.2	0.0	0.0	0.2	0.0	1.9	0.0	2.6	0.0	0.0	0.6	0.2	1.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.3	0.0	0.0	0.3	0.5	0.0
Septicemia	6.1	2.7	7.1	7.1	7.8	4.9	0.0	16.0	4.0	0.0	13.6	0.0	7.7	7.0	2.0	0.9	50.0	5.4	7.5	14.3	6.3	0.0	10.0	2.4	5.5	9.2	1.5	0.0	10.5	0.0	15.2	6.5	10.3	12.8
Pneumonia	16.6	11.6	7.9	6.3	19.3	8.4	10.3	7.5	28.0	2.6	9.1	5.9	3.7	11.1	21.0	12.0	0.0	8.1	4.0	7.1	15.6	0.0	8.1	14.3	21.6	7.7	44.6	5.9	5.5	15.4	3.0	13.7	11.7	17.0
Influenza	3.3	0.3	3.1	0.0	3.6	2.1	1.7	1.9	2.7	0.0	0.0	11.8	1.7	1.0	2.0	0.9	0.0	8.1	1.1	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.6	4.6	0.0	3.3	6.4	4.3
Intestinal infections other than typhoid, diphtheria (0–14 yrs)	2.2	2.4	2.7	3.9	8.6	3.3	3.4	2.8	5.3	7.7	0.0	2.9	10.5	3.8	0.0	8.3	0.0	0.0	0.2	0.0	0.0	0.0	4.5	2.4	1.5	1.5	1.5	5.9	1.5	9.2	6.1	2.5	1.5	4.3
Diphtheria, Tetanus, Poliomyelitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Whooping cough (0–14 yrs)	0.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1
Measles (1–14 yrs)	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Colorectal cancer	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Malignant neoplasm of skin	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Breast cancer	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cervical cancer and uterine cancer	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	7.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Neoplasm of the testis	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hodgkin's disease	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Leukemia	14.4	20.1	15.3	10.2	9.5	19.4	17.2	11.3	12.0	28.2	18.2	14.7	19.4	16.3	15.0	18.5	0.0	16.2	21.8	21.4	15.6	0.0	21.7	23.8	10.7	23.1	15.4	17.6	18.3	29.2	30.3	11.2	15.2	14.9
Thyroid disorders	0.0	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.1	0.0	0.0
Diabetes mellitus	0.6	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.7	0.0	0.0	0.0	0.0	0.2	0.0	3.1	0.0	0.0	0.0	0.2	0.0	1.5	0.0	0.0	0.0	0.0	0.4	0.0	0.0
Epilepsy	7.2	11.9	3.4	22.0	1.5	17.5	5.2	10.3	6.7	5.1	18.2	5.9	12.8	10.9	3.0	11.1	0.0	21.6	9.2	7.1	9.4	0.0	19.0	7.1	4.6	7.7	0.0	5.9	6.4	6.2	3.0	9.1	8.8	12.8
Rheumatic heart diseases	0.0	0.0	0.2	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Ischemic heart diseases: 50% of deaths	0.3	0.0	0.6	0.4	0.4	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.2	0.0
Cerebrovascular diseases	7.2	2.7	6.0	2.4	1.4	3.5	0.0	0.9	0.0	0.0	0.0	2.9	6.0	3.1	2.0	1.9	0.0	2.7	4.6	7.1	3.1	0.0	1.8	7.1	1.1	3.1	3.1	0.0	3.5	1.5	6.1	3.1	2.9	0.0
Hypertensive diseases	0.0	0.3	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nephritis and nephrosis	0.0	2.4	1.6	2.4	0.9	1.4	1.7	3.8	0.0	0.0	0.0	5.9	0.9	1.6	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.9	2.4	0.9	0.0	0.0	0.0	0.9	0.0	0.0	0.4	1.0	0.0
Benign prostatic hyperplasia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All respiratory diseases, excl. pneumonia/influenza (1–14 yrs)	13.9	11.2	19.8	12.5	14.1	12.9	17.2	14.1	20.0	15.4	9.1	17.6	12.3	12.7	7.0	20.4	0.0	2.7	12.3	7.1	0.0	100.0	15.4	2.4	2.0	7.7	4.6	5.9	13.7	10.8	9.1	19.1	18.1	8.5
Peptic ulcer	0.0	0.3	0.0	0.0	0.6	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	2.7	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0
Appendicitis	0.6	0.3	0.2	0.8	0.1	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.0
Abdominal hernia	0.6	0.3	0.5	0.0	0.5	0.2	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.2	7.1	0.0	0.0	0.0	0.0	0.0	1.5	0.0	0.0	0.3	0.0	0.0	0.3	0.5	0.0
Cholelithiasis and cholecystitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maternal deaths	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Perinatal deaths, excl. stillbirths	5.5	5.1	5.6	1.6	3.2	8.4	8.6	5.6	8.0	2.6	0.0	5.9	0.6	5.7	0.0	1.9	0.0	0.0	9.2	0.0	0.0	0.0	2.7	2.4	2.2	1.5	0.0	11.8	10.5	9.2	6.1	5.9	6.4	10.6
Congenital cardiovascular anomalies	21.1	26.9	22.8	29.8	27.1	17.1	31.0	21.6	13.3	30.8	31.8	26.5	21.9	21.5	43.0	23.1	50.0	32.4	25.1	21.4	43.8	0.0	14.5	35.7	47.3	33.8	27.7	41.2	26.7	13.8	21.2	20.8	15.6	12.8
Misadventures to patients during surgical and medical care	0.6	0.3	1.6	0.8	1.1	0.2	3.4	0.0	0.0	5.1	0.0	0.0	0.9	1.4	4.0	0.0	0.0	0.0	0.9	0.0	3.1	0.0	0.9	0.0	0.6	1.5	0.0	5.9	1.2	0.0	0.0	2.3	0.5	0.0

Table S6. Percentage Distribution of Causes of Death Amenable to Healthcare for Ages 5–9 Years in 34 OECD Countries, Years 2011/2015.

Cause of Death	Country																																
	CA	CL	US	IL	JP	KR	AT	BE	CZ	DK	EE	FI	FR	DE	GR	HU	IS	IE	IT	LV	LT	LU	NL	NO	PL	PT	SK	SI	ES	SE	CH	GB	AU	NZ
Tuberculosis	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Septicemia	10.5	2.2	6.2	12.7	8.9	1.8	0.0	2.1	0.0	0.0	0.0	0.0	7.1	4.1	0.0	0.0	50.0	0.0	5.7	5.6	10.5	0.0	5.9	0.0	3.5	2.9	0.0	0.0	1.2	4.8	3.7	5.8	5.5	8.3
Pneumonia	7.8	7.7	6.4	7.6	16.8	3.7	3.2	6.3	27.9	15.0	60.0	0.0	2.5	6.6	6.8	6.7	0.0	0.0	2.3	0.0	0.0	0.0	8.8	0.0	28.0	5.8	26.9	12.5	2.0	4.8	3.7	9.0	6.3	0.0
Influenza	5.2	0.0	3.2	0.0	7.3	0.9	0.0	2.1	3.3	5.0	0.0	7.1	1.5	0.9	3.4	0.0	0.0	0.0	0.4	0.0	0.0	0.0	2.9	0.0	1.8	0.0	0.0	12.5	1.6	7.1	0.0	4.5	3.9	8.3
Intestinal infections other than typhoid, diphtheria (0–14 yrs)	0.0	0.6	1.6	2.5	4.7	1.8	0.0	4.2	1.6	0.0	20.0	0.0	2.5	3.4	0.0	3.4	0.0	0.0	0.8	0.0	5.3	0.0	4.4	0.0	0.4	0.0	0.0	0.0	1.2	0.0	0.0	1.3	1.6	0.0
Diphtheria, Tetanus, Poliomyelitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
Whooping cough (0–14 yrs)	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Measles (1–14 yrs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Colorectal cancer	0.0	0.0	0.0	2.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
Malignant neoplasm of skin	0.0	0.6	0.0	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
Breast cancer	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cervical cancer and uterine cancer	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Neoplasm of the testis	0.0	0.0	0.2	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hodgkin's disease	0.0	0.6	0.2	2.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.8	0.8	0.0
Leukemia	17.0	47.5	20.6	21.5	20.9	39.4	22.6	22.9	27.9	30.0	0.0	28.6	34.6	25.3	39.0	28.6	0.0	29.4	39.9	27.8	42.1	33.3	26.5	48.0	16.7	37.7	23.1	62.5	43.4	35.7	40.7	21.4	28.1	25.0
Thyroid disorders	1.3	0.0	0.2	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diabetes mellitus	0.0	0.0	1.9	0.0	0.2	0.0	0.0	0.0	3.3	0.0	0.0	7.1	0.5	1.6	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.8	0.0	0.0	0.8	2.3	0.0
Epilepsy	14.4	12.2	5.7	11.4	3.7	17.9	19.4	16.7	9.8	10.0	0.0	14.3	19.3	19.1	8.5	23.5	0.0	5.9	6.5	11.1	15.8	0.0	19.1	20.0	9.2	8.7	7.7	12.5	10.5	9.5	14.8	11.8	11.7	25.0
Rheumatic heart diseases	1.3	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	1.5	4.0	0.4	0.0	0.0	0.0	0.4	0.0	3.7	0.3	0.0	0.0
Ischemic heart diseases: 50% of deaths	0.7	0.0	0.3	1.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.8	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	1.4	0.0	0.0	0.2	0.0	0.0	0.3	0.0	0.0
Cerebrovascular diseases	3.9	3.9	8.3	2.5	7.3	11.0	0.0	12.5	9.8	15.0	20.0	0.0	12.2	4.4	1.7	11.8	0.0	0.0	6.1	27.8	10.5	0.0	5.9	4.0	3.5	2.9	7.7	0.0	5.3	2.4	7.4	5.0	4.7	0.0
Hypertensive diseases	0.0	1.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.0	0.0	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Nephritis and nephrosis	0.0	1.1	1.6	5.1	1.6	1.8	0.0	4.2	0.0	0.0	0.0	7.1	0.5	1.6	0.0	1.7	0.0	11.8	3.8	0.0	0.0	0.0	2.9	0.0	1.4	2.9	3.8	0.0	2.8	0.0	0.0	1.5	0.0	0.0
Benign prostatic hyperplasia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All respiratory diseases, excl. pneumonia/influenza (1–14 yrs)	19.6	3.9	24.5	11.4	12.3	9.2	9.7	12.5	8.2	5.0	0.0	21.4	9.7	10.6	5.1	13.4	0.0	23.5	10.3	11.1	5.3	33.3	8.8	4.0	4.6	8.7	11.5	0.0	7.3	4.8	14.8	20.6	18.0	33.3
Peptic ulcer	0.0	0.6	0.2	0.0	0.6	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0
Appendicitis	0.0	1.7	0.5	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.4	2.9	0.0	0.0	0.4	0.0	0.0	1.0	0.0	0.0
Abdominal hernia	0.0	0.0	0.4	0.0	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0
Cholelithiasis and cholecystitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maternal deaths	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Perinatal deaths, excl. stillbirths	5.2	3.3	3.4	0.0	2.7	0.0	6.5	12.5	1.6	0.0	0.0	7.1	0.0	3.8	0.0	0.0	0.0	5.9	5.3	0.0	0.0	0.0	0.0	8.0	0.4	0.0	0.0	0.0	5.3	9.5	0.0	2.0	3.1	0.0
Congenital cardiovascular anomalies	11.8	12.2	12.5	16.5	8.7	9.6	25.8	4.2	4.9	15.0	0.0	7.1	8.1	14.4	30.5	10.1	50.0	23.5	14.4	16.7	10.5	0.0	13.2	12.0	27.7	17.4	15.4	0.0	15.4	16.7	11.1	11.6	12.5	0.0
Misadventures to patients during surgical and medical care	1.3	0.0	1.6	2.5	2.7	0.9	12.9	0.0	0.0	0.0	0.0	0.0	0.5	1.6	3.4	0.0	0.0	0.0	0.8	0.0	0.0	33.3	0.0	0.0	1.4	8.7	3.8	0.0	0.8	2.4	0.0	2.0	1.6	0.0

Table S7. Percentage Distribution of Causes of Death Amenable to Healthcare for Ages 10–14 Years in 34 OECD Countries, Years 2011/2015.

Cause of Death	Country																																	
	CA	CL	US	IL	JP	KR	AT	BE	CZ	DK	EE	FI	FR	DE	GR	HU	IS	IE	IT	LV	LT	LU	NL	NO	PL	PT	SK	SI	ES	SE	CH	GB	AU	NZ
Tuberculosis	0.0	0.0	0.0	0.0	0.0	0.7	2.9	2.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.8	0.0	0.0	0.5	0.8	0.0
Septicemia	6.5	0.5	5.7	8.3	4.9	1.0	2.9	4.3	2.3	0.0	0.0	5.6	4.1	5.0	2.7	0.0	0.0	0.0	6.1	0.0	22.2	0.0	7.5	4.3	1.6	4.8	0.0	0.0	2.9	2.2	3.1	5.3	4.0	0.0
Pneumonia	1.9	4.1	4.6	6.7	11.6	5.6	0.0	4.3	30.2	8.3	36.4	0.0	0.5	5.0	10.8	4.3	0.0	4.2	1.3	0.0	11.1	0.0	9.6	4.3	26.6	2.4	44.4	0.0	3.7	10.9	3.1	6.7	3.2	11.5
Influenza	0.0	0.0	3.1	0.0	1.9	0.3	0.0	2.1	0.0	0.0	0.0	0.0	2.7	0.6	2.7	0.0	0.0	0.0	1.3	0.0	0.0	0.0	1.1	17.4	0.7	0.0	0.0	0.0	0.4	2.2	6.3	2.9	1.6	7.7
Intestinal infections other than typhoid, diphtheria (0–14 yrs)	0.9	0.5	1.0	0.0	1.7	1.4	0.0	0.0	2.3	0.0	0.0	0.0	2.3	1.2	0.0	1.4	0.0	4.2	0.0	0.0	0.0	0.0	1.1	0.0	0.0	0.0	0.0	0.0	1.2	0.0	0.0	1.0	0.0	7.7
Diphtheria, Tetanus, Poliomyelitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Whooping cough (0–14 yrs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Measles (1–14 yrs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Colorectal cancer	0.0	0.0	0.2	3.3	0.8	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.6	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.8	0.0	3.1	0.0	0.0	0.0
Malignant neoplasm of skin	0.0	0.5	0.0	1.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Breast cancer	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cervical cancer and uterine cancer	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.0	0.0	0.0	0.0	4.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Neoplasm of the testis	0.9	0.5	0.0	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Hodgkin's disease	1.9	0.5	0.6	0.0	0.0	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.3	2.7	0.0	0.0	0.0	1.3	0.0	0.0	0.0	1.1	0.0	0.3	0.0	0.0	0.0	0.4	0.0	3.1	1.0	0.8	0.0
Leukemia	34.3	47.8	23.2	28.3	30.2	40.4	23.5	29.8	4.7	25.0	18.2	38.9	37.9	28.1	40.5	35.5	66.7	37.5	46.5	16.7	22.2	100.0	29.9	39.1	20.7	38.6	7.4	50.0	41.2	28.3	34.4	20.2	26.2	11.5
Thyroid disorders	0.0	0.0	0.2	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Diabetes mellitus	2.8	0.5	3.9	0.0	1.9	2.1	0.0	4.3	2.3	8.3	0.0	5.6	0.5	1.8	1.4	0.0	0.0	4.2	1.3	0.0	0.0	0.0	1.1	4.3	0.3	0.0	0.0	0.0	0.4	0.0	0.0	2.4	2.4	0.0
Epilepsy	11.1	8.1	7.3	8.3	6.0	15.3	17.6	12.8	18.6	8.3	18.2	22.2	13.5	19.5	2.7	17.0	33.3	16.7	5.8	16.7	0.0	0.0	18.2	8.7	12.5	7.2	7.4	0.0	5.0	13.0	9.4	13.0	13.5	19.2
Rheumatic heart diseases	0.9	0.5	0.2	3.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.5	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.2	1.6	3.8
Ischemic heart diseases: 50% of deaths	0.0	0.3	0.9	0.0	0.9	0.7	0.0	0.0	0.0	0.0	9.1	0.0	0.2	0.0	0.0	0.7	0.0	0.0	0.6	0.0	0.0	0.0	1.6	0.0	0.3	1.2	0.0	0.0	1.5	0.0	0.0	0.4	0.0	0.0
Cerebrovascular diseases	4.6	11.2	9.0	5.0	14.1	12.9	5.9	4.3	4.7	8.3	0.0	16.7	9.9	8.6	1.4	7.1	0.0	0.0	10.3	33.3	11.1	0.0	5.3	8.7	6.9	9.6	3.7	12.5	7.9	13.0	18.8	4.8	5.6	15.4
Hypertensive diseases	0.0	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
Nephritis and nephrosis	0.0	3.6	1.0	3.3	1.6	2.8	0.0	2.1	2.3	0.0	0.0	0.0	0.0	0.9	2.7	0.0	0.0	0.0	0.6	0.0	11.1	0.0	0.0	0.0	1.6	0.0	0.0	0.0	0.8	0.0	0.0	1.2	1.6	0.0
Benign prostatic hyperplasia	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
All respiratory diseases, excl. pneumonia/influenza (1–14 yrs)	12.0	5.1	21.6	11.7	11.0	5.9	2.9	10.6	11.6	25.0	0.0	0.0	10.8	9.2	5.4	18.4	0.0	12.5	11.0	16.7	0.0	0.0	12.8	4.3	5.6	9.6	14.8	0.0	13.3	8.7	9.4	23.8	23.8	7.7
Peptic ulcer	0.0	0.5	0.3	0.0	0.2	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	2.4	3.7	0.0	0.8	0.0	0.0	0.2	0.0	0.0
Appendicitis	0.0	1.0	0.7	0.0	0.0	0.0	0.0	2.1	4.7	0.0	0.0	0.0	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.4	0.0	0.0	2.2	0.8	0.0
Abdominal hernia	0.9	0.0	0.3	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0
Cholelithiasis and cholecystitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.8
Maternal deaths	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Perinatal deaths, excl. stillbirths	2.8	1.0	2.3	0.0	0.6	0.0	14.7	2.1	0.0	8.3	0.0	0.0	0.0	3.8	0.0	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.8	8.7	0.0	0.7	1.6	3.8
Congenital cardiovascular anomalies	17.6	13.2	12.4	18.3	9.7	8.0	20.6	14.9	16.3	8.3	18.2	11.1	14.0	11.2	25.7	14.2	0.0	16.7	9.7	16.7	11.1	0.0	10.7	8.7	19.3	12.0	14.8	25.0	16.2	13.0	9.4	11.0	11.9	7.7
Misadventures to patients during surgical and medical care	0.9	0.0	1.3	1.7	2.1	0.7	8.8	4.3	0.0	0.0	0.0	0.0	0.0	3.3	0.0	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	7.2	3.7	12.5	0.4	0.0	0.0	1.9	0.8	0.0

BMJ Open

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-027909.R1
Article Type:	Research
Date Submitted by the Author:	08-Mar-2019
Complete List of Authors:	Gianino, Maria Michela; University of Torino, Dept. Public Health and Pediatrics Lenzi, Jacopo; Alma Mater Studiorum - University of Bologna, Department of Biomedical and Neuromotor Sciences Bonaudo, Marco; Università degli Studi di Torino, Department of Public Health Sciences and Pediatrics Fantini, Maria Pia; University of Bologna, Department of Biomedical and Neuromotor Sciences Siliquini, Roberta; University of Turin, Department of Public Health Sciences and Pediatrics Ricciardi, W; Universita Cattolica del Sacro Cuore Sede di Roma, Istituto di Sanità Pubblica; Fondazione Policlinico Universitario 'Agostino Gemelli' IRCCS Damiani, Gianfranco; Universita Cattolica del Sacro Cuore Sede di Roma, Istituto di Sanità Pubblica; Fondazione Policlinico Universitario 'Agostino Gemelli' IRCCS
Primary Subject Heading:	Public health
Secondary Subject Heading:	Health services research, Paediatrics
Keywords:	International health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, amenable mortality, child, childhooh, healthcare, OECD countries

Amenable mortality in children in 34 OECD countries: evidence from a 15–year time trend analysis

Authors:

Maria Michela Gianino[a], Jacopo Lenzi[b], Marco Bonaudo[a], Maria Pia Fantini[b], Roberta Siliquini[a], Walter Ricciardi[cd], Gianfranco Damiani[cd].

Maria Michela Gianino, Professor

a) Department of Public Health Sciences and Pediatrics, Università di Torino

Via Santena 5 bis - 10126 Turin (Italy)

Tel #: +39(0)116705839 - Fax #: +39(0)116705889

mariola.gianino@unito.it

Jacopo Lenzi, PhD

b) Department of Biomedical and Neuromotor Sciences, Alma Mater Studiorum - Università di Bologna

Via Ugo Foscolo 7 - 40123 Bologna (Italy)

Tel #: +39(0)512094836

jacopo.lenzi2@unibo.it

Marco Bonaudo, MSN

a) Department of Public Health Sciences and Pediatrics, Università di Torino

Via Santena 5 bis - 10126 Turin (Italy)

Tel #: +39(0)116705839 - Fax #: +39(0)116705889

marco.bonaudo@unito.it

Maria Pia Fantini, MD, Professor

b) Department of Biomedical and Neuromotor Sciences, Alma Mater Studiorum - Università di Bologna

Via Ugo Foscolo 7 - 40123 Bologna (Italy)

Tel #: +39(0)512094836

mariapia.fantini@unibo.it

Roberta Siliquini, Professor

a) Department of Public Health Sciences and Pediatrics, Università di Torino

Via Santena 5 bis - 10126 Turin (Italy)

Tel #: +39(0)116705812

roberta.siliquini@unito.it

Walter Ricciardi, MD, Professor

c) Fondazione Policlinico Universitario 'Agostino Gemelli' IRCCS, Roma, Italia

Largo Agostino Gemelli 8 - 00168 Roma (Italia)

Tel #: +39(0)630154396

walter.ricciardi@unicatt.it

and

d) Istituto di Sanità Pubblica, Università Cattolica del Sacro Cuore, Roma, Italia

Largo Francesco Vito 1 - 00168 Roma (Italia)

Tel #: +39(0)630154396

walter.ricciardi@unicatt.it

Gianfranco Damiani MD, Professor

c) Fondazione Policlinico Universitario 'Agostino Gemelli' IRCCS, Roma, Italia

Largo Agostino Gemelli 8 - 00168 Roma (Italia)

Tel #: +39(0)630154396

gianfranco.damiani@policlinicogemelli.it

and

d) Istituto di Sanità Pubblica, Università Cattolica del Sacro Cuore, Roma, Italia

Largo Francesco Vito 1 - 00168 Roma (Italia)

Tel #: +39(0)630154396

gianfranco.damiani@unicatt.it

Corresponding Author:

Marco Bonaudo, MSN

a) Department of Public Health Sciences and Pediatrics, Università di Torino

Via Santena 5 bis - 10126 Turin (Italy)

Tel #: +39(0)116705839 - Fax #: +39(0)116705889

marco.bonaudo@unito.it

Words count paper: 3077

Words count abstract: 274

ABSTRACT

Background. The child mortality burden conditioned by the performance of the healthcare system has not been well investigated. This study aimed to analyse the trends of amenable mortality rates (AMRs) in children in 34 OECD countries over the period 2001-2015.

Methods. A time trend analysis was performed. Using data from the WHO Mortality Database and Nolte and McKee's list, AMRs were calculated as the annual number of deaths over the population aged ≤14 years/100,000 inhabitants. The rates were stratified by the age groups (<1, 1–4, 5–9, 10–14 years). All data were summarised by presenting the average rates for the years 2001/2005, 2006/2010, and 2011/2015.

Results. There was a significant decline in children's AMRs in the <1-year group in all 34 OECD countries from 2001/2005 to 2006/2010 (332.78 to 295.17/100,000; %Δ -11.30%; 95% CI -18.75%, - 3.85%) and from 2006/2010 to 2011/2015 (295.17 to 240.22/100,000; %Δ -18.62%; 95% CI -26.53%, -10.70%), and a slow decline in the other age classes. The only cause of death that was significantly reduced was conditions originating in the early neonatal period for the <1-year group. The age-specific distribution of causes of death did not vary significantly over the study period.

Conclusion. The low decline in amenable mortality rates for children aged ≥1 year, the large variation in amenable mortality rates across countries and the insufficient success in reducing mortality from all causes suggest that the heath system should increase its efforts to enhance child survival. Promoting models of co-management between primary care and subspecialty services, encouraging high-quality healthcare and knowledge, financing universal access to healthcare, and adopting best practice guidelines might help reduce amenable child mortality.

Strengths and limitations of this study:

1. This is the first study to analyse trends in child mortality amenable to healthcare.
2. Thirty-four OECD countries were included in the analyses to provide a thorough depiction of amenable child mortality in high-income economies.
3. Mortality was not disaggregated by ethnicity or socioeconomic characteristics.

4. Making international comparisons is difficult due to variations in birth registration laws and death certification practices.

Key words: Amenable mortality, child, childhood, healthcare, healthcare services, OECD countries

INTRODUCTION

The health of children and adolescents is an important goal for every society, both because they are vulnerable and because diseases can affect their quality of life. Measures for protecting and improving children's and adolescents' health will yield economic and social benefits beyond improved health outcomes. Indeed, young people have the potential to affect the health of future populations as well as global economic development unless timely and effective strategies are put into place.[1,2]

For the adoption of new strategies and the planning of interventions, information on the leading causes of death is essential. Many studies have analysed the mortality rates and have identified the main causes of death of children in specific countries [3] or areas.[4] Studies have demonstrated that many different factors contribute to child and adolescent mortality [5], including biological and psychosocial,[6] socioeconomic status,[7,8] environmental and behavioural factors.[9] In the landscape described, the mortality burden conditioned by the performance of the healthcare system has not been well investigated. Although there is no indicator that is able to compressively reflect the performance of the healthcare system, a suitable measurement seems to be the concept of amenable mortality.

Amenable mortality is defined as deaths that, in the light of medical knowledge and technology at the time of death, could be prevented by timely access to good quality care. The concept of mortality amenable to healthcare finds its origins in the evolution of the concept of avoidable mortality, developed by Rutstein et al., who created a list of conditions that were considered either treatable or preventable through healthcare services given the current medical knowledge and technology.[10] Rutstein was the first to introduce the term amenable mortality, differentiating between causes which are responsive to medical intervention through treatment and secondary/tertiary prevention actions (e.g., cervical cancer, hypertensive disease or appendicitis), and causes responsive to actions beyond healthcare services (preventable conditions such as lung cancer and liver cirrhosis).

In recent years the concept of amenable mortality has been used as a potential indicator of the performance of healthcare systems by several countries. The amenable mortality has been chosen as indicator in the UK National Health Service Outcomes Framework for 2011-2012,[11] and in Australian and New Zealand atlas of avoidable mortality 1997-2001 [12] or in European Community atlas of "avoidable death".[13] Amenable mortality indicators have also been used to report on spatial and temporal distributions and variations in health system performance across countries,[14–20] as well as across subnational entities,[12,21–25] socio-economic status, ethnic groups and sex.[14,24,26,27] Most of these studies did not assess amenable mortality across ages in different populations and did not focus on child and adolescent age classes.

According to the World Health Organization (WHO), an estimated 6.3 million children under the age of 15 years died in 2017 (117,000 in the OECD region). Five point four million of these children were under the age of 5, and 2.5 million died within the first month of life. More than half of these early child deaths were due to conditions that could be prevented or treated with access to simple, affordable interventions and were, consequently, amenable.[2]

The purpose of this study was to analyse the trends of amenable child mortality rates in 34 OECD countries from 2001 to 2015, and to evaluate the pattern across age classes.

MATERIALS AND METHODS

This descriptive study was conducted using secondary data from 34 OECD countries during the period from 2001 to 2015. Mexico and Turkey, albeit members of the OECD, were not included in the analysis because these countries are not listed among high-income economies in the World Development Indicators dataset (gross national income per capita ≥$12,056 for fiscal year 2019)[28] and had limited data availability. The mortality and population data came from the WHO Mortality Database,[29] which comprises deaths registered in national vital registration systems, with the

underlying causes of death coded according to the International Classification of Diseases; no permission is required from the WHO if data are used for non-commercial purposes. If reference populations were not available in the WHO Mortality Database, the data were extracted from UNdata.[30] The country-level data availability is presented in online supplementary file 1.

The causes of death amenable to healthcare were selected by means of the list proposed by Nolte and McKee[14,31] and used in a working paper by the OECD to generate estimates of amenable mortality for 31 countries.[15] This list includes a selected number of conditions which are treatable based on the clinical effectiveness of existing medical interventions. The age limit for amenable deaths is set at 75 years for most conditions, such as cancer and cardiovascular diseases, but the age limit for some diseases (i.e., whooping cough, measles, intestinal infections, and respiratory diseases other than pneumonia/influenza) is set at 14 (see online supplementary file 2 for Nolte and McKee's full list). The aggregation of the causes of death operated in the WHO Mortality Database prevents the use of the list of amenable deaths currently adopted by Eurostat.[32]

For each country, the amenable mortality rates were calculated as the annual number of deaths in the population aged 0–14 years per 100,000 inhabitants. The rates were stratified by the age groups adopted in the WHO Mortality Database (<1, 1–4, 5–9, 10–14 years) and by the 33 disease categories defined by Gay et al..[15] Due to the instability in the estimates of the annual amenable mortality rates, especially for small-population countries, all data were summarised by presenting the average rates for the years 2001/2005, 2006/2010 and 2011/2015. The statistical significance of the percentage changes between these time periods was assessed by using the formula suggested by Hildebrandt et al..[33] Data interpretation focused on the countries that showed significant percentage changes over the entire study period (i.e., both between 2001/05 and 2006/10 and between 2006/10 and 2011/15). Differences in the ranking of age-specific causes of death between time periods were evaluated with the Friedman test.

All data were analysed using the Stata software package, version 15 (StataCorp. 2017. *Stata Statistical Software: Release 15*. College Station, TX: StataCorp LLC). The significance level was set at .05.

Ethics statement

This descriptive study involved aggregate data that exist in the public domain, where it is not possible to identify individuals from the information provided. For this reason, this research did not require ethical approval.

Patient and public involvement

Patients were not involved in this study.

RESULTS

All-cause amenable child mortality rates

The results of the trend analyses conducted over the five-year periods 2001/05, 2006/10 and 2011/15 are presented in Figure 1 and in online supplementary file 3. The amenable mortality rate of the OECD population with <1 year dropped significantly from 2001/05 to 2006/10 (332.78 to 295.17 per 100,000, %Δ = -11.3%) and from 2006/10 to 2011/15 (295.17 to 240.22 per 100,000, %Δ = -18.6%). Contrary to the OECD rate of children aged <1 year, in the population aged ≥1 year the overall OECD rate did not decrease significantly. From 2001/05 to 2006/10 and from 2006/10 to 2011/15, the mortality rates decreased by 13.4% and 13.0%, respectively, in the 1-4 age group; by 11.9% and 11.3% in the 5-9 age group; and by 13.5% and 13.1% for the 10-14 age group. In 2011/15, the OECD rate was 4.73 per 100,000 for the 1-4 age group, 2.02 per 100,000 for the 5-9 age group, and 2.16 per 100,000 for the 10-14 age group.

Cause-specific child mortality rates

When we examined the distribution of cause-specific mortality rates across multiple age groups and study periods, no statistically significant variations in the OECD population were found. The only exception was a significant decrease in deaths in the first year of life for conditions originating in the early neonatal period (2001/05 to 2006/10: 266.3 to 239.8 per 100,000, %Δ = -9.9%; 2006/10 to 2011/15: 239.8 to 193.8 per 100,000, %Δ = -19.2%) (see online supplementary file 4).

Globally, for the years 2001/05, 2006/10 and 2011/15, there were no significant differences in the age-specific percentage distribution of causes of death [<1 year: Friedman test (*P*) = 0.955 (0.372); 1-4 years: 0.864 (0.607); 5-9 years: 0.470 (0.740); 10-14 years: 1.773 (0.398)]. As shown in Table 1, the three leading causes of death by age groups over the 15-year study period were the following: conditions originating in the early neonatal period, congenital cardiovascular anomalies, and pneumonia for children aged <1 year; congenital cardiovascular anomalies, leukaemia, and respiratory diseases (excl. pneumonia/flu) for all other age groups.

Table 1 Percentage Distribution of the Top 10 Causes of Death Amenable to Healthcare in Children in 34 OECD Countries, Years 2001/2005, 2006/2010 and 2011/2015.

Cause of Death	2001/05		2006/10		2011/15	
	Rank	%	Rank	%	Rank	%
<1 Year	(n = 190,169.5)		(n = 175,008)		(n = 105,210.5)	
Conditions originating in the early neonatal period	#1	80.02	#1	81.25	#1	80.69
Congenital cardiovascular anomalies	#2	14.38	#2	13.15	#2	14.55
Pneumonia	#3	1.82	#3	1.53	#3	1.30
Septicaemia	#4	1.50	#4	1.39	#4	1.04
Intestinal infections other than typhoid, diphtheria	#7	0.27	#5	0.60	#5	0.72
Cerebrovascular diseases	#6	0.51	#6	0.60	#6	0.38
Nephritis and nephrosis	#5	0.54	#7	0.49	#7	0.25
Leukaemia	#8	0.21	#8	0.26	#8	0.24
Epilepsy	#9	0.17	#9	0.17	#9	0.23
Whooping cough	#11*	0.11	#12*	0.10	#10	0.19
Other causes	-	0.46	-	0.46	-	0.39
1–4 Years	(n = 14,438)		(n = 12,738)		(n = 8491.5)	
Congenital cardiovascular anomalies	#1	25.67	#1	23.63	#1	25.21
Leukaemia	#3	14.55	#3	13.99	#2	14.99
All respiratory diseases, excl. pneumonia/influenza	#2	15.60	#2	16.79	#3	14.25
Pneumonia	#4	12.35	#4	12.20	#4	12.24
Epilepsy	#7	5.16	#7	5.50	#5	7.20
Septicaemia	#5	7.57	#5	8.18	#6	6.88
Conditions originating in the early neonatal period	#6	5.59	#6	5.60	#7	5.06
Intestinal infections other than typhoid, diphtheria	#9	2.45	#9	3.05	#8	3.98
Cerebrovascular diseases	#8	3.86	#8	4.13	#9	3.38

Influenza	#10	2.16	#10	1.92	#10	2.39
Other causes	-	5.05	-	5.00	-	4.42
5–9 Years	(n = 7705)		(n = 6706)		(n = 4541)	
Leukaemia	#1	31.72	#1	28.35	#1	27.31
All respiratory diseases, excl. pneumonia/influenza	#3	12.91	#2	16.28	#2	13.87
Congenital cardiovascular anomalies	#2	14.91	#3	13.67	#3	13.12
Epilepsy	#5	7.81	#5	7.86	#4	10.37
Pneumonia	#4	8.58	#4	7.90	#5	9.12
Cerebrovascular diseases	#6	6.87	#6	7.13	#6	6.69
Septicaemia	#7	5.15	#7	5.67	#7	5.26
Influenza	#9	1.66	#8	2.54	#8	2.97
Conditions originating in the early neonatal period	#8	2.25	#9	2.48	#9	2.80
Intestinal infections other than typhoid, diphtheria	#13†	0.87	#12†	1.25	#10	2.00
Other causes	-	7.26	-	6.87	-	6.47
10–14 Years	(n = 9109)		(n = 7579)		(n = 4921)	
Leukaemia	#1	31.30	#1	30.01	#1	30.24
All respiratory diseases, excl. pneumonia/influenza	#3	13.66	#2	15.28	#2	13.66
Congenital cardiovascular anomalies	#2	14.13	#3	12.17	#3	12.62
Epilepsy	#5	7.73	#5	7.89	#4	10.36
Cerebrovascular diseases	#4	8.12	#4	8.99	#5	9.08
Pneumonia	#6	7.59	#6	6.73	#6	7.27
Septicaemia	#7	4.17	#7	4.92	#7	4.29
Diabetes mellitus	#8	2.49	#8	2.31	#8	1.97
Influenza	#11‡	1.15	#9	2.15	#9	1.77
Conditions originating in the early neonatal period	#10	1.57	#11‡	1.78	#10	1.52
Other causes	-	8.09	-	7.78	-	7.21

* Abdominal hernia was ranked #10 in 2001/05 (0.17%) and 2006/10 (0.13%).
† Nephritis and nephrosis were ranked #10 in 2001/05 (1.60%) and 2006/10 (1.69%).
‡ Nephritis and nephrosis were ranked #9 in 2001/05 (1.79%) and #10 in 2006/10 (1.91%).

Country-specific amenable child mortality rates

As shown in Figure 1 and online supplementary file 3, the amenable mortality rate for the population aged <1 year dropped significantly over the entire study period in 15 countries (United States, Israel, Japan, South Korea, Czechia, Estonia, Germany, Italy, Latvia, Hungary, Poland, Spain, Austria, United Kingdom and Australia). In addition to the decrease in conditions originating in the early neonatal period, other causes contributed to a significant reduction in mortality for some of these countries: septicaemia, pneumonia and nephritis/nephrosis in the United States, septicaemia in Poland, and congenital cardiovascular anomalies in Japan and Spain. See online supplementary file 4 for country-specific and cause-specific mortality rates in the <1-year population.

Although the overall OECD rate did not decrease significantly in the population aged ≥1 year, some country-specific data exhibited significant trends (Figure 1). However, no country showed a significant linear decline in mortality over the entire study period for all age groups (Figure 1).

Figure 1 Yearly Amenable Mortality Rates (Per 100,000) for Ages <1 (a), 1–4 (b), 5–9 (c) and 10–14 (d) in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015 (See Online Supplementary File 1 for Country-Level Data Availability)

* Percentage decrease is statistically significant (*P*<.05).
Abbreviations: CA, Canada; CL, Chile; US, United State of America; IL, Israel; JP, Japan; KR, Republic of Korea; AT, Austria; BE, Belgium; CZ, Czechia; DK, Denmark; EE, Estonia; FI, Finland; FR, France; DE, Germany; GR, Greece; HU, Hungary; IS, Iceland; IE, Ireland; IT, Italy; LV, Latvia; LT, Lithuania; LU, Luxembourg; NL, Netherlands; NO, Norway; PL, Poland; PT, Portugal; SK, Slovakia; SI, Slovenia; ES, Spain; SE, Sweden; CH, Switzerland; GB, United Kingdom; AU, Australia; NZ, New Zealand.

DISCUSSION

In this time trend analysis, we found a significant decline in amenable child mortality rates for the <1-year age group in the 34 OECD countries between 2001/05 and 2011/15, and a slow decline in the other age groups. These results confirm the trend shown by previous studies conducted on six OECD countries that had been selected to provide a variety of forms of healthcare delivery between 1956 and 1980,[21] and highlight that policies to reduce amenable mortality rates are still needed, even in settings where the quality of medical services and resources is high.

These results are driven by the fact that the only significantly reduced cause of death was conditions originating in the early neonatal period in the <1-year group. Surprisingly**,** the decline was not more pronounced among countries with higher mortality in 2001/05, indicating that continued gains in child survival occurred both in low- and high-mortality countries. The most representative countries are Japan, which showed an improvement in its performance despite starting from low values in 2001/05, and Hungary and the US, which showed high amenable mortality rates in 2001/05.

The results concerning country-specific amenable child mortality rates showed that the reductions in the age-specific rates were not evenly distributed across OECD countries. There was not a single cause for which the age-specific mortality rates declined in the countries studied, and the success in reducing mortality rates was not consistent for all causes. These achievements corroborate another of our results, highlighting that the causal distribution of the age-specific mortality rates did not vary over the period examined and that, namely, the conditions originating in the early neonatal period, congenital cardiovascular anomalies, pneumonia, leukaemia, and all respiratory diseases

(excl. pneumonia/influenza) were consistently top-ranked. Because these are the main causes related to chronic disorders and pathologies that require acute care delivered quickly, our results suggest that the models of care for children should be revised. Sidebotham has argued that child diseases might broadly be divided into chronic (e.g., leukaemia) and acute diseases (e.g., pneumonia), and that a single model cannot be proposed but each needs a different, albeit interconnected, health system solution.[5]

Wolfe [34] highlights that the presence of children with chronic disorders requires substantial changes from a hospital-centric model to a model in which primary care and secondary care providers and public health services work closely together. Models of co-management are essential to promote ongoing communication and coordination between primary care and subspecialty services. It would be inefficient for subspecialists to provide primary care, and ineffective for primary care providers to attempt to stay abreast of the latest therapies for chronic diseases. Because the majority of chronic illness care is performed within the primary care setting and because primary care physicians spend a considerable amount of time treating chronic illness, primary care should play a central role in the overall coordination and continuity of people's care providing greater access to specialists and more timely follow-up care after emergency room visits.[35] The few studies evaluating this new approach to work showed an improvement in child survival [36–38], and thus traced a possible path to improve amenable mortality from chronic diseases.

Sidebotham and Mackenbach judge as determinants of amenable mortality in acute diseases the universal access to healthcare and the presence of professionals with appropriate training.[5,18] The relevance of access may at least partially explain our results in some countries. For example, in Chile, where the mortality rate of pneumonia was consistently high for the <1-year group, the healthcare system replicates class inequalities. Studies have identified and tracked several important inequalities in the burden of infant mortality for infectious diseases by socioeconomic level in Chile, showing that this gap is discriminatory because disadvantaged households underutilise healthcare services (due to social or economic exclusion).[39,40] In Slovakia, where also the mortality rate of

pneumonia was high for the <1-year group, social health insurance system formally covers all residents and has a benefit package that all insurance companies must provide for their insured. In theory, the insurance system is thus designed to provide everybody with the same benefit package, regardless of their health status, ability to pay or place of residence. In practice, coverage varies across the country, mainly because the supply of human resources (especially specialists and general practitioners [GPs]) is not adequate in all regions and districts, and sometimes providers are simply not available.[41]

The access to healthcare professionals with adequate training looks at the models of first contact between patients and clinicians and on their expertise. Although an international debate is open on the best pattern of paediatric primary care among a paediatrician-based system, a combined system or a system based on GPs/family doctors,[42] some authors highlight the importance of primary care paediatricians, especially because primary care paediatricians who look after children are likely to have more professional training and competencies than GPs, who often, receiving an insufficient or not existing or non-mandatory training, do not have capabilities to diagnose and treat a child in effective times.[34,43,44]

Supported by the specialised literature, the availability of high-quality healthcare and knowledge and the use of best practice guidelines are also determinants of amenable mortality.[5,18] These determinants provide one possible explanation for our results, in particular for the reduction in mortality by conditions originating in the early neonatal period. Several lines of evidence support the hypothesis that neonatal intensive care has resulted in decreased mortality. Marked declines in neonatal and infant mortality rates are coincident with the introduction and progressive development of neonatal intensive care [45,46] and with specific neonatal intensive therapeutic improvements.[47–50] The second line of evidence regarding the effect of neonatal intensive care on infant mortality is the observation that low birth weight infants born in hospitals with tertiary level neonatal intensive care units have lower mortality rates than infants born in hospitals without such units. [51,52] Finally,

a third line of evidence referring to improving high-risk obstetric care has been associated with decreases in neonatal mortality.[46,53]

Variations in child mortality exist even in countries where high-quality healthcare is available. Part of this variation may be due to a failure in implementing treatment protocols or evidence-based best practices tailored with the local conditions. This suggestion may provide some explanation of the mortality decrease in some countries, such as Hungary and Japan, which have supported the introduction of evidence-based protocols on routine newborn care and have trained nursery staff members on the protocols.[54,55]

Our study has the same limitations as all studies that use secondary data. It is undeniable that international variations in birth registration laws and practices and the process of death certification have the potential to bias the international comparisons of child mortality. Additionally, international comparisons of mortality rates are confounded by the various ways in which countries classify preterm infants near the threshold of viability.[56–58] Considering these issues, our study only evaluates the trend of amenable mortality rates, and a comparison analysis was not performed. Also, although much of the literature assessing the contribution of healthcare to health focuses on mortality data, data on children may be of limited value because the number of deaths is small, making interpretation difficult. However, we believe that the small numbers were mitigated by the fact that our study analysed the rates and trajectories of multiple countries over a 15-year time period. Another limitation is that our analysis did not account for mortality disparities within countries that were attributable to ethnicity, race, socioeconomic status or geographic residence, since our data sources did not this information. Evidence from the US, for example, showed higher levels of amenable mortality among people disadvantaged in terms of race or socioeconomic status.[59,60] Considering that the perinatal mortality of the US has a prevailing effect on premature births and that striking racial disparities persist, with African Americans exhibiting higher rates of preterm delivery than any other major racial/ethnic group,[61] potentially large variations within populations may be concealed. Lastly, our study is based on the definition of amenable death in its original sense of mortality

responsive to medical intervention through treatment, although several countries, such as UK, Canada and Australia, have broadened definitions for their avoidable mortality indicators to include deaths from conditions avoidable through primary prevention. This broadened definition suggests that not only the models of care for children should be revised but also that policies must be adopted in order to prevent specific causes of death before the point of reaching the healthcare system. These policies include population health interventions such as the obligation of physical activity during adolescence in schools, or the taxation of tobacco and sugar-sweetened beverages.

Some preliminary conclusions can be drawn from this study. Over the 15-year period from 2001 to 2015, the amenable mortality rate in <1-year-olds progressively declined in most OECD countries. Second, OECD countries had success in reducing mortality from conditions originating in the early neonatal period. Lastly, the low decline in amenable mortality rates for children aged ≥1 year, the high variation in amenable mortality rates across countries and the insufficient success in reducing mortality from all causes suggest that the heath system should increase its efforts to improve health outcomes for children.

DECLARATIONS

Ethics approval and consent to participate

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Acknowledgements

Data for this study came from the World Health Organization. All analyses, interpretations and conclusions are credited to the authors of this study, not to the World Health Organization.

Author Contributions

MMG and GD formulated the research goals and supervised the research activity; MMG, GD, JL defined the design of the methodology; MMG wrote the article; RS, WR and MPF revised the article; MB collected the data and managed the database; JL utilised statistical techniques to analyse the study data.

All authors have read and approved the manuscript.

REFERENCES

1 Blum RW, Nelson-Mmari K. The health of young people in a global context. *J Adolesc Health Off Publ Soc Adolesc Med* 2004;**35**:402–18. doi:10.1016/j.jadohealth.2003.10.007

2 WHO. Children: reducing mortality. http://www.who.int/news-room/fact-sheets/detail/children-reducing-mortality (accessed 3 Oct 2018).

3 Fraser J, Sidebotham P, Frederick J, *et al.* Learning from child death review in the USA, England, Australia, and New Zealand. *Lancet Lond Engl* 2014;**384**:894–903. doi:10.1016/S0140-6736(13)61089-2

4 Kyu HH, Stein CE, Pinto CB, *et al.* Causes of death among children aged 5–14 years in the WHO European Region: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet Child Adolesc Health* 2018;**2**:321–37. doi:10.1016/S2352-4642(18)30095-6

5 Sidebotham P, Fraser J, Covington T, *et al.* Understanding why children die in high-income countries. *The Lancet* 2014;**384**:915–27. doi:10.1016/S0140-6736(14)60581-X

6 Alio AP, Richman AR, Clayton HB, *et al.* An ecological approach to understanding black-white disparities in perinatal mortality. *Matern Child Health J* 2010;**14**:557–66. doi:10.1007/s10995-009-0495-9

7 Gakidou E, Cowling K, Lozano R, *et al.* Increased educational attainment and its effect on child mortality in 175 countries between 1970 and 2009: a systematic analysis. *Lancet Lond Engl* 2010;**376**:959–74. doi:10.1016/S0140-6736(10)61257-3

8 Lightfoot TJ, Johnston WT, Simpson J, *et al.* Survival from childhood acute lymphoblastic leukaemia: the impact of social inequality in the United Kingdom. *Eur J Cancer* 2012;**48**:263–9. doi:10.1016/j.ejca.2011.10.007

9 Gore FM, Bloem PJN, Patton GC, *et al.* Global burden of disease in young people aged 10-24 years: a systematic analysis. *Lancet Lond Engl* 2011;**377**:2093–102. doi:10.1016/S0140-6736(11)60512-6

10 Rutstein DD, Berenberg W, Chalmers TC, *et al.* Measuring the quality of medical care. A clinical method. *N Engl J Med* 1976;**294**:582–8. doi:10.1056/NEJM197603112941104

11 Department of Health. The NHS Outcomes Framework 2011/12. 2010.https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/213789/dh_123138.pdf

12 Page A, New Zealand, University of Adelaide, editors. *Australian and New Zealand atlas of avoidable mortality*. Adelaide, S. Aust.: : Public Health Information Development Unit, University of Adelaide 2006.

13 Holland WW. European Community atlas of "avoidable death." 1991.

14 Nolte E, McKee CM. Measuring the health of nations: updating an earlier analysis. *Health Aff Proj Hope* 2008;**27**:58–71. doi:10.1377/hlthaff.27.1.58

15 Gay JG, Paris V, Devaux M, *et al.* Mortality Amenable to Health Care in 31 OECD Countries: estimates and methodological Issues. Published Online First: 31 January 2011. doi:https://doi.org/10.1787/5kgj35f9f8s2-en

16 Treurniet H, Boshuizen H, Harteloh P. Avoidable mortality in Europe (1980–1997): a comparison of trends. *J Epidemiol Community Health* 2004;**58**:290–5. doi:10.1136/jech.2002.006452

17 Nolte E, McKee M. Variations in amenable mortality--trends in 16 high-income nations. *Health Policy Amst Neth* 2011;**103**:47–52. doi:10.1016/j.healthpol.2011.08.002

18 Mackenbach JP, Hoffmann R, Khoshaba B, *et al.* Using "amenable mortality" as indicator of healthcare effectiveness in international comparisons: results of a validation study. *J Epidemiol Community Health* 2013;**67**:139–46. doi:10.1136/jech-2012-201471

19 Mackenbach JP, Bouvier-Colle MH, Jougla E. "Avoidable" mortality and health services: a review of aggregate data studies. *J Epidemiol Community Health* 1990;**44**:106–11.

20 Gianino MM, Lenzi J, Muça A, *et al.* Declining Amenable Mortality: Time Trend (2000-2013) and Geographic Area Analysis. *Health Serv Res* 2017;**52**:1908–27. doi:10.1111/1475-6773.12563

21 Charlton JR, Velez R. Some international comparisons of mortality amenable to medical intervention. *Br Med J Clin Res Ed* 1986;**292**:295–301.

22 James PD, Manuel DG, Mao Y. Avoidable mortality across Canada from 1975 to 1999. *BMC Public Health* 2006;**6**:137. doi:10.1186/1471-2458-6-137

23 Pampalon R. Avoidable mortality in Québec and its regions. *Soc Sci Med* 1993;**37**:823–31. doi:10.1016/0277-9536(93)90376-F

24 Piers LS, Carson NJ, Brown K, *et al.* Avoidable mortality in Victoria between 1979 and 2001. *Aust N Z J Public Health* 2007;**31**:5–12.

25 Fantini MP, Lenzi J, Franchino G, *et al.* Amenable mortality as a performance indicator of Italian health-care services. *BMC Health Serv Res* 2012;**12**:310. doi:10.1186/1472-6963-12-310

26 Tobias M, Jackson G. Avoidable mortality in New Zealand, 1981-97. *Aust N Z J Public Health* 2001;**25**:12–20. doi:10.1111/j.1467-842X.2001.tb00543.x

27 Schoenbaum SC, Schoen C, Nicholson JL, *et al.* Mortality amenable to health care in the United States: The roles of demographics and health systems performance. *J Public Health Policy* 2011;**32**:407–29.

28 World Bank. World Development Indicators | DataBank. 2018.http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators (accessed 3 Oct 2018).

29 World Health Organization. WHO Mortality Database. 2018.http://www.who.int/healthinfo/mortality_data/en/ (accessed 3 Oct 2018).

30 United Nations. Demographic Statistics Database. 2018.http://data.un.org/Data.aspx?d=POP&f=tableCode%3A22 (accessed 3 Oct 2018).

31 Nolte E, McKee M. *Does health care save lives? Avoidable mortality revisited.* The Nuffield Trust 2004. http://researchonline.lshtm.ac.uk/15535/ (accessed 3 Oct 2018).

32 Eurostat. Amenable and preventable deaths of residents. https://ec.europa.eu/eurostat/web/products-datasets/-/hlth_cd_apr (accessed 3 Oct 2018).

33 Hildebrandt M, Bender R, Gehrmann U, *et al.* Calculating confidence intervals for impact numbers. *BMC Med Res Methodol* 2006;**6**:32. doi:10.1186/1471-2288-6-32

34 Wolfe I, Thompson M, Gill P, *et al.* Health services for children in western Europe. *Lancet Lond Engl* 2013;**381**:1224–34. doi:10.1016/S0140-6736(12)62085-6

35 Expert Panel on Effective Ways of Investing in Health. Definition of a frame of Reference in relation to Primary Care with a special emphasis on Financing Systems and Referral Systems. 2014.https://ec.europa.eu/health/expert_panel/sites/expertpanel/files/004_definitionprimarycare_en.pdf (accessed 2 Mar 2019).

36 Adams J, Woods E. Redesign of chronic illness care in children and adolescents. *Curr Opin Pediatr* 2016;**28**:428–33. doi:10.1097/MOP.0000000000000368

37 Britto MT, Vockell A-LB, Munafo JK, *et al.* Improving outcomes for underserved adolescents with asthma. *Pediatrics* 2014;**133**:e418-427. doi:10.1542/peds.2013-0684

38 Mangione-Smith R, Schonlau M, Chan KS, *et al.* Measuring the effectiveness of a collaborative for quality improvement in pediatric asthma care: does implementing the chronic care model improve processes and outcomes of care? *Ambul Pediatr Off J Ambul Pediatr Assoc* 2005;**5**:75–82. doi:10.1367/A04-106R.1

39 Hertel-Fernandez AW, Giusti AE, Sotelo JM. The Chilean infant mortality decline: improvement for whom? Socioeconomic and geographic inequalities in infant mortality, 1990-2005. *Bull World Health Organ* 2007;**85**:798–804.

40 Rodrigo A, van der Veer R, Vermeer HJ, *et al.* From foundling homes to day care: a historical review of childcare in Chile. *Cad Saúde Pública*;**30**:461–72.

41 OECD. State of Health in the EU Slovak Republic: Country Health Profile 2017 - European Observatory on Health Systems and Policies. 2017.

42 Katz M, Rubino A, Collier J, *et al.* Demography of pediatric primary care in Europe: delivery of care and training. *Pediatrics* 2002;**109**:788–96.

43 Pearson GA, Ward-Platt M, Harnden A, *et al.* Why children die: avoidable factors associated with child deaths. *Arch Dis Child* 2011;**96**:927–31. doi:10.1136/adc.2009.177071

44 van Esso D, del Torso S, Hadjipanayis A, *et al.* Paediatric primary care in Europe: variation between countries. *Arch Dis Child* 2010;**95**:791–5. doi:10.1136/adc.2009.178459

45 Williams RL, Chen PM. Identifying the Sources of the Recent Decline in Perinatal Mortality Rates in California. *N Engl J Med* 1982;**306**:207–14. doi:10.1056/NEJM198201283060404

46 Richardson DK, Gray JE, Gortmaker SL, *et al.* Declining severity adjusted mortality: evidence of improving neonatal intensive care. *Pediatrics* 1998;**102**:893–9.

47 Horbar JD, Wright LL, Soll RF, *et al.* A multicenter randomized trial comparing two surfactants for the treatment of neonatal respiratory distress syndrome. National Institute of Child Health and Human Development Neonatal Research Network. *J Pediatr* 1993;**123**:757–66.

48 Vermont-Oxford Neonatal Network. A multicenter, randomized trial comparing synthetic surfactant with modified bovine surfactant extract in the treatment of neonatal respiratory distress syndrome. *Pediatrics* 1996;**97**:1–6.

49 Clark RH, Yoder BA, Sell MS. Prospective, randomized comparison of high-frequency oscillation and conventional ventilation in candidates for extracorporeal membrane oxygenation. *J Pediatr* 1994;**124**:447–54.

50 Rastogi A, Akintorin SM, Bez ML, *et al.* A Controlled Trial of Dexamethasone to Prevent Bronchopulmonary Dysplasia in Surfactant-treated Infants. *Pediatrics* 1996;**98**:204–10.

51 Phibbs CS, Baker LC, Caughey AB, *et al.* Level and volume of neonatal intensive care and mortality in very-low-birth-weight infants. *N Engl J Med* 2007;**356**:2165–75. doi:10.1056/NEJMsa065029

52 Paneth N. Technology at birth. *Am J Public Health* 1990;**80**:791–2.

53 Alfirevic Z, Neilson JP. Doppler ultrasonography in high-risk pregnancies: systematic review with meta-analysis. *Am J Obstet Gynecol* 1995;**172**:1379–87.

54 Kuchna D, Hovsepyan A, Leonard S. Preventing Newborn Deaths In Romania And Hungary. *Health Aff (Millwood)* 2017;**36**:1160–1160. doi:10.1377/hlthaff.2017.0382

55 Maeda K. Progress of Perinatal Medicine in Japan. *J Health Med Inform* 2013;**s11**. doi:10.4172/2157-7420.S11-002

56 Kramer MS, Platt RW, Yang H, *et al.* Registration artifacts in international comparisons of infant mortality. *Paediatr Perinat Epidemiol* 2002;**16**:16–22. doi:10.1046/j.1365-3016.2002.00390.x

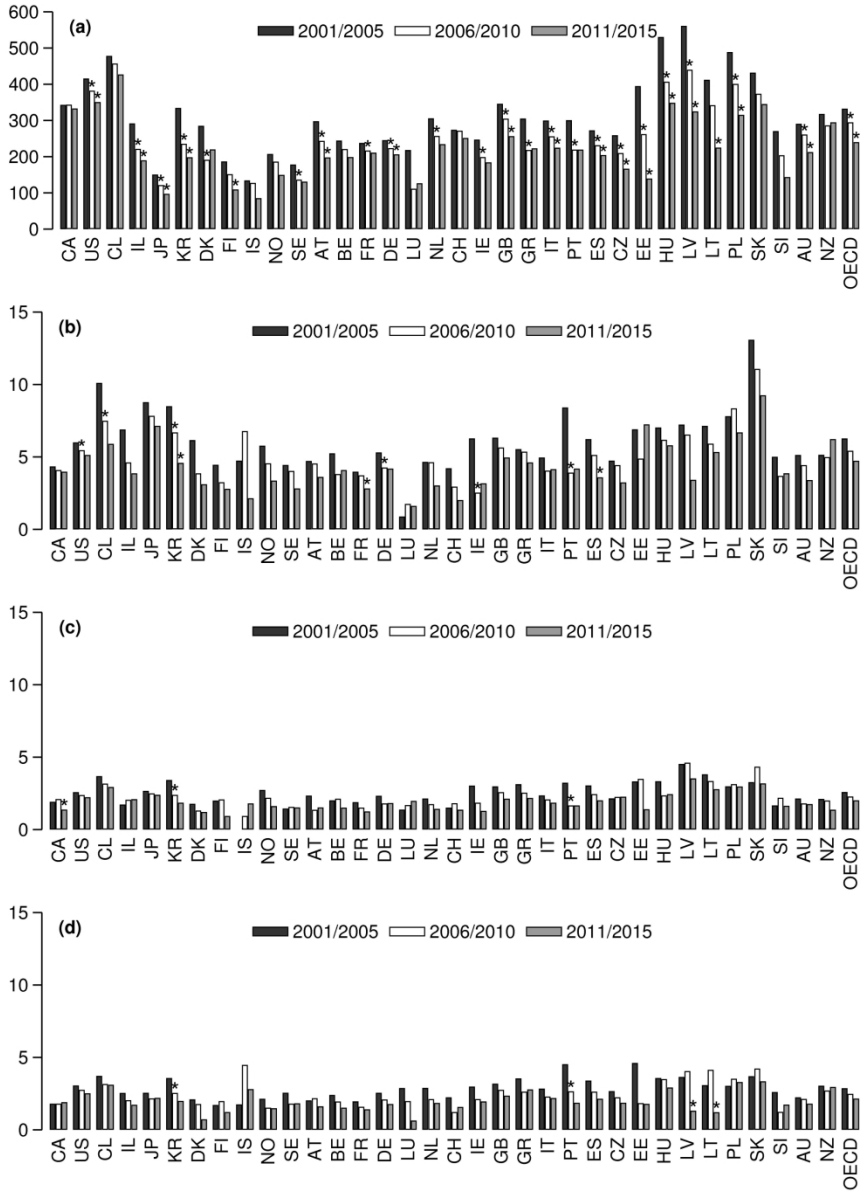
57 Joseph KS, Liu S, Rouleau J, *et al.* Influence of definition based versus pragmatic birth registration on international comparisons of perinatal and infant mortality: population based retrospective study. *The BMJ* 2012;**344**. doi:10.1136/bmj.e746

58 Mohangoo AD, Blondel B, Gissler M, *et al.* International Comparisons of Fetal and Neonatal Mortality Rates in High-Income Countries: Should Exclusion Thresholds Be Based on Birth Weight or Gestational Age? *PLOS ONE* 2013;**8**:e64869. doi:10.1371/journal.pone.0064869

59 Schwartz E, Kofie VY, Rivo M, *et al.* Black/white comparisons of deaths preventable by medical intervention: United States and the District of Columbia 1980-1986. *Int J Epidemiol* 1990;**19**:591–8. doi:10.1093/ije/19.3.591

60 Macinko J, Elo IT. Black–white differences in avoidable mortality in the USA, 1980–2005. *J Epidemiol Community Health* 2009;**63**:715–21. doi:10.1136/jech.2008.081141

61 Riddell CA, Harper S, Kaufman JS. Trends in Differences in US Mortality Rates Between Black and White Infants. *JAMA Pediatr* 2017;**171**:911–3. doi:10.1001/jamapediatrics.2017.1365



* Percentage decrease is statistically significant (P<.05).

Abbreviations: CA, Canada; CL, Chile; US, United State of America; IL, Israel; JP, Japan; KR, Republic of Korea; AT, Austria; BE, Belgium; CZ, Czechia; DK, Denmark; EE, Estonia; FI, Finland; FR, France; DE, Germany; GR, Greece; HU, Hungary; IS, Iceland; IE, Ireland; IT, Italy; LV, Latvia; LT, Lithuania; LU, Luxembourg; NL, Netherlands; NO, Norway; PL, Poland; PT, Portugal; SK, Slovakia; SI, Slovenia; ES, Spain; SE, Sweden; CH, Switzerland; GB, United Kingdom; AU, Australia; NZ, New Zealand.

203x279mm (300 x 300 DPI)

Table 1 Data Availability for the 34 OECD Countries (0 “Not Available”/1 “Available”)

Country	Year															Total
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Canada	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	13
Chile	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
United States of America	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	12
Israel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Japan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Republic of Korea	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Austria	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Belgium	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Czechia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Denmark	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Estonia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Finland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
France	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	14
Germany	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Greece	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Hungary	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Iceland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Ireland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	14
Italy	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Latvia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Lithuania	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Luxembourg	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Netherlands	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Norway	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Poland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Portugal	1	1	1	0	0	0	1	1	1	1	1	1	1	1	0	11
Slovakia	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	13
Slovenia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Spain	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Sweden	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Switzerland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
United Kingdom	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Australia	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	14
New Zealand	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	13
All OECD countries	*34*	*34*	*34*	*33*	*32*	*33*	*34*	*34*	*34*	*34*	*32*	*34*	*33*	*31*	*28*	*494*

Notes: Causes of death are coded according to the ICD-9 (Austria 2001; Greece 2001/2013; Ireland 2001/2006; Italy 2001/2002; Portugal 2001) or ICD-10 (all other country-years). Reference populations for some country-years were retrieved from UNdata if not available in the WHO Mortality Database (Canada 2006/2013; Chile 2001/2015; United States of America 2008/2010, 2012, 2015; Finland 2015; Ireland 2010, 2014; Switzerland 2014/2015).

Table 1 Nolte and McKee's list of causes of death considered amenable to health care

Disease category	Age	Diseases	ICD-9 codes	ICD-10 codes
Infectious diseases	0-74	Tuberculosis	010-8, 137	A15-9, B90
	0-74	Septicaemia	038	A40-1
	0-74	Pneumonia	480-6	J12-8
	0-74	Influenza	487	J10-1
	0-14	Intestinal infections (other than typhoid, diphtheria)	001-9	A00-9
	0-74	Diphtheria, Tetanus, Poliomyelitis	032, 037, 045	A35-6, A80
	0-14	Whooping cough	033	A37
	1-14	Measles	055	B05
Cancers	0-74	Colorectal cancer	153-4	C18-21
	0-74	Malignant neoplasm of skin	173	C44
	0-74	Breast cancer	174	C50
	0-44	Cervical cancer and uterine cancer	179, 180, 182	C53-5
	0-74	Neoplasm of the testis	186	C62
	0-74	Hodgkin's disease	201	C81
	0-44	Leukaemia	204-8	C91-5
Endocrine, nutritional and metabolic diseases	0-74	Thyroid disorders	240-6	E00-7
	0-49	Diabetes mellitus	250	E10-4
Diseases of the nervous system	0-74	Epilepsy	345	G40-1
Diseases of the circulatory system	0-74	Rheumatic heart diseases	393-8	I05-9
	0-74	Ischemic heart diseases: 50% of deaths	410-4	I20-5
	0-74	Cerebrovascular diseases	430-8	I60-9
	0-74	Hypertensive diseases	401-5	I10-3, I15
Diseases of the genitourinary system	0-74	Nephritis and nephrosis	580-9	N00-7, N17-9, N25-7
	0-74	Benign prostatic hyperplasia	600	N40
Diseases of the respiratory system	1-14	All respiratory diseases (excl. pneumonia/influenza)	460-79, 488-519	J00-9, J20-99
Diseases of the digestive system	0-74	Peptic ulcer	531-3	K25-7
	0-74	Appendicitis	540-3	K35-8
	0-74	Abdominal hernia	550-3	K40-6
	0-74	Cholelithiasis and cholecystitis	574-5	K80-1
Perinatal mortality	0-74	Maternal deaths	630-76	O00-99
	0-74	Conditions originating in the early neonatal period	760-79	P00-96
	0-74	Congenital cardiovascular anomalies	745-7	Q20-8
External causes	0-74	Misadventures to patients during surgical and medical care	E870-6, E878-9	Y60-9, Y83-4

Source: Nolte and McKee 2008; Gay et al. 2011.

Table 1 Yearly Amenable Mortality Rates (Per 100,000) for Ages <1 and 1–4 Years in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015 (See Table S1 for Country-Level Data Availability)

Country	<1 Year					1–4 Years				
	Yearly Amenable Mortality Rate			% Change (95% CI)		Yearly Amenable Mortality Rate			% Change (95% CI)	
	2001/05	2006/10	2011/15	2006/10–2001/05	2011/15–2006/10	2001/05	2006/10	2011/15	2006/10–2001/05	2011/15–2006/10
CA	343.10	343.46	332.97	.1	-3.1	4.34	4.09	3.98	-5.7	-2.6
US	415.80	382.24	350.87	-8.1*	-8.2*	6.00	5.46	5.13	-8.9*	-6.1
CL	478.56	457.40	427.15	-4.4	-6.6	10.11	7.50	5.90	-25.8*	-21.3
IL	291.77	221.77	189.73	-24.0*	-14.4*	6.89	4.62	3.86	-32.9	-16.5
JP	150.76	121.39	97.24	-19.5*	-19.9*	8.78	7.84	7.15	-10.7	-8.7
KR	334.41	235.84	198.16	-29.5*	-16.0*	8.50	6.69	4.59	-21.3*	-31.5*
DK	285.08	191.17	220.19	-32.9*	15.2	6.16	3.87	3.11	-37.2	-19.6
IS	134.24	127.50	85.5	-5.0	-32.9	4.74	6.78	2.14	43.2	-68.4
FI	186.77	151.76	109.42	-18.7	-27.9*	4.46	3.25	2.80	-27.2	-14.0
NO	207.32	186.37	149.55	-10.1	-19.8	5.77	4.56	3.36	-21.0	-26.4
SE	178.05	136.44	130.95	-23.4*	-4.0	4.44	4.03	2.82	-9.2	-30.1
AT	297.83	243.56	198.02	-18.2*	-18.7*	4.72	4.54	3.62	-3.7	-20.4
BE	244.36	220.91	198.89	-9.6	-10.0	5.25	3.82	4.09	-27.3	7.1
FR	237.86	216.89	211.19	-8.8*	-2.6	3.98	3.73	2.82	-6.2	-24.3*
DE	245.69	223.48	206.37	-9.0*	-7.7*	5.31	4.27	4.19	-19.6*	-1.9
LU	218.18	111.42	126.65	-48.9	13.7	0.88	1.76	1.62	98.8	-7.6
NL	306.18	257.29	234.49	-16.0*	-8.9	4.66	4.63	3.03	-.8	-34.6
CH	274.24	272.00	251.67	-.8	-7.5	4.22	2.95	2.02	-30.2	-31.3
IE	247.00	198.95	184.09	-19.5*	-7.5	6.28	2.53	3.18	-59.7*	25.6
GB	346.07	305.01	256.65	-11.9*	-15.9*	6.33	5.65	4.96	-10.7	-12.2
GR	305.19	218.33	222.92	-28.5*	2.1	5.54	5.36	4.62	-3.4	-13.8
IT	299.93	256.16	224.78	-14.6*	-12.2*	4.96	4.05	4.15	-18.4	2.4
PT	300.62	219.72	219.56	-26.9*	-.1	8.41	3.92	4.19	-53.4*	6.9
ES	272.67	231.74	204.24	-15.0*	-11.9*	6.23	5.13	3.59	-17.6	-30.0*
CZ	259.40	209.92	166.61	-19.1*	-20.6*	4.74	4.43	3.24	-6.7	-26.9
EE	394.90	262.22	139.38	-33.6*	-46.8*	6.91	4.89	7.25	-29.3	48.4
HU	530.50	406.91	348.94	-23.3*	-14.2*	7.03	6.18	5.80	-12.2	-6.0
LV	561.36	440.42	324.98	-21.5*	-26.2*	7.23	6.54	3.42	-9.5	-47.8
LT	412.34	342.21	225.15	-17.0	-34.2*	7.14	5.92	5.34	-17.2	-9.7
PL	488.86	400.92	315.70	-18.0*	-21.3*	7.81	8.35	6.69	6.9	-19.9
SK	432.24	373.71	345.44	-13.5	-7.6	13.09	11.08	9.26	-15.3	-16.4
SI	270.48	203.78	143.64	-24.7	-29.5	5.01	3.69	3.87	-26.3	4.8
AU	290.88	261.16	212.74	-10.2*	-18.5*	5.13	4.43	3.40	-13.6	-23.3
NZ	317.89	286.41	294.76	-9.9	2.9	5.14	4.98	6.23	-3.1	24.9
All	*332.78*	*295.17*	*240.22*	*-11.3**	*-18.6**	*6.27*	*5.43*	*4.73*	*-13.4*	*-13.0*

* Percentage decrease is statistically significant (*P*<.05).

Abbreviations: CA, Canada; CL, Chile; US, United State of America; IL, Israel; JP, Japan; KR, Republic of Korea; AT, Austria; BE, Belgium; CZ, Czechia; DK, Denmark; EE, Estonia; FI, Finland; FR, France; DE, Germany; GR, Greece; HU, Hungary; IS, Iceland; IE, Ireland; IT, Italy; LV, Latvia; LT, Lithuania; LU, Luxembourg; NL, Netherlands; NO, Norway; PL, Poland; PT, Portugal; SK, Slovakia; SI, Slovenia; ES, Spain; SE, Sweden; CH, Switzerland; GB, United Kingdom; AU, Australia; NZ, New Zealand.

Table 2 Yearly Amenable Mortality Rates (Per 100,000) for Ages 5–9 and 10–14 Years in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015 (See Table S1 for Country-Level Data Availability)

Country	5–9 Years					10–14 Years				
	Yearly Amenable Mortality Rate			% Change (95% CI)		Yearly Amenable Mortality Rate			% Change (95% CI)	
	2001/05	2006/10	2011/15	2006/10–2001/05	2011/15–2006/10	2001/05	2006/10	2011/15	2006/10–2001/05	2011/15–2006/10
CA	1.92	2.11	1.38	9.7	-34.6*	1.80	1.80	1.91	.3	5.7
US	2.58	2.38	2.23	-7.6	-6.4	3.06	2.76	2.52	-9.6	-8.9
CL	3.69	3.17	2.94	-14.1	-7.2	3.72	3.16	3.11	-15.0	-1.4
IL	1.73	2.05	2.10	18.2	2.6	2.54	2.04	1.73	-19.8	-14.8
JP	2.67	2.50	2.40	-6.2	-3.9	2.55	2.17	2.20	-14.8	1.2
KR	3.42	2.39	1.86	-30.1*	-22.0	3.58	2.55	1.99	-28.9*	-21.7
DK	1.78	1.32	1.21	-25.8	-8.4	2.10	1.78	0.72	-15.6	-59.7
IS	2.00	2.08	0.94	4.2	-54.9	1.71	1.98	1.23	15.9	-37.8
FI	0	0.94	1.80	N/A	92.2	1.75	4.48	2.81	156.1	-37.2
NO	2.73	2.20	1.62	-19.4	-26.3	2.14	1.53	1.49	-28.8	-2.6
SE	1.45	1.56	1.53	8.2	-2.1	2.56	1.80	1.83	-29.7	1.6
AT	2.35	1.36	1.53	-42.1	12.7	2.03	2.18	1.62	7.8	-25.9
BE	2.02	2.13	1.52	5.5	-28.7	2.41	1.96	1.53	-18.6	-22.1
FR	1.89	1.52	1.25	-19.7	-17.5	1.96	1.59	1.41	-18.8	-11.5
DE	2.33	1.80	1.83	-22.9	1.6	2.55	2.09	1.78	-18.0	-15.1
LU	1.38	1.69	1.98	22.6	17.4	2.88	1.98	0.64	-31.1	-67.5
NL	2.14	1.76	1.43	-17.8	-18.8	2.89	2.12	1.85	-26.6	-12.7
CH	1.52	1.82	1.37	19.8	-24.5	2.24	1.23	1.58	-45.2	27.9
IE	3.03	1.86	1.29	-38.7	-30.4	2.98	2.12	1.96	-28.7	-7.8
GB	2.98	2.59	2.13	-13.1	-17.8	3.18	2.76	2.35	-13.0	-14.8
GR	3.13	2.54	2.18	-18.8	-14.2	3.55	2.63	2.79	-25.7	6.0
IT	2.36	2.08	1.86	-11.8	-10.6	2.84	2.29	2.19	-19.3	-4.2
PT	3.23	1.67	1.67	-48.2*	.1	4.53	2.66	1.87	-41.2*	-29.7
ES	3.04	2.45	2.02	-19.3	-17.5	3.40	2.64	2.14	-22.3	-18.9
CZ	2.15	2.26	2.27	5.2	.7	2.67	2.25	1.87	-15.7	-17.0
EE	3.32	3.50	1.40	5.7	-60.2	4.61	1.84	1.79	-60.0	-3.0
HU	3.34	2.36	2.44	-29.4	3.3	3.58	3.50	2.92	-2.3	-16.5
LV	4.53	4.62	3.53	1.9	-23.4	3.65	4.06	1.32	11.0	-67.4*
LT	3.82	3.35	2.78	-12.2	-16.9	3.08	4.14	1.21	34.2	-70.7*
PL	2.99	3.14	2.97	4.9	-5.3	3.03	3.52	3.30	16.1	-6.1
SK	3.27	4.34	3.19	32.7	-26.5	3.70	4.23	3.35	14.4	-20.9
SI	1.67	2.20	1.64	31.6	-25.6	2.61	1.24	1.74	-52.4	40.3
AU	2.14	1.81	1.76	-15.6	-2.5	2.24	2.13	1.80	-4.8	-15.6
NZ	2.11	2.01	1.37	-5.0	-32.0	3.04	2.71	2.96	-10.6	9.1
All	*2.59*	*2.28*	*2.02*	*-11.9*	*-11.3*	*2.87*	*2.48*	*2.16*	*-13.5*	*-13.1*

* Percentage decrease is statistically significant (*P*<.05).

Table 1 Yearly Amenable Mortality Rates (Per 100,000) of Conditions Originating in Early Neonatal Period for Age <1 in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015

Country	Rate 2001/2005	Rate 2006/2010	Rate 2011/2015	% Change 2006/10 – 2001/05	% Change 2011/15 – 2006/10
Canada	293.1	297.1	290.8	1.3 (-7.4, 10.1)	-2.1 (-10.3, 6.1)
Chile	329.3	341.9	324.2	3.8 (-6.2, 13.8)	-5.2 (-14.3, 3.9)
United States of America	349.6	322.1	295.6	-7.9 (-10.0, -5.7) *	-8.2 (-10.5, -5.9) *
Israel	229.6	174.4	142.4	-24 (-36.3, -11.7) *	-18.3 (-32.5, -4.2) *
Japan	83.6	68.1	54.2	-18.5 (-26.4, -10.7) *	-20.4 (-29.2, -11.6) *
Republic of Korea	262.0	186.9	160.1	-28.7 (-34.9, -22.4) *	-14.3 (-22.9, -5.7) *
Austria	250.9	203.5	162.4	-18.9 (-36.0, -1.8) *	-20.2 (-38.8, -1.6) *
Belgium	193.2	182.4	162.9	-5.6 (-23.1, 11.9)	-10.7 (-27.5, 6.1)
Czechia	209.9	167.0	136.0	-20.4 (-36.3, -4.6) *	-18.6 (-36.0, -1.1) *
Denmark	231.3	160.1	190.5	-30.8 (-48.1, -13.4) *	18.9 (-12.9, 50.8)
Estonia	290.7	188.6	109.8	-35.1 (-66.2, -4.0) *	-41.8 (-77.5, -6.0) *
Finland	142.0	117.4	84.4	-17.3 (-43.8, 9.2)	28.2 (-54.3, -2.1) *
France	190.6	175.2	177.1	-8.1 (-14.9, -1.3) *	1.1 (-6.5, 8.7)
Germany	195.0	182.5	170.3	-6.4 (-13.5, .8)	-6.7 (-14.1, .8)
Greece	209.0	155.4	164.9	-25.7 (-40.4, -10.9) *	6.1 (-16.4, 28.7)
Hungary	432.5	334.2	278.4	-22.7 (-34.0, -11.5) *	-16.7 (-30.5, -2.9) *
Iceland	119.9	102.0	67.5	-14.9 (-121.4, 85.1)	-33.8 (-129.2, 61.6)
Ireland	189.8	154.0	145.1	-18.9 (-40.4, 2.7)	-5.8 (-31.2, 19.6)
Italy	232.6	203.1	177.9	-12.7 (-19.7, -5.7) *	-12.4 (-20.0, -4.8) *
Latvia	408.7	348.6	270.5	-14.7 (-41.0, 11.6)	-22.4 (-49.2, 4.4)
Lithuania	261.4	235.8	162.6	-9.8 (-38.6, 19.1)	-31.1 (-56.0, -6.1) *
Luxembourg	203.1	104.2	113.3	-48.7 (-100.4, 3.0)	8.7 (-111.7, 108.7)
Netherlands	249.5	211.4	199.9	-15.3 (-26.5, -4.1) *	-5.4 (-19.1, 8.2)
Norway	166.1	158.6	123.9	-4.5 (-31.7, 22.7)	-21.9 (-45.6, 1.8)
Poland	360.4	306.1	232.3	-15.1 (-21.7, -8.4) *	-24.1 (-30.7, -17.5) *
Portugal	233.6	179.5	181.2	-23.2 (-37.6, -8.7) *	.9 (-20.4, 22.3)
Slovakia	301.7	256.6	240.2	-15.0 (-34.1, 4.2)	-6.4 (-28.3, 15.5)
Slovenia	203.7	168.8	122.3	-17.1 (-55.7, 21.5)	-27.6 (-64.2, 9.1)
Spain	209.6	181.7	166.7	-13.3 (-21.4, -5.3) *	-8.2 (-17.2, .7)
Sweden	142.5	103.8	109.4	-27.2 (-45.3, -9.1) *	5.4 (-21.4, 32.2)
Switzerland	217.4	233.3	207.7	7.3 (-15.7, 30.4)	-11.0 (-29.8, 7.8)
United Kingdom	289.4	256.5	214.1	-11.4 (-16.9, -5.9) *	-16.6 (-22.0, -11.2) *
Australia	244.0	218.0	180.6	-10.7 (-20.6, -.7) *	-17.2 (-26.7, -7.6) *
New Zealand	255.5	225.8	242.9	-11.6 (-32.2, 8.9)	7.6 (-17.2, 32.4)
All OECD countries	*266.3*	*239.8*	*193.8*	*-9.9 (-18.4, -1.5)* *	*-19.2 (-27.9, -10.4)* *

* Percentage decrease is statistically significant (*P*<.05).

Table 2 Yearly Amenable Mortality Rates (Per 100,000) of Congenital Cardiovascular Anomalies for Age <1 in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015

Country	Rate 2001/2005	Rate 2006/2010	Rate 2011/2015	% Change 2006/10 – 2001/05	% Change 2011/15 – 2006/10
Canada	36.7	34.6	33.0	-5.6 (-29.1, 17.9)	-4.8 (-28.5, 18.9)
Chile	91.6	79.8	80.9	-12.9 (-29.6, 3.7)	1.3 (-18.5, 21.2)
United States of America	41.6	35.8	33.5	-13.9 (-19.9, -7.9) *	-6.5 (-13.4, .4)
Israel	45.3	38.8	37.2	-14.4 (-44.6, 15.9)	-4.0 (-37.9, 29.9)
Japan	51.5	39.7	32.0	-22.9 (-32.6, -13.3) *	-19.3 (-30.9, -7.7) *
Republic of Korea	59.3	38.3	32.1	-35.4 (-47.7, -23.1) *	-16.2 (-35.0, 2.5)
Austria	43.1	35.9	31.6	-16.6 (-58.7, 25.5)	-12.1 (-59.6, 35.5)
Belgium	40.8	29.1	28.2	-28.6 (-59.7, 2.4)	-2.9 (-47.8, 42)
Czechia	34.4	29.5	21.1	-14.2 (-55.6, 27.2)	-28.5 (-66.3, 9.3)
Denmark	48.9	25.4	26.1	-47.9 (-79.0, -16.8) *	2.7 (-69.0, 74.3)
Estonia	68.9	59.4	26.8	-13.8 (-92.5, 64.9)	-55.0 (-108.8, -1.2) *
Finland	37.9	26.6	20.3	-29.8 (-75.4, 15.8)	-23.5 (-80.9, 33.8)
France	37.3	34.4	29.0	-7.6 (-23.0, 7.9)	-15.8 (-30.8, -.8) *
Germany	44.2	33.6	30.6	-24.0 (-36.9, -11.1) *	-8.9 (-26.0, 8.2)
Greece	71.7	43.5	40.9	-39.3 (-61.1, -17.5) *	-6.0 (-45.1, 33.0)
Hungary	75.6	69.0	62.6	-8.7 (-39.2, 21.8)	-9.3 (-41.5, 22.9)
Iceland	4.8	21.2	13.5	343.2 (-1784.6, 443.2)	-36.5 (-239.8, 63.5)
Ireland	46.8	38.9	36.2	-16.9 (-61.1, 27.3)	-6.9 (-57.0, 43.2)
Italy	57.1	41.8	36.0	-26.8 (-39.2, -14.4) *	-13.9 (-30.5, 2.6)
Latvia	119.2	77.6	42.6	-34.9 (-75.0, 5.2)	-45.1 (-89.9, -.2) *
Lithuania	99.8	79.3	45.4	-20.5 (-63.2, 22.1)	-42.7 (-80.6, -4.8) *
Luxembourg	15.0	0	13.3	-100 (., 0)	N/A
Netherlands	47.6	38.4	28.7	-19.4 (-44.2, 5.5)	-25.3 (-52.3, 1.8)
Norway	38.4	23.0	22.0	-39.9 (-80.4, .6)	-4.6 (-76.6, 67.4)
Poland	91.5	69.2	67.0	-24.4 (-36.5, -12.2) *	-3.2 (-19.8, 13.4)
Portugal	47.7	33.9	32.0	-29.0 (-59.3, 1.3)	-5.5 (-52.3, 41.2)
Slovakia	70.2	64.2	67.4	-8.6 (-50.5, 33.4)	5.0 (-42.7, 52.7)
Slovenia	55.5	29.1	17.6	-47.5 (-100.8, 5.8)	-39.5 (-117.2, 38.2)
Spain	54.1	41.7	31.2	-23.1 (-37.5, -8.6) *	-25.2 (-41.4, -9.1) *
Sweden	29.3	20.2	13.0	-31.1 (-69.5, 7.2)	-35.8 (-78.1, 6.5)
Switzerland	46.4	34.2	39.2	-26.4 (-64.1, 11.3)	14.8 (-44.9, 74.5)
United Kingdom	42.1	36.2	33.3	-13.8 (-28.0, .4)	-8.1 (-23.6, 7.3)
Australia	33.7	32.5	24.7	-3.7 (-32.2, 24.8)	-24.0 (-47.2, -.7) *
New Zealand	40.6	37.2	30.6	-8.4 (-61.3, 44.5)	-17.8 (-67.9, 32.2)
All OECD countries	38.8	47.9	35.0	-18.9 (-37.3, -.5) *	-9.9 (-33.4, 13.5)

* Percentage decrease is statistically significant (*P*<.05).

Table 3 Yearly Amenable Mortality Rates (Per 100,000) of Pneumonia for Age <1 in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015

Country	Rate 2001/2005	Rate 2006/2010	Rate 2011/2015	% Change 2006/10 – 2001/05	% Change 2011/15 – 2006/10
Canada	3.3	2.6	1.8	-19.9 (-89.2, 49.5)	-32.5 (-99.2, 34.2)
Chile	41.0	24.1	11.7	-41.2 (-60.0, -22.4) *	-51.2 (-72.7, -29.7) *
United States of America	6.6	5.0	3.8	-23.9 (-37.6, -10.1) *	-23.8 (-39.7, -7.9) *
Israel	2.8	2.2	1.8	-22.3 (-134.6, 77.7)	-20.6 (-143.8, 79.4)
Japan	4.7	4.4	3.5	-6.0 (-43.0, 31.1)	-20.9 (-55.5, 13.7)
Republic of Korea	2.7	2.1	1.5	-22.7 (-87.8, 42.4)	-30.4 (-100.6, 39.8)
Austria	1.3	.5	1.3	-59.9 (-207.0, 40.1)	142.7 (-747.1, 242.7)
Belgium	2.1	2.1	1.4	-.3 (-175.2, 99.7)	-32.4 (-160.8, 67.6)
Czechia	10.2	8.3	4.6	-19.0 (-91.8, 53.9)	-44.9 (-104.7, 14.9)
Denmark	2.2	1.2	1.7	-42.6 (-200.2, 57.4)	38.5 (-368.6, 138.5)
Estonia	16.5	3.9	2.8	-76.5 (-143.6, -9.4) *	-27.3 (-318, 72.7)
Finland	1.8	1.7	1.0	-5.0 (-268.4, 95)	-39.6 (-232.9, 60.4)
France	.8	.6	.2	-22.5 (-113.2, 68.1)	-69.6 (-125, -14.3) *
Germany	1.8	1.5	1.0	-18.1 (-85, 48.8)	-34.5 (-98.1, 29.1)
Greece	15.0	14.6	8.9	-3.1 (-70.1, 63.8)	-38.8 (-88.8, 11.1)
Hungary	16.3	2.1	3.6	-87.2 (-106.1, -68.3) *	70.9 (-231, 170.9)
Iceland	4.8	0	0	-100 (., 0)	N/A
Ireland	5.1	2.0	0	-60.6 (-139.6, 18.3)	-100 (., 0)
Italy	2.3	.9	1.2	-59.5 (-101, -18) *	29.5 (-121.4, 129.5)
Latvia	21.7	11.6	5.0	-46.5 (-128.5, 35.5)	-57.3 (-155.8, 41.3)
Lithuania	37.2	19.8	8.6	-46.8 (-99.5, 6)	-56.8 (-119.7, 6)
Luxembourg	0	3.6	0	N/A	-100 (., 0)
Netherlands	1.4	1.7	.6	24 (-174.9, 124)	-67.3 (-140.7, 6.2)
Norway	1.1	2.3	1.3	121.4 (-548.2, 221.4)	-43 (-199.5, 57)
Poland	14.8	11.8	11.6	-19.9 (-51.4, 11.6)	-1.9 (-42.5, 38.7)
Portugal	7.4	1.2	1.4	-83.3 (-114.7, -52) *	13.4 (-267.7, 113.4)
Slovakia	47.2	41.3	30.8	-12.6 (-62, 36.9)	-25.5 (-71.8, 20.8)
Slovenia	3.4	4.9	3.7	42.9 (-414.5, 142.9)	-23.6 (-248.2, 76.4)
Spain	1.5	1.3	.7	-14.8 (-107.4, 77.9)	-45 (-118.8, 28.8)
Sweden	1.4	2.8	3.2	90.5 (-291.7, 190.5)	14.6 (-161, 114.6)
Switzerland	1.6	1.1	1.7	-35.7 (-217.5, 64.3)	64 (-386.5, 164)
United Kingdom	5.0	3.6	2.5	-29.2 (-64.8, 6.3)	-28.5 (-69.6, 12.6)
Australia	5.3	3.5	2.0	-34 (-88.5, 20.6)	-41.2 (-100.3, 17.9)
New Zealand	11.0	11.5	10.9	4.5 (-107.7, 104.5)	-5.4 (-105, 94.1)
All OECD countries	6.1	4.5	3.1	-25.7 (-74.3, 22.9)	-30.7 (-88.1, 26.7)

* Percentage decrease is statistically significant (*P*<.05).

Table 4 Yearly Amenable Mortality Rates (Per 100,000) of Septicaemia for Age <1 in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015

Country	Rate 2001/2005	Rate 2006/2010	Rate 2011/2015	% Change 2006/10 – 2001/05	% Change 2011/15 – 2006/10
Canada	3.2	3.3	2.0	2.0 (-81.8, 85.9)	-40.6 (-95.2, 14)
Chile	2.6	2.1	1.6	-20.6 (-112.5, 71.4)	-23.4 (-123.2, 76.4)
United States of America	7.2	6.1	4.5	-15.5 (-29.7, -1.2) *	-25.6 (-39.8, -11.4) *
Israel	4.7	2.5	2.6	-47.4 (-113.8, 19)	4.1 (-138.8, 104.1)
Japan	6.2	5.0	4.2	-19.9 (-48.5, 8.7)	-15.4 (-49.4, 18.7)
Republic of Korea	1.8	1.8	.8	3.2 (-96.2, 102.5)	-55 (-111, 1)
Austria	.5	.5	.3	.3 (-439.3, 100.3)	-51.5 (-312, 48.5)
Belgium	2.3	1.6	1.6	-29.2 (-159.7, 70.8)	-2.4 (-193.7, 97.6)
Czechia	1.1	1.9	1.8	82.1 (-348.3, 182.1)	-5.8 (-186.1, 94.2)
Denmark	.9	.9	0	.4 (-358.8, 100.4)	-100 (., 0)
Estonia	7.5	3.9	0	-48.3 (-213.8, 51.7)	-100 (., 0)
Finland	1.4	2.4	1.0	66.3 (-390.5, 166.3)	-56.9 (-187.3, 43.1)
France	1.7	1.2	1.1	-25.6 (-87.9, 36.6)	-7.8 (-92.3, 76.7)
Germany	.9	1.4	1.3	60.7 (-102.3, 160.7)	-8 (-92.6, 76.6)
Greece	7.1	3.7	4.9	-48.3 (-110.2, 13.5)	31.8 (-140.8, 131.8)
Hungary	1.7	0	.2	-100 (., 0)	N/A
Iceland	0	0	4.5	N/A	N/A
Ireland	.7	.3	1.4	-57.8 (-284.2, 42.2)	383.5 (-1937.6, 483.5)
Italy	2.5	4.6	3.7	84.5 (-37.4, 184.5)	-19.4 (-67.2, 28.5)
Latvia	4.9	0	1.0	-100 (., 0)	N/A
Lithuania	6.0	2.6	4.0	-55.9 (-172.1, 44.1)	49.5 (-373.4, 149.5)
Luxembourg	0	0	0	N/A	N/A
Netherlands	2.9	1.8	1.3	-36.4 (-121.5, 48.8)	-32.3 (-147.1, 67.7)
Norway	.7	.7	.7	-5.1 (-421, 94.9)	-.3 (-437.3, 99.7)
Poland	18.2	8.8	2.6	-51.6 (-71.5, -31.7) *	-69.9 (-91.2, -48.6) *
Portugal	3.5	2.9	1.9	-16.7 (-141.4, 83.3)	-33.9 (-157.1, 66.1)
Slovakia	3.5	3.9	1.8	12.4 (-209, 112.4)	-54.3 (-162.3, 45.7)
Slovenia	2.3	0	0	-100 (., 0)	N/A
Spain	2.1	2.0	1.3	-6.4 (-90.6, 77.9)	-37.1 (-102.4, 28.1)
Sweden	1.2	5.5	2.8	344.5 (-526.7, 444.5)	-49.1 (-118.2, 20)
Switzerland	3.6	1.1	0	-70.3 (-144.7, 4)	-100 (., 0)
United Kingdom	4.4	3.2	1.6	-28.1 (-66.3, 10.1)	-50.3 (-84.1, -16.6) *
Australia	2.9	1.8	1.4	-38.4 (-108.6, 31.8)	-21.9 (-123.2, 78.1)
New Zealand	3.2	4.2	2.7	30 (-217, 130)	-34.5 (-161.8, 65.5)
All OECD countries	5.0	4.1	2.5	-18 (-75.5, 39.5)	-39.1 (-94.3, 16.1)

* Percentage decrease is statistically significant (*P*<.05).

Table 5 Yearly Amenable Mortality Rates (Per 100,000) of Nephritis and Nephrosis for Age <1 in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015

Country	Rate 2001/2005	Rate 2006/2010	Rate 2011/2015	% Change 2006/10 – 2001/05	% Change 2011/15 – 2006/10
Canada	1.4	.8	.3	-40.1 (-127.2, 47)	-67.6 (-140.9, 5.7)
Chile	1.3	.6	.4	-57.2 (-142.2, 27.7)	-28.9 (-211.4, 71.1)
United States of America	4.0	3.2	2.1	-19.7 (-38.2, -1.3) *	-33.6 (-51.8, -15.4) *
Israel	4.0	.5	.4	-86.9 (-117.5, -56.4) *	-32.5 (-258.3, 67.5)
Japan	.8	.7	.3	-11.1 (-94.9, 72.6)	-60.4 (-112.9, -7.8) *
Republic of Korea	.5	.6	.3	29.4 (-193.7, 129.4)	-50 (-151.5, 50)
Austria	.0	0	0	N/A	N/A
Belgium	.2	.5	0	176 (-1220.6, 276)	-100 (., 0)
Czechia	.4	.5	.2	24.1 (-472.5, 124.1)	-65.5 (-240.2, 34.5)
Denmark	0	0	0	N/A	N/A
Estonia	0	0	0	N/A	N/A
Finland	.4	0	1	-100 (., 0)	N/A
France	.5	.1	.1	-79.1 (-129.5, -28.8) *	-5.1 (-304, 94.9)
Germany	.2	.3	.1	94.3 (-337.9, 194.3)	-64.3 (-155.7, 27.2)
Greece	0	.2	0	N/A	-100 (., 0)
Hungary	.4	0	.9	-100 (., 0)	N/A
Iceland	0	0	0	N/A	N/A
Ireland	.3	.6	.3	68.7 (-836.7, 168.7)	-39.6 (-341.5, 60.4)
Italy	.9	1.2	1	38.5 (-126.4, 138.5)	-14.4 (-112.8, 84)
Latvia	0	0	0	N/A	N/A
Lithuania	0	0	0	N/A	N/A
Luxembourg	0	0	0	N/A	N/A
Netherlands	.3	.1	.2	-63.8 (-246.9, 36.2)	109.4 (-1014.6, 209.4)
Norway	0	.3	.3	N/A	-.3 (-618.4, 99.7)
Poland	.2	.5	.1	126.8 (-461.3, 226.8)	-78.7 (-151.1, -6.2) *
Portugal	1.5	.5	0	-66.7 (-172.0, 33.3)	-100 (., 0)
Slovakia	.4	.4	0	-8.1 (-577.8, 91.9)	-100 (., 0)
Slovenia	0	0	0	N/A	N/A
Spain	.5	.4	.1	-12.1 (-184.4, 87.9)	-78 (-152.7, -3.3) *
Sweden	0	.2	0	N/A	-100 (., 0)
Switzerland	.3	.3	.5	-3.6 (-601.0, 96.4)	87.4 (-918.6, 187.4)
United Kingdom	.6	.5	.2	-20.1 (-133.9, 79.9)	-51.5 (-138.3, 35.2)
Australia	.2	.5	.3	150.0 (-657.3, 250.0)	-46.9 (-192.8, 53.1)
New Zealand	.4	.3	0	-10.0 (-567.8, 90.0)	-100 (., 0)
All OECD countries	1.8	1.4	.6	-19.9 (-114.1, 74.3)	-58.2 (-131.3, 14.9)

* Percentage decrease is statistically significant (*P*<.05).

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on 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	4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6
Objectives	3	State specific objectives, including any pre-specified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	8
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8
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	*8*
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	8-9
		(*c*) Explain how missing data were addressed	8-9
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
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	9
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-10
		(b) Indicate number of participants with missing data for each variable of interest	9-10
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	9-10-11
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
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	9-10-11
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
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	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	13-14-15
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	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
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

Patterns of amenable child mortality over time in 34 member countries of the Organisation for Economic Co-operation and Development (OECD): evidence from a 15-year time trend analysis (2001-2015)

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-027909.R2
Article Type:	Research
Date Submitted by the Author:	18-Apr-2019
Complete List of Authors:	Gianino, Maria Michela; University of Torino, Dept. Public Health and Pediatrics Lenzi, Jacopo; Alma Mater Studiorum - University of Bologna, Department of Biomedical and Neuromotor Sciences Bonaudo, Marco; Università degli Studi di Torino, Department of Public Health Sciences and Pediatrics Fantini, Maria Pia; University of Bologna, Department of Biomedical and Neuromotor Sciences Siliquini, Roberta; University of Turin, Department of Public Health Sciences and Pediatrics Ricciardi, W; Universita Cattolica del Sacro Cuore Sede di Roma, Istituto di Sanità Pubblica; Fondazione Policlinico Universitario 'Agostino Gemelli' IRCCS Damiani, Gianfranco; Universita Cattolica del Sacro Cuore Sede di Roma, Istituto di Sanità Pubblica; Fondazione Policlinico Universitario 'Agostino Gemelli' IRCCS
Primary Subject Heading:	Public health
Secondary Subject Heading:	Health services research, Paediatrics
Keywords:	International health services < HEALTH SERVICES ADMINISTRATION & MANAGEMENT, amenable mortality, child, childhooh, healthcare, OECD countries

Patterns of amenable child mortality over time in 34 member countries of the Organisation for Economic Co-operation and Development (OECD): evidence from a 15-year time trend analysis (2001-2015)

Authors:

Maria Michela Gianino[a], Jacopo Lenzi[b], Marco Bonaudo[a], Maria Pia Fantini[b], Roberta Siliquini[a], Walter Ricciardi[cd], Gianfranco Damiani[cd].

Maria Michela Gianino, Professor

a) Department of Public Health Sciences and Pediatrics, Università di Torino

Via Santena 5 bis - 10126 Turin (Italy)

Tel #: +39(0)116705839 - Fax #: +39(0)116705889

mariola.gianino@unito.it

Jacopo Lenzi, PhD

b) Department of Biomedical and Neuromotor Sciences, Alma Mater Studiorum - Università di Bologna

Via Ugo Foscolo 7 - 40123 Bologna (Italy)

Tel #: +39(0)512094836

jacopo.lenzi2@unibo.it

Marco Bonaudo, MSN

a) Department of Public Health Sciences and Pediatrics, Università di Torino

Via Santena 5 bis - 10126 Turin (Italy)

Tel #: +39(0)116705839 - Fax #: +39(0)116705889

marco.bonaudo@unito.it

Maria Pia Fantini, MD, Professor

b) Department of Biomedical and Neuromotor Sciences, Alma Mater Studiorum - Università di Bologna

Via Ugo Foscolo 7 - 40123 Bologna (Italy)

Tel #: +39(0)512094836

mariapia.fantini@unibo.it

Roberta Siliquini, Professor

a) Department of Public Health Sciences and Pediatrics, Università di Torino

Via Santena 5 bis - 10126 Turin (Italy)

Tel #: +39(0)116705812

roberta.siliquini@unito.it

Walter Ricciardi, MD, Professor

c) Fondazione Policlinico Universitario 'Agostino Gemelli' IRCCS, Roma, Italia

Largo Agostino Gemelli 8 - 00168 Roma (Italia)

Tel #: +39(0)630154396

walter.ricciardi@unicatt.it

and

d) Istituto di Sanità Pubblica, Università Cattolica del Sacro Cuore, Roma, Italia

Largo Francesco Vito 1 - 00168 Roma (Italia)

Tel #: +39(0)630154396

walter.ricciardi@unicatt.it

Gianfranco Damiani MD, Professor

c) Fondazione Policlinico Universitario 'Agostino Gemelli' IRCCS, Roma, Italia

Largo Agostino Gemelli 8 - 00168 Roma (Italia)

Tel #: +39(0)630154396

gianfranco.damiani@policlinicogemelli.it

and

d) Istituto di Sanità Pubblica, Università Cattolica del Sacro Cuore, Roma, Italia

Largo Francesco Vito 1 - 00168 Roma (Italia)

Tel #: +39(0)630154396

gianfranco.damiani@unicatt.it

Corresponding Author:

Marco Bonaudo, MSN

a) Department of Public Health Sciences and Pediatrics, Università di Torino

Via Santena 5 bis - 10126 Turin (Italy)

Tel #: +39(0)116705839 - Fax #: +39(0)116705889

marco.bonaudo@unito.it

Words count paper: 3077

Words count abstract: 273

ABSTRACT

Objectives. To analyse the trends of amenable mortality rates (AMRs) in children over the period 2001-2015.

Design. Time trend analysis.

Setting. Thirty-four member countries of the Organisation for Economic Co-operation and Development (OECD).

Participants. Mid-year estimates of the resident population aged ≤14 years.

Primary and secondary outcome measures. Using data from the World Health Organization Mortality Database and Nolte and McKee's list, AMRs were calculated as the annual number of deaths over the population/100,000 inhabitants. The rates were stratified by age groups (<1, 1–4, 5–9, 10–14 years). All data were summarised by presenting the average rates for the years 2001/2005, 2006/2010, and 2011/2015.

Results. There was a significant decline in children's AMRs in the <1-year group in all 34 OECD countries from 2001/2005 to 2006/2010 (332.78 to 295.17/100,000; %Δ -11.30%; 95% CI -18.75%, - 3.85%) and from 2006/2010 to 2011/2015 (295.17 to 240.22/100,000; %Δ -18.62%; 95% CI -26.53%, -10.70%), and a slow decline in the other age classes. The only cause of death that was significantly reduced was conditions originating in the early neonatal period for the <1-year group. The age-specific distribution of causes of death did not vary significantly over the study period.

Conclusions. The low decline in amenable mortality rates for children aged ≥1 year, the large variation in amenable mortality rates across countries and the insufficient success in reducing mortality from all causes suggest that the heath system should increase its efforts to enhance child survival. Promoting models of co-management between primary care and subspecialty services, encouraging high-quality healthcare and knowledge, financing universal access to healthcare, and adopting best practice guidelines might help reduce amenable child mortality.

Strengths and limitations of this study:

1. This is the first study to analyse trends in child mortality amenable to healthcare.
2. Thirty-four OECD countries were included in the analyses to provide a thorough depiction of amenable child mortality in high-income economies.
3. Mortality was not disaggregated by ethnicity or socioeconomic characteristics.
4. Making international comparisons is difficult due to variations in birth registration laws and death certification practices.

Key words: Amenable mortality, child, childhood, healthcare, healthcare services, OECD countries

INTRODUCTION

The health of children and adolescents is an important goal for every society, both because they are vulnerable and because diseases can affect their quality of life. Measures for protecting and improving children's and adolescents' health will yield economic and social benefits beyond improved health outcomes. Indeed, young people have the potential to affect the health of future populations as well as global economic development unless timely and effective strategies are put into place.[1,2]

For the adoption of new strategies and the planning of interventions, information on the leading causes of death is essential. Many studies have analysed the mortality rates and have identified the main causes of death of children in specific countries [3] or areas.[4] Studies have demonstrated that many different factors contribute to child and adolescent mortality [5], including biological and psychosocial,[6] socioeconomic status,[7,8] environmental and behavioural factors.[9] In the landscape described, the mortality burden conditioned by the performance of the healthcare system has not been well investigated. Although there is no indicator that is able to compressively reflect the performance of the healthcare system, a suitable measurement seems to be the concept of amenable mortality.

Amenable mortality is defined as deaths that, in the light of medical knowledge and technology at the time of death, could be prevented by timely access to good quality care. The concept of mortality amenable to healthcare finds its origins in the evolution of the concept of avoidable mortality, developed by Rutstein et al., who created a list of conditions that were considered either treatable or preventable through healthcare services given the current medical knowledge and technology.[10] Rutstein was the first to introduce the term amenable mortality, differentiating between causes which are responsive to medical intervention through treatment and secondary/tertiary prevention actions (e.g., cervical cancer, hypertensive disease or appendicitis), and causes responsive to actions beyond healthcare services (preventable conditions such as lung cancer and liver cirrhosis).

In recent years the concept of amenable mortality has been used as a potential indicator of the performance of healthcare systems by several countries. The amenable mortality has been chosen as indicator in the UK National Health Service Outcomes Framework for 2011-2012,[11] and in Australian and New Zealand atlas of avoidable mortality 1997-2001 [12] or in European Community atlas of "avoidable death".[13] Amenable mortality indicators have also been used to report on spatial and temporal distributions and variations in health system performance across countries,[14–20] as well as across subnational entities,[12,21–25] socio-economic status, ethnic groups and sex.[14,24,26,27] Most of these studies did not assess amenable mortality across ages in different populations and did not focus on child and adolescent age classes.

According to the World Health Organization (WHO), an estimated 6.3 million children under the age of 15 years died in 2017 (117,000 in the OECD region). Five point four million of these children were under the age of 5, and 2.5 million died within the first month of life. More than half of these early child deaths were due to conditions that could be prevented or treated with access to simple, affordable interventions and were, consequently, amenable.[2]

The purpose of this study was to analyse the trends of amenable child mortality rates in 34 OECD countries from 2001 to 2015, and to evaluate the pattern across age classes.

MATERIALS AND METHODS

This descriptive study was conducted using secondary data from 34 OECD countries during the period from 2001 to 2015. Mexico and Turkey, albeit members of the OECD, were not included in the analysis because these countries are not listed among high-income economies in the World Development Indicators dataset (gross national income per capita ≥$12,056 for fiscal year 2019)[28] and had limited data availability. The mortality and population data came from the WHO Mortality Database,[29] which comprises deaths registered in national vital registration systems, with the

underlying causes of death coded according to the International Classification of Diseases; no permission is required from the WHO if data are used for non-commercial purposes. If reference populations were not available in the WHO Mortality Database, the data were extracted from UNdata.[30] The country-level data availability is presented in online supplementary file 1.

The causes of death amenable to healthcare were selected by means of the list proposed by Nolte and McKee[14,31] and used in a working paper by the OECD to generate estimates of amenable mortality for 31 countries.[15] This list includes a selected number of conditions which are treatable based on the clinical effectiveness of existing medical interventions. The age limit for amenable deaths is set at 75 years for most conditions, such as cancer and cardiovascular diseases, but the age limit for some diseases (i.e., whooping cough, measles, intestinal infections, and respiratory diseases other than pneumonia/influenza) is set at 14 (see online supplementary file 2 for Nolte and McKee's full list). The aggregation of the causes of death operated in the WHO Mortality Database prevents the use of the list of amenable deaths currently adopted by Eurostat.[32]

For each country, the amenable mortality rates were calculated as the annual number of deaths in the population aged 0–14 years per 100,000 inhabitants. The rates were stratified by the age groups adopted in the WHO Mortality Database (<1, 1–4, 5–9, 10–14 years) and by the 33 disease categories defined by Gay et al..[15] Due to the instability in the estimates of the annual amenable mortality rates, especially for small-population countries, all data were summarised by presenting the average rates for the years 2001/2005, 2006/2010 and 2011/2015. The statistical significance of the percentage changes between these time periods was assessed by using the formula suggested by Hildebrandt et al..[33] Data interpretation focused on the countries that showed significant percentage changes over the entire study period (i.e., both between 2001/05 and 2006/10 and between 2006/10 and 2011/15). Differences in the ranking of age-specific causes of death between time periods were evaluated with the Friedman test.

All data were analysed using the Stata software package, version 15 (StataCorp. 2017. *Stata Statistical Software: Release 15*. College Station, TX: StataCorp LLC). The significance level was set at .05.

Ethics statement

This descriptive study involved aggregate data that exist in the public domain, where it is not possible to identify individuals from the information provided. For this reason, this research did not require ethical approval.

Patient and public involvement

Patients and the public were not involved in the design or planning of the study.

RESULTS

All-cause amenable child mortality rates

The results of the trend analyses conducted over the five-year periods 2001/05, 2006/10 and 2011/15 are presented in Figure 1 and in online supplementary file 3. The amenable mortality rate of the OECD population with <1 year dropped significantly from 2001/05 to 2006/10 (332.78 to 295.17 per 100,000, %Δ = -11.3%) and from 2006/10 to 2011/15 (295.17 to 240.22 per 100,000, %Δ = -18.6%). Contrary to the OECD rate of children aged <1 year, in the population aged ≥1 year the overall OECD rate did not decrease significantly. From 2001/05 to 2006/10 and from 2006/10 to 2011/15, the mortality rates decreased by 13.4% and 13.0%, respectively, in the 1-4 age group; by 11.9% and 11.3% in the 5-9 age group; and by 13.5% and 13.1% for the 10-14 age group. In 2011/15, the OECD rate was 4.73 per 100,000 for the 1-4 age group, 2.02 per 100,000 for the 5-9 age group, and 2.16 per 100,000 for the 10-14 age group.

Cause-specific child mortality rates

When we examined the distribution of cause-specific mortality rates across multiple age groups and study periods, no statistically significant variations in the OECD population were found. The only exception was a significant decrease in deaths in the first year of life for conditions originating in the early neonatal period (2001/05 to 2006/10: 266.3 to 239.8 per 100,000, %Δ = -9.9%; 2006/10 to 2011/15: 239.8 to 193.8 per 100,000, %Δ = -19.2%) (see online supplementary file 4).

Globally, for the years 2001/05, 2006/10 and 2011/15, there were no significant differences in the age-specific percentage distribution of causes of death [<1 year: Friedman test (*P*) = 0.955 (0.372); 1-4 years: 0.864 (0.607); 5-9 years: 0.470 (0.740); 10-14 years: 1.773 (0.398)]. As shown in Table 1, the three leading causes of death by age groups over the 15-year study period were the following: conditions originating in the early neonatal period, congenital cardiovascular anomalies, and pneumonia for children aged <1 year; congenital cardiovascular anomalies, leukaemia, and respiratory diseases (excl. pneumonia/flu) for all other age groups.

Table 1 Percentage Distribution of the Top 10 Causes of Death Amenable to Healthcare in Children in 34 OECD Countries, Years 2001/2005, 2006/2010 and 2011/2015.

Cause of Death	2001/05		2006/10		2011/15	
	Rank	%	Rank	%	Rank	%
<1 Year	(n = 190,169.5)		(n = 175,008)		(n = 105,210.5)	
Conditions originating in the early neonatal period	#1	80.02	#1	81.25	#1	80.69
Congenital cardiovascular anomalies	#2	14.38	#2	13.15	#2	14.55
Pneumonia	#3	1.82	#3	1.53	#3	1.30
Septicaemia	#4	1.50	#4	1.39	#4	1.04
Intestinal infections other than typhoid, diphtheria	#7	0.27	#5	0.60	#5	0.72
Cerebrovascular diseases	#6	0.51	#6	0.60	#6	0.38
Nephritis and nephrosis	#5	0.54	#7	0.49	#7	0.25
Leukaemia	#8	0.21	#8	0.26	#8	0.24
Epilepsy	#9	0.17	#9	0.17	#9	0.23
Whooping cough	#11*	0.11	#12*	0.10	#10	0.19
Other causes	-	0.46	-	0.46	-	0.39
1–4 Years	(n = 14,438)		(n = 12,738)		(n = 8491.5)	
Congenital cardiovascular anomalies	#1	25.67	#1	23.63	#1	25.21
Leukaemia	#3	14.55	#3	13.99	#2	14.99
All respiratory diseases, excl. pneumonia/influenza	#2	15.60	#2	16.79	#3	14.25
Pneumonia	#4	12.35	#4	12.20	#4	12.24
Epilepsy	#7	5.16	#7	5.50	#5	7.20
Septicaemia	#5	7.57	#5	8.18	#6	6.88
Conditions originating in the early neonatal period	#6	5.59	#6	5.60	#7	5.06
Intestinal infections other than typhoid, diphtheria	#9	2.45	#9	3.05	#8	3.98
Cerebrovascular diseases	#8	3.86	#8	4.13	#9	3.38
Influenza	#10	2.16	#10	1.92	#10	2.39
Other causes	-	5.05	-	5.00	-	4.42

5–9 Years	(n = 7705)		(n = 6706)		(n = 4541)	
Leukaemia	#1	31.72	#1	28.35	#1	27.31
All respiratory diseases, excl. pneumonia/influenza	#3	12.91	#2	16.28	#2	13.87
Congenital cardiovascular anomalies	#2	14.91	#3	13.67	#3	13.12
Epilepsy	#5	7.81	#5	7.86	#4	10.37
Pneumonia	#4	8.58	#4	7.90	#5	9.12
Cerebrovascular diseases	#6	6.87	#6	7.13	#6	6.69
Septicaemia	#7	5.15	#7	5.67	#7	5.26
Influenza	#9	1.66	#8	2.54	#8	2.97
Conditions originating in the early neonatal period	#8	2.25	#9	2.48	#9	2.80
Intestinal infections other than typhoid, diphtheria	#13†	0.87	#12†	1.25	#10	2.00
Other causes	-	7.26	-	6.87	-	6.47
10–14 Years	(n = 9109)		(n = 7579)		(n = 4921)	
Leukaemia	#1	31.30	#1	30.01	#1	30.24
All respiratory diseases, excl. pneumonia/influenza	#3	13.66	#2	15.28	#2	13.66
Congenital cardiovascular anomalies	#2	14.13	#3	12.17	#3	12.62
Epilepsy	#5	7.73	#5	7.89	#4	10.36
Cerebrovascular diseases	#4	8.12	#4	8.99	#5	9.08
Pneumonia	#6	7.59	#6	6.73	#6	7.27
Septicaemia	#7	4.17	#7	4.92	#7	4.29
Diabetes mellitus	#8	2.49	#8	2.31	#8	1.97
Influenza	#11‡	1.15	#9	2.15	#9	1.77
Conditions originating in the early neonatal period	#10	1.57	#11‡	1.78	#10	1.52
Other causes	-	8.09	-	7.78	-	7.21

* Abdominal hernia was ranked #10 in 2001/05 (0.17%) and 2006/10 (0.13%).
† Nephritis and nephrosis were ranked #10 in 2001/05 (1.60%) and 2006/10 (1.69%).
‡ Nephritis and nephrosis were ranked #9 in 2001/05 (1.79%) and #10 in 2006/10 (1.91%).

Country-specific amenable child mortality rates

As shown in Figure 1 and online supplementary file 3, the amenable mortality rate for the population aged <1 year dropped significantly over the entire study period in 15 countries (United States, Israel, Japan, South Korea, Czechia, Estonia, Germany, Italy, Latvia, Hungary, Poland, Spain, Austria, United Kingdom and Australia). In addition to the decrease in conditions originating in the early neonatal period, other causes contributed to a significant reduction in mortality for some of these countries: septicaemia, pneumonia and nephritis/nephrosis in the United States, septicaemia in Poland, and congenital cardiovascular anomalies in Japan and Spain. See online supplementary file 4 for country-specific and cause-specific mortality rates in the <1-year population.

Although the overall OECD rate did not decrease significantly in the population aged ≥1 year, some country-specific data exhibited significant trends (Figure 1). However, no country showed a significant linear decline in mortality over the entire study period for all age groups (Figure 1).

Figure 1 Yearly Amenable Mortality Rates (Per 100,000) for Ages <1 (a), 1–4 (b), 5–9 (c) and 10–14 (d) in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015 (See Online Supplementary File 1 for Country-Level Data Availability)

* Percentage decrease is statistically significant (P<.05).
Abbreviations: CA, Canada; CL, Chile; US, United State of America; IL, Israel; JP, Japan; KR, Republic of Korea; AT, Austria; BE, Belgium; CZ, Czechia; DK, Denmark; EE, Estonia; FI, Finland; FR, France; DE, Germany; GR, Greece; HU, Hungary; IS, Iceland; IE, Ireland; IT, Italy; LV, Latvia; LT, Lithuania; LU, Luxembourg; NL, Netherlands; NO, Norway; PL, Poland; PT, Portugal; SK, Slovakia; SI, Slovenia; ES, Spain; SE, Sweden; CH, Switzerland; GB, United Kingdom; AU, Australia; NZ, New Zealand.

DISCUSSION

In this time trend analysis, we found a significant decline in amenable child mortality rates for the <1-year age group in the 34 OECD countries between 2001/05 and 2011/15, and a slow decline in the other age groups. These results confirm the trend shown by previous studies conducted on six OECD countries that had been selected to provide a variety of forms of healthcare delivery between 1956 and 1980,[21] and highlight that policies to reduce amenable mortality rates are still needed, even in settings where the quality of medical services and resources is high.

These results are driven by the fact that the only significantly reduced cause of death was conditions originating in the early neonatal period in the <1-year group. Surprisingly**,** the decline was not more pronounced among countries with higher mortality in 2001/05, indicating that continued gains in child survival occurred both in low- and high-mortality countries. The most representative countries are Japan, which showed an improvement in its performance despite starting from low values in 2001/05, and Hungary and the US, which showed high amenable mortality rates in 2001/05.

The results concerning country-specific amenable child mortality rates showed that the reductions in the age-specific rates were not evenly distributed across OECD countries. There was not a single cause for which the age-specific mortality rates declined in the countries studied, and the success in reducing mortality rates was not consistent for all causes. These achievements corroborate another of our results, highlighting that the causal distribution of the age-specific mortality rates did not vary over the period examined and that, namely, the conditions originating in the early neonatal period, congenital cardiovascular anomalies, pneumonia, leukaemia, and all respiratory diseases (excl. pneumonia/influenza) were consistently top-ranked. Because these are the main causes related

to chronic disorders and pathologies that require acute care delivered quickly, our results suggest that the models of care for children should be revised. Sidebotham has argued that child diseases might broadly be divided into chronic (e.g., leukaemia) and acute diseases (e.g., pneumonia), and that a single model cannot be proposed but each needs a different, albeit interconnected, health system solution.[5]

Wolfe [34] highlights that the presence of children with chronic disorders requires substantial changes from a hospital-centric model to a model in which primary care and secondary care providers and public health services work closely together. Models of co-management are essential to promote ongoing communication and coordination between primary care and subspecialty services. It would be inefficient for subspecialists to provide primary care, and ineffective for primary care providers to attempt to stay abreast of the latest therapies for chronic diseases. Because the majority of chronic illness care is performed within the primary care setting and because primary care physicians spend a considerable amount of time treating chronic illness, primary care should play a central role in the overall coordination and continuity of people's care providing greater access to specialists and more timely follow-up care after emergency room visits.[35] The few studies evaluating this new approach to work showed an improvement in child survival [36–38], and thus traced a possible path to improve amenable mortality from chronic diseases.

Sidebotham and Mackenbach judge as determinants of amenable mortality in acute diseases the universal access to healthcare and the presence of professionals with appropriate training.[5,18] The relevance of access may at least partially explain our results in some countries. For example, in Chile, where the mortality rate of pneumonia was consistently high for the <1-year group, the healthcare system replicates class inequalities. Studies have identified and tracked several important inequalities in the burden of infant mortality for infectious diseases by socioeconomic level in Chile, showing that this gap is discriminatory because disadvantaged households underutilise healthcare services (due to social or economic exclusion).[39,40] In Slovakia, where also the mortality rate of pneumonia was high for the <1-year group, social health insurance system formally covers all

residents and has a benefit package that all insurance companies must provide for their insured. In theory, the insurance system is thus designed to provide everybody with the same benefit package, regardless of their health status, ability to pay or place of residence. In practice, coverage varies across the country, mainly because the supply of human resources (especially specialists and general practitioners [GPs]) is not adequate in all regions and districts, and sometimes providers are simply not available.[41]

The access to healthcare professionals with adequate training looks at the models of first contact between patients and clinicians and on their expertise. Although an international debate is open on the best pattern of paediatric primary care among a paediatrician-based system, a combined system or a system based on GPs/family doctors,[42] some authors highlight the importance of primary care paediatricians, especially because primary care paediatricians who look after children are likely to have more professional training and competencies than GPs, who often, receiving an insufficient or not existing or non-mandatory training, do not have capabilities to diagnose and treat a child in effective times.[34,43,44]

Supported by the specialised literature, the availability of high-quality healthcare and knowledge and the use of best practice guidelines are also determinants of amenable mortality.[5,18] These determinants provide one possible explanation for our results, in particular for the reduction in mortality by conditions originating in the early neonatal period. Several lines of evidence support the hypothesis that neonatal intensive care has resulted in decreased mortality. Marked declines in neonatal and infant mortality rates are coincident with the introduction and progressive development of neonatal intensive care [45,46] and with specific neonatal intensive therapeutic improvements.[47–50] The second line of evidence regarding the effect of neonatal intensive care on infant mortality is the observation that low birth weight infants born in hospitals with tertiary level neonatal intensive care units have lower mortality rates than infants born in hospitals without such units. [51,52] Finally, a third line of evidence referring to improving high-risk obstetric care has been associated with decreases in neonatal mortality.[46,53]

Variations in child mortality exist even in countries where high-quality healthcare is available. Part of this variation may be due to a failure in implementing treatment protocols or evidence-based best practices tailored with the local conditions. This suggestion may provide some explanation of the mortality decrease in some countries, such as Hungary and Japan, which have supported the introduction of evidence-based protocols on routine newborn care and have trained nursery staff members on the protocols.[54,55]

Our study has the same limitations as all studies that use secondary data. It is undeniable that international variations in birth registration laws and practices and the process of death certification have the potential to bias the international comparisons of child mortality. Additionally, international comparisons of mortality rates are confounded by the various ways in which countries classify preterm infants near the threshold of viability.[56–58] Considering these issues, our study only evaluates the trend of amenable mortality rates, and a comparison analysis was not performed. Also, although much of the literature assessing the contribution of healthcare to health focuses on mortality data, data on children may be of limited value because the number of deaths is small, making interpretation difficult. However, we believe that the small numbers were mitigated by the fact that our study analysed the rates and trajectories of multiple countries over a 15-year time period. Another limitation is that our analysis did not account for mortality disparities within countries that were attributable to ethnicity, race, socioeconomic status or geographic residence, since our data sources did not this information. Evidence from the US, for example, showed higher levels of amenable mortality among people disadvantaged in terms of race or socioeconomic status.[59,60] Considering that the perinatal mortality of the US has a prevailing effect on premature births and that striking racial disparities persist, with African Americans exhibiting higher rates of preterm delivery than any other major racial/ethnic group,[61] potentially large variations within populations may be concealed. Lastly, our study is based on the definition of amenable death in its original sense of mortality responsive to medical intervention through treatment, although several countries, such as UK, Canada and Australia, have broadened definitions for their avoidable mortality indicators to include deaths

from conditions avoidable through primary prevention. This broadened definition suggests that not only the models of care for children should be revised but also that policies must be adopted in order to prevent specific causes of death before the point of reaching the healthcare system. These policies include population health interventions such as the obligation of physical activity during adolescence in schools, or the taxation of tobacco and sugar-sweetened beverages.

Some preliminary conclusions can be drawn from this study. Over the 15-year period from 2001 to 2015, the amenable mortality rate in <1-year-olds progressively declined in most OECD countries. Second, OECD countries had success in reducing mortality from conditions originating in the early neonatal period. Lastly, the low decline in amenable mortality rates for children aged ≥1 year, the high variation in amenable mortality rates across countries and the insufficient success in reducing mortality from all causes suggest that the heath system should increase its efforts to improve health outcomes for children.

DECLARATIONS

Ethics approval and consent to participate

Not applicable.

Availability of data and materials

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

Competing interests

The authors declare that they have no competing interests.

Funding

This research received no specific grant from any funding agency in the public, commercial or not-for-profit sectors.

Acknowledgements

Data for this study came from the World Health Organization. All analyses, interpretations and conclusions are credited to the authors of this study, not to the World Health Organization.

Author Contributions

MMG and GD formulated the research goals and supervised the research activity; MMG, GD, JL defined the design of the methodology; MMG wrote the article; RS, WR and MPF revised the article; MB collected the data and managed the database; JL utilised statistical techniques to analyse the study data.

All authors have read and approved the manuscript.

REFERENCES

1 Blum RW, Nelson-Mmari K. The health of young people in a global context. *J Adolesc Health Off Publ Soc Adolesc Med* 2004;**35**:402–18. doi:10.1016/j.jadohealth.2003.10.007

2 WHO. Children: reducing mortality. http://www.who.int/news-room/fact-sheets/detail/children-reducing-mortality (accessed 3 Oct 2018).

3 Fraser J, Sidebotham P, Frederick J, *et al.* Learning from child death review in the USA, England, Australia, and New Zealand. *Lancet Lond Engl* 2014;**384**:894–903. doi:10.1016/S0140-6736(13)61089-2

4 Kyu HH, Stein CE, Pinto CB, *et al.* Causes of death among children aged 5–14 years in the WHO European Region: a systematic analysis for the Global Burden of Disease Study 2016. *Lancet Child Adolesc Health* 2018;**2**:321–37. doi:10.1016/S2352-4642(18)30095-6

5 Sidebotham P, Fraser J, Covington T, *et al.* Understanding why children die in high-income countries. *The Lancet* 2014;**384**:915–27. doi:10.1016/S0140-6736(14)60581-X

6 Alio AP, Richman AR, Clayton HB, *et al.* An ecological approach to understanding black-white disparities in perinatal mortality. *Matern Child Health J* 2010;**14**:557–66. doi:10.1007/s10995-009-0495-9

7 Gakidou E, Cowling K, Lozano R, *et al.* Increased educational attainment and its effect on child mortality in 175 countries between 1970 and 2009: a systematic analysis. *Lancet Lond Engl* 2010;**376**:959–74. doi:10.1016/S0140-6736(10)61257-3

8 Lightfoot TJ, Johnston WT, Simpson J, *et al.* Survival from childhood acute lymphoblastic leukaemia: the impact of social inequality in the United Kingdom. *Eur J Cancer* 2012;**48**:263–9. doi:10.1016/j.ejca.2011.10.007

9 Gore FM, Bloem PJN, Patton GC, *et al.* Global burden of disease in young people aged 10-24 years: a systematic analysis. *Lancet Lond Engl* 2011;**377**:2093–102. doi:10.1016/S0140-6736(11)60512-6

10 Rutstein DD, Berenberg W, Chalmers TC, *et al.* Measuring the quality of medical care. A clinical method. *N Engl J Med* 1976;**294**:582–8. doi:10.1056/NEJM197603112941104

11 Department of Health. The NHS Outcomes Framework 2011/12. 2010.https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/213789/dh_123138.pdf

12 Page A, New Zealand, University of Adelaide, editors. *Australian and New Zealand atlas of avoidable mortality*. Adelaide, S. Aust.: : Public Health Information Development Unit, University of Adelaide 2006.

13 Holland WW. European Community atlas of "avoidable death." 1991.

14 Nolte E, McKee CM. Measuring the health of nations: updating an earlier analysis. *Health Aff Proj Hope* 2008;**27**:58–71. doi:10.1377/hlthaff.27.1.58

15 Gay JG, Paris V, Devaux M, *et al.* Mortality Amenable to Health Care in 31 OECD Countries: estimates and methodological Issues. Published Online First: 31 January 2011. doi:https://doi.org/10.1787/5kgj35f9f8s2-en

16 Treurniet H, Boshuizen H, Harteloh P. Avoidable mortality in Europe (1980–1997): a comparison of trends. *J Epidemiol Community Health* 2004;**58**:290–5. doi:10.1136/jech.2002.006452

17 Nolte E, McKee M. Variations in amenable mortality--trends in 16 high-income nations. *Health Policy Amst Neth* 2011;**103**:47–52. doi:10.1016/j.healthpol.2011.08.002

18 Mackenbach JP, Hoffmann R, Khoshaba B, *et al.* Using "amenable mortality" as indicator of healthcare effectiveness in international comparisons: results of a validation study. *J Epidemiol Community Health* 2013;**67**:139–46. doi:10.1136/jech-2012-201471

19 Mackenbach JP, Bouvier-Colle MH, Jougla E. "Avoidable" mortality and health services: a review of aggregate data studies. *J Epidemiol Community Health* 1990;**44**:106–11.

20 Gianino MM, Lenzi J, Muça A, *et al.* Declining Amenable Mortality: Time Trend (2000-2013) and Geographic Area Analysis. *Health Serv Res* 2017;**52**:1908–27. doi:10.1111/1475-6773.12563

21 Charlton JR, Velez R. Some international comparisons of mortality amenable to medical intervention. *Br Med J Clin Res Ed* 1986;**292**:295–301.

22 James PD, Manuel DG, Mao Y. Avoidable mortality across Canada from 1975 to 1999. *BMC Public Health* 2006;**6**:137. doi:10.1186/1471-2458-6-137

23 Pampalon R. Avoidable mortality in Québec and its regions. *Soc Sci Med* 1993;**37**:823–31. doi:10.1016/0277-9536(93)90376-F

24 Piers LS, Carson NJ, Brown K, *et al.* Avoidable mortality in Victoria between 1979 and 2001. *Aust N Z J Public Health* 2007;**31**:5–12.

25 Fantini MP, Lenzi J, Franchino G, *et al.* Amenable mortality as a performance indicator of Italian health-care services. *BMC Health Serv Res* 2012;**12**:310. doi:10.1186/1472-6963-12-310

26 Tobias M, Jackson G. Avoidable mortality in New Zealand, 1981-97. *Aust N Z J Public Health* 2001;**25**:12–20. doi:10.1111/j.1467-842X.2001.tb00543.x

27 Schoenbaum SC, Schoen C, Nicholson JL, *et al.* Mortality amenable to health care in the United States: The roles of demographics and health systems performance. *J Public Health Policy* 2011;**32**:407–29.

28 World Bank. World Development Indicators | DataBank. 2018.http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators (accessed 3 Oct 2018).

29 World Health Organization. WHO Mortality Database. 2018.http://www.who.int/healthinfo/mortality_data/en/ (accessed 3 Oct 2018).

30 United Nations. Demographic Statistics Database. 2018.http://data.un.org/Data.aspx?d=POP&f=tableCode%3A22 (accessed 3 Oct 2018).

31 Nolte E, McKee M. *Does health care save lives? Avoidable mortality revisited.* The Nuffield Trust 2004. http://researchonline.lshtm.ac.uk/15535/ (accessed 3 Oct 2018).

32 Eurostat. Amenable and preventable deaths of residents. https://ec.europa.eu/eurostat/web/products-datasets/-/hlth_cd_apr (accessed 3 Oct 2018).

33 Hildebrandt M, Bender R, Gehrmann U, *et al.* Calculating confidence intervals for impact numbers. *BMC Med Res Methodol* 2006;**6**:32. doi:10.1186/1471-2288-6-32

34 Wolfe I, Thompson M, Gill P, *et al.* Health services for children in western Europe. *Lancet Lond Engl* 2013;**381**:1224–34. doi:10.1016/S0140-6736(12)62085-6

35 Expert Panel on Effective Ways of Investing in Health. Definition of a frame of Reference in relation to Primary Care with a special emphasis on Financing Systems and Referral Systems. 2014.https://ec.europa.eu/health/expert_panel/sites/expertpanel/files/004_definitionprimarycare_en.pdf (accessed 2 Mar 2019).

36 Adams J, Woods E. Redesign of chronic illness care in children and adolescents. *Curr Opin Pediatr* 2016;**28**:428–33. doi:10.1097/MOP.0000000000000368

37 Britto MT, Vockell A-LB, Munafo JK, *et al.* Improving outcomes for underserved adolescents with asthma. *Pediatrics* 2014;**133**:e418-427. doi:10.1542/peds.2013-0684

38 Mangione-Smith R, Schonlau M, Chan KS, *et al.* Measuring the effectiveness of a collaborative for quality improvement in pediatric asthma care: does implementing the chronic care model improve processes and outcomes of care? *Ambul Pediatr Off J Ambul Pediatr Assoc* 2005;**5**:75–82. doi:10.1367/A04-106R.1

39 Hertel-Fernandez AW, Giusti AE, Sotelo JM. The Chilean infant mortality decline: improvement for whom? Socioeconomic and geographic inequalities in infant mortality, 1990-2005. *Bull World Health Organ* 2007;**85**:798–804.

40 Rodrigo A, van der Veer R, Vermeer HJ, *et al.* From foundling homes to day care: a historical review of childcare in Chile. *Cad Saúde Pública*;**30**:461–72.

41 OECD. State of Health in the EU Slovak Republic: Country Health Profile 2017 - European Observatory on Health Systems and Policies. 2017.

42 Katz M, Rubino A, Collier J, *et al.* Demography of pediatric primary care in Europe: delivery of care and training. *Pediatrics* 2002;**109**:788–96.

43 Pearson GA, Ward-Platt M, Harnden A, *et al.* Why children die: avoidable factors associated with child deaths. *Arch Dis Child* 2011;**96**:927–31. doi:10.1136/adc.2009.177071

44 van Esso D, del Torso S, Hadjipanayis A, *et al.* Paediatric primary care in Europe: variation between countries. *Arch Dis Child* 2010;**95**:791–5. doi:10.1136/adc.2009.178459

45 Williams RL, Chen PM. Identifying the Sources of the Recent Decline in Perinatal Mortality Rates in California. *N Engl J Med* 1982;**306**:207–14. doi:10.1056/NEJM198201283060404

46 Richardson DK, Gray JE, Gortmaker SL, *et al.* Declining severity adjusted mortality: evidence of improving neonatal intensive care. *Pediatrics* 1998;**102**:893–9.

47 Horbar JD, Wright LL, Soll RF, *et al.* A multicenter randomized trial comparing two surfactants for the treatment of neonatal respiratory distress syndrome. National Institute of Child Health and Human Development Neonatal Research Network. *J Pediatr* 1993;**123**:757–66.

48 Vermont-Oxford Neonatal Network. A multicenter, randomized trial comparing synthetic surfactant with modified bovine surfactant extract in the treatment of neonatal respiratory distress syndrome. *Pediatrics* 1996;**97**:1–6.

49 Clark RH, Yoder BA, Sell MS. Prospective, randomized comparison of high-frequency oscillation and conventional ventilation in candidates for extracorporeal membrane oxygenation. *J Pediatr* 1994;**124**:447–54.

50 Rastogi A, Akintorin SM, Bez ML, *et al.* A Controlled Trial of Dexamethasone to Prevent Bronchopulmonary Dysplasia in Surfactant-treated Infants. *Pediatrics* 1996;**98**:204–10.

51 Phibbs CS, Baker LC, Caughey AB, *et al.* Level and volume of neonatal intensive care and mortality in very-low-birth-weight infants. *N Engl J Med* 2007;**356**:2165–75. doi:10.1056/NEJMsa065029

52 Paneth N. Technology at birth. *Am J Public Health* 1990;**80**:791–2.

53 Alfirevic Z, Neilson JP. Doppler ultrasonography in high-risk pregnancies: systematic review with meta-analysis. *Am J Obstet Gynecol* 1995;**172**:1379–87.

54 Kuchna D, Hovsepyan A, Leonard S. Preventing Newborn Deaths In Romania And Hungary. *Health Aff (Millwood)* 2017;**36**:1160–1160. doi:10.1377/hlthaff.2017.0382

55 Maeda K. Progress of Perinatal Medicine in Japan. *J Health Med Inform* 2013;**s11**. doi:10.4172/2157-7420.S11-002

56 Kramer MS, Platt RW, Yang H, *et al.* Registration artifacts in international comparisons of infant mortality. *Paediatr Perinat Epidemiol* 2002;**16**:16–22. doi:10.1046/j.1365-3016.2002.00390.x

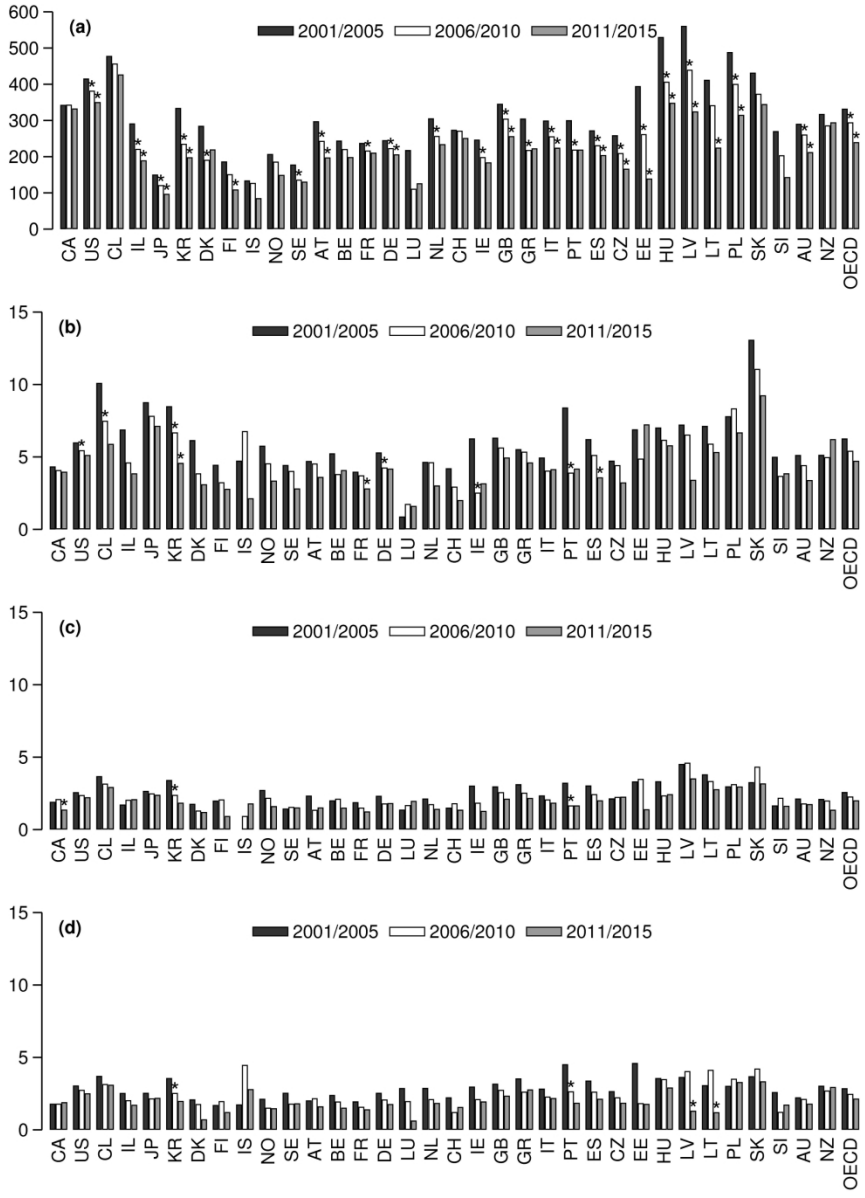
57 Joseph KS, Liu S, Rouleau J, *et al.* Influence of definition based versus pragmatic birth registration on international comparisons of perinatal and infant mortality: population based retrospective study. *The BMJ* 2012;**344**. doi:10.1136/bmj.e746

58 Mohangoo AD, Blondel B, Gissler M, *et al.* International Comparisons of Fetal and Neonatal Mortality Rates in High-Income Countries: Should Exclusion Thresholds Be Based on Birth Weight or Gestational Age? *PLOS ONE* 2013;**8**:e64869. doi:10.1371/journal.pone.0064869

59 Schwartz E, Kofie VY, Rivo M, *et al.* Black/white comparisons of deaths preventable by medical intervention: United States and the District of Columbia 1980-1986. *Int J Epidemiol* 1990;**19**:591–8. doi:10.1093/ije/19.3.591

60 Macinko J, Elo IT. Black–white differences in avoidable mortality in the USA, 1980–2005. *J Epidemiol Community Health* 2009;**63**:715–21. doi:10.1136/jech.2008.081141

61 Riddell CA, Harper S, Kaufman JS. Trends in Differences in US Mortality Rates Between Black and White Infants. *JAMA Pediatr* 2017;**171**:911–3. doi:10.1001/jamapediatrics.2017.1365



* Percentage decrease is statistically significant (P<.05).

Abbreviations: CA, Canada; CL, Chile; US, United State of America; IL, Israel; JP, Japan; KR, Republic of Korea; AT, Austria; BE, Belgium; CZ, Czechia; DK, Denmark; EE, Estonia; FI, Finland; FR, France; DE, Germany; GR, Greece; HU, Hungary; IS, Iceland; IE, Ireland; IT, Italy; LV, Latvia; LT, Lithuania; LU, Luxembourg; NL, Netherlands; NO, Norway; PL, Poland; PT, Portugal; SK, Slovakia; SI, Slovenia; ES, Spain; SE, Sweden; CH, Switzerland; GB, United Kingdom; AU, Australia; NZ, New Zealand.

203x279mm (300 x 300 DPI)

Table 1 Data Availability for the 34 OECD Countries (0 “Not Available”/1 “Available”)

Country	Year															Total
	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Canada	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	13
Chile	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
United States of America	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	12
Israel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Japan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Republic of Korea	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Austria	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Belgium	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Czechia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Denmark	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Estonia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Finland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
France	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	14
Germany	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Greece	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Hungary	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Iceland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Ireland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	14
Italy	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Latvia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Lithuania	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Luxembourg	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Netherlands	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Norway	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Poland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Portugal	1	1	1	0	0	0	1	1	1	1	1	1	1	1	0	11
Slovakia	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	13
Slovenia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Spain	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Sweden	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Switzerland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
United Kingdom	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
Australia	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	14
New Zealand	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	13
All OECD countries	*34*	*34*	*34*	*33*	*32*	*33*	*34*	*34*	*34*	*34*	*32*	*34*	*33*	*31*	*28*	*494*

Notes: Causes of death are coded according to the ICD-9 (Austria 2001; Greece 2001/2013; Ireland 2001/2006; Italy 2001/2002; Portugal 2001) or ICD-10 (all other country-years). Reference populations for some country-years were retrieved from UNdata if not available in the WHO Mortality Database (Canada 2006/2013; Chile 2001/2015; United States of America 2008/2010, 2012, 2015; Finland 2015; Ireland 2010, 2014; Switzerland 2014/2015).

Table 1 Nolte and McKee's list of causes of death considered amenable to health care

Disease category	Age	Diseases	ICD-9 codes	ICD-10 codes
Infectious diseases	0-74	Tuberculosis	010-8, 137	A15-9, B90
	0-74	Septicaemia	038	A40-1
	0-74	Pneumonia	480-6	J12-8
	0-74	Influenza	487	J10-1
	0-14	Intestinal infections (other than typhoid, diphtheria)	001-9	A00-9
	0-74	Diphtheria, Tetanus, Poliomyelitis	032, 037, 045	A35-6, A80
	0-14	Whooping cough	033	A37
	1-14	Measles	055	B05
Cancers	0-74	Colorectal cancer	153-4	C18-21
	0-74	Malignant neoplasm of skin	173	C44
	0-74	Breast cancer	174	C50
	0-44	Cervical cancer and uterine cancer	179, 180, 182	C53-5
	0-74	Neoplasm of the testis	186	C62
	0-74	Hodgkin's disease	201	C81
	0-44	Leukaemia	204-8	C91-5
Endocrine, nutritional and metabolic diseases	0-74	Thyroid disorders	240-6	E00-7
	0-49	Diabetes mellitus	250	E10-4
Diseases of the nervous system	0-74	Epilepsy	345	G40-1
Diseases of the circulatory system	0-74	Rheumatic heart diseases	393-8	I05-9
	0-74	Ischemic heart diseases: 50% of deaths	410-4	I20-5
	0-74	Cerebrovascular diseases	430-8	I60-9
	0-74	Hypertensive diseases	401-5	I10-3, I15
Diseases of the genitourinary system	0-74	Nephritis and nephrosis	580-9	N00-7, N17-9, N25-7
	0-74	Benign prostatic hyperplasia	600	N40
Diseases of the respiratory system	1-14	All respiratory diseases (excl. pneumonia/influenza)	460-79, 488-519	J00-9, J20-99
Diseases of the digestive system	0-74	Peptic ulcer	531-3	K25-7
	0-74	Appendicitis	540-3	K35-8
	0-74	Abdominal hernia	550-3	K40-6
	0-74	Cholelithiasis and cholecystitis	574-5	K80-1
Perinatal mortality	0-74	Maternal deaths	630-76	O00-99
	0-74	Conditions originating in the early neonatal period	760-79	P00-96
	0-74	Congenital cardiovascular anomalies	745-7	Q20-8
External causes	0-74	Misadventures to patients during surgical and medical care	E870-6, E878-9	Y60-9, Y83-4

Source: Nolte and McKee 2008; Gay et al. 2011.

Table 1 Yearly Amenable Mortality Rates (Per 100,000) for Ages <1 and 1–4 Years in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015 (See Table S1 for Country-Level Data Availability)

Country	<1 Year					1–4 Years				
	Yearly Amenable Mortality Rate			% Change (95% CI)		Yearly Amenable Mortality Rate			% Change (95% CI)	
	2001/05	2006/10	2011/15	2006/10–2001/05	2011/15–2006/10	2001/05	2006/10	2011/15	2006/10–2001/05	2011/15–2006/10
CA	343.10	343.46	332.97	.1	-3.1	4.34	4.09	3.98	-5.7	-2.6
US	415.80	382.24	350.87	-8.1*	-8.2*	6.00	5.46	5.13	-8.9*	-6.1
CL	478.56	457.40	427.15	-4.4	-6.6	10.11	7.50	5.90	-25.8*	-21.3
IL	291.77	221.77	189.73	-24.0*	-14.4*	6.89	4.62	3.86	-32.9	-16.5
JP	150.76	121.39	97.24	-19.5*	-19.9*	8.78	7.84	7.15	-10.7	-8.7
KR	334.41	235.84	198.16	-29.5*	-16.0*	8.50	6.69	4.59	-21.3*	-31.5*
DK	285.08	191.17	220.19	-32.9*	15.2	6.16	3.87	3.11	-37.2	-19.6
IS	134.24	127.50	85.5	-5.0	-32.9	4.74	6.78	2.14	43.2	-68.4
FI	186.77	151.76	109.42	-18.7	-27.9*	4.46	3.25	2.80	-27.2	-14.0
NO	207.32	186.37	149.55	-10.1	-19.8	5.77	4.56	3.36	-21.0	-26.4
SE	178.05	136.44	130.95	-23.4*	-4.0	4.44	4.03	2.82	-9.2	-30.1
AT	297.83	243.56	198.02	-18.2*	-18.7*	4.72	4.54	3.62	-3.7	-20.4
BE	244.36	220.91	198.89	-9.6	-10.0	5.25	3.82	4.09	-27.3	7.1
FR	237.86	216.89	211.19	-8.8*	-2.6	3.98	3.73	2.82	-6.2	-24.3*
DE	245.69	223.48	206.37	-9.0*	-7.7*	5.31	4.27	4.19	-19.6*	-1.9
LU	218.18	111.42	126.65	-48.9	13.7	0.88	1.76	1.62	98.8	-7.6
NL	306.18	257.29	234.49	-16.0*	-8.9	4.66	4.63	3.03	-.8	-34.6
CH	274.24	272.00	251.67	-.8	-7.5	4.22	2.95	2.02	-30.2	-31.3
IE	247.00	198.95	184.09	-19.5*	-7.5	6.28	2.53	3.18	-59.7*	25.6
GB	346.07	305.01	256.65	-11.9*	-15.9*	6.33	5.65	4.96	-10.7	-12.2
GR	305.19	218.33	222.92	-28.5*	2.1	5.54	5.36	4.62	-3.4	-13.8
IT	299.93	256.16	224.78	-14.6*	-12.2*	4.96	4.05	4.15	-18.4	2.4
PT	300.62	219.72	219.56	-26.9*	-.1	8.41	3.92	4.19	-53.4*	6.9
ES	272.67	231.74	204.24	-15.0*	-11.9*	6.23	5.13	3.59	-17.6	-30.0*
CZ	259.40	209.92	166.61	-19.1*	-20.6*	4.74	4.43	3.24	-6.7	-26.9
EE	394.90	262.22	139.38	-33.6*	-46.8*	6.91	4.89	7.25	-29.3	48.4
HU	530.50	406.91	348.94	-23.3*	-14.2*	7.03	6.18	5.80	-12.2	-6.0
LV	561.36	440.42	324.98	-21.5*	-26.2*	7.23	6.54	3.42	-9.5	-47.8
LT	412.34	342.21	225.15	-17.0	-34.2*	7.14	5.92	5.34	-17.2	-9.7
PL	488.86	400.92	315.70	-18.0*	-21.3*	7.81	8.35	6.69	6.9	-19.9
SK	432.24	373.71	345.44	-13.5	-7.6	13.09	11.08	9.26	-15.3	-16.4
SI	270.48	203.78	143.64	-24.7	-29.5	5.01	3.69	3.87	-26.3	4.8
AU	290.88	261.16	212.74	-10.2*	-18.5*	5.13	4.43	3.40	-13.6	-23.3
NZ	317.89	286.41	294.76	-9.9	2.9	5.14	4.98	6.23	-3.1	24.9
All	*332.78*	*295.17*	*240.22*	*-11.3**	*-18.6**	*6.27*	*5.43*	*4.73*	*-13.4*	*-13.0*

* Percentage decrease is statistically significant (*P*<.05).

Abbreviations: CA, Canada; CL, Chile; US, United State of America; IL, Israel; JP, Japan; KR, Republic of Korea; AT, Austria; BE, Belgium; CZ, Czechia; DK, Denmark; EE, Estonia; FI, Finland; FR, France; DE, Germany; GR, Greece; HU, Hungary; IS, Iceland; IE, Ireland; IT, Italy; LV, Latvia; LT, Lithuania; LU, Luxembourg; NL, Netherlands; NO, Norway; PL, Poland; PT, Portugal; SK, Slovakia; SI, Slovenia; ES, Spain; SE, Sweden; CH, Switzerland; GB, United Kingdom; AU, Australia; NZ, New Zealand.

Table 2 Yearly Amenable Mortality Rates (Per 100,000) for Ages 5–9 and 10–14 Years in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015 (See Table S1 for Country-Level Data Availability)

Country	5–9 Years					10–14 Years				
	Yearly Amenable Mortality Rate			% Change (95% CI)		Yearly Amenable Mortality Rate			% Change (95% CI)	
	2001/05	2006/10	2011/15	2006/10–2001/05	2011/15–2006/10	2001/05	2006/10	2011/15	2006/10–2001/05	2011/15–2006/10
CA	1.92	2.11	1.38	9.7	-34.6*	1.80	1.80	1.91	.3	5.7
US	2.58	2.38	2.23	-7.6	-6.4	3.06	2.76	2.52	-9.6	-8.9
CL	3.69	3.17	2.94	-14.1	-7.2	3.72	3.16	3.11	-15.0	-1.4
IL	1.73	2.05	2.10	18.2	2.6	2.54	2.04	1.73	-19.8	-14.8
JP	2.67	2.50	2.40	-6.2	-3.9	2.55	2.17	2.20	-14.8	1.2
KR	3.42	2.39	1.86	-30.1*	-22.0	3.58	2.55	1.99	-28.9*	-21.7
DK	1.78	1.32	1.21	-25.8	-8.4	2.10	1.78	0.72	-15.6	-59.7
IS	2.00	2.08	0.94	4.2	-54.9	1.71	1.98	1.23	15.9	-37.8
FI	0	0.94	1.80	N/A	92.2	1.75	4.48	2.81	156.1	-37.2
NO	2.73	2.20	1.62	-19.4	-26.3	2.14	1.53	1.49	-28.8	-2.6
SE	1.45	1.56	1.53	8.2	-2.1	2.56	1.80	1.83	-29.7	1.6
AT	2.35	1.36	1.53	-42.1	12.7	2.03	2.18	1.62	7.8	-25.9
BE	2.02	2.13	1.52	5.5	-28.7	2.41	1.96	1.53	-18.6	-22.1
FR	1.89	1.52	1.25	-19.7	-17.5	1.96	1.59	1.41	-18.8	-11.5
DE	2.33	1.80	1.83	-22.9	1.6	2.55	2.09	1.78	-18.0	-15.1
LU	1.38	1.69	1.98	22.6	17.4	2.88	1.98	0.64	-31.1	-67.5
NL	2.14	1.76	1.43	-17.8	-18.8	2.89	2.12	1.85	-26.6	-12.7
CH	1.52	1.82	1.37	19.8	-24.5	2.24	1.23	1.58	-45.2	27.9
IE	3.03	1.86	1.29	-38.7	-30.4	2.98	2.12	1.96	-28.7	-7.8
GB	2.98	2.59	2.13	-13.1	-17.8	3.18	2.76	2.35	-13.0	-14.8
GR	3.13	2.54	2.18	-18.8	-14.2	3.55	2.63	2.79	-25.7	6.0
IT	2.36	2.08	1.86	-11.8	-10.6	2.84	2.29	2.19	-19.3	-4.2
PT	3.23	1.67	1.67	-48.2*	.1	4.53	2.66	1.87	-41.2*	-29.7
ES	3.04	2.45	2.02	-19.3	-17.5	3.40	2.64	2.14	-22.3	-18.9
CZ	2.15	2.26	2.27	5.2	.7	2.67	2.25	1.87	-15.7	-17.0
EE	3.32	3.50	1.40	5.7	-60.2	4.61	1.84	1.79	-60.0	-3.0
HU	3.34	2.36	2.44	-29.4	3.3	3.58	3.50	2.92	-2.3	-16.5
LV	4.53	4.62	3.53	1.9	-23.4	3.65	4.06	1.32	11.0	-67.4*
LT	3.82	3.35	2.78	-12.2	-16.9	3.08	4.14	1.21	34.2	-70.7*
PL	2.99	3.14	2.97	4.9	-5.3	3.03	3.52	3.30	16.1	-6.1
SK	3.27	4.34	3.19	32.7	-26.5	3.70	4.23	3.35	14.4	-20.9
SI	1.67	2.20	1.64	31.6	-25.6	2.61	1.24	1.74	-52.4	40.3
AU	2.14	1.81	1.76	-15.6	-2.5	2.24	2.13	1.80	-4.8	-15.6
NZ	2.11	2.01	1.37	-5.0	-32.0	3.04	2.71	2.96	-10.6	9.1
All	*2.59*	*2.28*	*2.02*	*-11.9*	*-11.3*	*2.87*	*2.48*	*2.16*	*-13.5*	*-13.1*

* Percentage decrease is statistically significant (*P*<.05).

Table 1 Yearly Amenable Mortality Rates (Per 100,000) of Conditions Originating in Early Neonatal Period for Age <1 in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015

Country	Rate 2001/2005	Rate 2006/2010	Rate 2011/2015	% Change 2006/10 – 2001/05	% Change 2011/15 – 2006/10
Canada	293.1	297.1	290.8	1.3 (-7.4, 10.1)	-2.1 (-10.3, 6.1)
Chile	329.3	341.9	324.2	3.8 (-6.2, 13.8)	-5.2 (-14.3, 3.9)
United States of America	349.6	322.1	295.6	-7.9 (-10.0, -5.7) *	-8.2 (-10.5, -5.9) *
Israel	229.6	174.4	142.4	-24 (-36.3, -11.7) *	-18.3 (-32.5, -4.2) *
Japan	83.6	68.1	54.2	-18.5 (-26.4, -10.7) *	-20.4 (-29.2, -11.6) *
Republic of Korea	262.0	186.9	160.1	-28.7 (-34.9, -22.4) *	-14.3 (-22.9, -5.7) *
Austria	250.9	203.5	162.4	-18.9 (-36.0, -1.8) *	-20.2 (-38.8, -1.6) *
Belgium	193.2	182.4	162.9	-5.6 (-23.1, 11.9)	-10.7 (-27.5, 6.1)
Czechia	209.9	167.0	136.0	-20.4 (-36.3, -4.6) *	-18.6 (-36.0, -1.1) *
Denmark	231.3	160.1	190.5	-30.8 (-48.1, -13.4) *	18.9 (-12.9, 50.8)
Estonia	290.7	188.6	109.8	-35.1 (-66.2, -4.0) *	-41.8 (-77.5, -6.0) *
Finland	142.0	117.4	84.4	-17.3 (-43.8, 9.2)	28.2 (-54.3, -2.1) *
France	190.6	175.2	177.1	-8.1 (-14.9, -1.3) *	1.1 (-6.5, 8.7)
Germany	195.0	182.5	170.3	-6.4 (-13.5, .8)	-6.7 (-14.1, .8)
Greece	209.0	155.4	164.9	-25.7 (-40.4, -10.9) *	6.1 (-16.4, 28.7)
Hungary	432.5	334.2	278.4	-22.7 (-34.0, -11.5) *	-16.7 (-30.5, -2.9) *
Iceland	119.9	102.0	67.5	-14.9 (-121.4, 85.1)	-33.8 (-129.2, 61.6)
Ireland	189.8	154.0	145.1	-18.9 (-40.4, 2.7)	-5.8 (-31.2, 19.6)
Italy	232.6	203.1	177.9	-12.7 (-19.7, -5.7) *	-12.4 (-20.0, -4.8) *
Latvia	408.7	348.6	270.5	-14.7 (-41.0, 11.6)	-22.4 (-49.2, 4.4)
Lithuania	261.4	235.8	162.6	-9.8 (-38.6, 19.1)	-31.1 (-56.0, -6.1) *
Luxembourg	203.1	104.2	113.3	-48.7 (-100.4, 3.0)	8.7 (-111.7, 108.7)
Netherlands	249.5	211.4	199.9	-15.3 (-26.5, -4.1) *	-5.4 (-19.1, 8.2)
Norway	166.1	158.6	123.9	-4.5 (-31.7, 22.7)	-21.9 (-45.6, 1.8)
Poland	360.4	306.1	232.3	-15.1 (-21.7, -8.4) *	-24.1 (-30.7, -17.5) *
Portugal	233.6	179.5	181.2	-23.2 (-37.6, -8.7) *	.9 (-20.4, 22.3)
Slovakia	301.7	256.6	240.2	-15.0 (-34.1, 4.2)	-6.4 (-28.3, 15.5)
Slovenia	203.7	168.8	122.3	-17.1 (-55.7, 21.5)	-27.6 (-64.2, 9.1)
Spain	209.6	181.7	166.7	-13.3 (-21.4, -5.3) *	-8.2 (-17.2, .7)
Sweden	142.5	103.8	109.4	-27.2 (-45.3, -9.1) *	5.4 (-21.4, 32.2)
Switzerland	217.4	233.3	207.7	7.3 (-15.7, 30.4)	-11.0 (-29.8, 7.8)
United Kingdom	289.4	256.5	214.1	-11.4 (-16.9, -5.9) *	-16.6 (-22.0, -11.2) *
Australia	244.0	218.0	180.6	-10.7 (-20.6, -.7) *	-17.2 (-26.7, -7.6) *
New Zealand	255.5	225.8	242.9	-11.6 (-32.2, 8.9)	7.6 (-17.2, 32.4)
All OECD countries	*266.3*	*239.8*	*193.8*	*-9.9 (-18.4, -1.5)* *	*-19.2 (-27.9, -10.4)* *

* Percentage decrease is statistically significant (*P*<.05).

Table 2 Yearly Amenable Mortality Rates (Per 100,000) of Congenital Cardiovascular Anomalies for Age <1 in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015

Country	Rate 2001/2005	Rate 2006/2010	Rate 2011/2015	% Change 2006/10 – 2001/05	% Change 2011/15 – 2006/10
Canada	36.7	34.6	33.0	-5.6 (-29.1, 17.9)	-4.8 (-28.5, 18.9)
Chile	91.6	79.8	80.9	-12.9 (-29.6, 3.7)	1.3 (-18.5, 21.2)
United States of America	41.6	35.8	33.5	-13.9 (-19.9, -7.9) *	-6.5 (-13.4, .4)
Israel	45.3	38.8	37.2	-14.4 (-44.6, 15.9)	-4.0 (-37.9, 29.9)
Japan	51.5	39.7	32.0	-22.9 (-32.6, -13.3) *	-19.3 (-30.9, -7.7) *
Republic of Korea	59.3	38.3	32.1	-35.4 (-47.7, -23.1) *	-16.2 (-35.0, 2.5)
Austria	43.1	35.9	31.6	-16.6 (-58.7, 25.5)	-12.1 (-59.6, 35.5)
Belgium	40.8	29.1	28.2	-28.6 (-59.7, 2.4)	-2.9 (-47.8, 42)
Czechia	34.4	29.5	21.1	-14.2 (-55.6, 27.2)	-28.5 (-66.3, 9.3)
Denmark	48.9	25.4	26.1	-47.9 (-79.0, -16.8) *	2.7 (-69.0, 74.3)
Estonia	68.9	59.4	26.8	-13.8 (-92.5, 64.9)	-55.0 (-108.8, -1.2) *
Finland	37.9	26.6	20.3	-29.8 (-75.4, 15.8)	-23.5 (-80.9, 33.8)
France	37.3	34.4	29.0	-7.6 (-23.0, 7.9)	-15.8 (-30.8, -.8) *
Germany	44.2	33.6	30.6	-24.0 (-36.9, -11.1) *	-8.9 (-26.0, 8.2)
Greece	71.7	43.5	40.9	-39.3 (-61.1, -17.5) *	-6.0 (-45.1, 33.0)
Hungary	75.6	69.0	62.6	-8.7 (-39.2, 21.8)	-9.3 (-41.5, 22.9)
Iceland	4.8	21.2	13.5	343.2 (-1784.6, 443.2)	-36.5 (-239.8, 63.5)
Ireland	46.8	38.9	36.2	-16.9 (-61.1, 27.3)	-6.9 (-57.0, 43.2)
Italy	57.1	41.8	36.0	-26.8 (-39.2, -14.4) *	-13.9 (-30.5, 2.6)
Latvia	119.2	77.6	42.6	-34.9 (-75.0, 5.2)	-45.1 (-89.9, -.2) *
Lithuania	99.8	79.3	45.4	-20.5 (-63.2, 22.1)	-42.7 (-80.6, -4.8) *
Luxembourg	15.0	0	13.3	-100 (., 0)	N/A
Netherlands	47.6	38.4	28.7	-19.4 (-44.2, 5.5)	-25.3 (-52.3, 1.8)
Norway	38.4	23.0	22.0	-39.9 (-80.4, .6)	-4.6 (-76.6, 67.4)
Poland	91.5	69.2	67.0	-24.4 (-36.5, -12.2) *	-3.2 (-19.8, 13.4)
Portugal	47.7	33.9	32.0	-29.0 (-59.3, 1.3)	-5.5 (-52.3, 41.2)
Slovakia	70.2	64.2	67.4	-8.6 (-50.5, 33.4)	5.0 (-42.7, 52.7)
Slovenia	55.5	29.1	17.6	-47.5 (-100.8, 5.8)	-39.5 (-117.2, 38.2)
Spain	54.1	41.7	31.2	-23.1 (-37.5, -8.6) *	-25.2 (-41.4, -9.1) *
Sweden	29.3	20.2	13.0	-31.1 (-69.5, 7.2)	-35.8 (-78.1, 6.5)
Switzerland	46.4	34.2	39.2	-26.4 (-64.1, 11.3)	14.8 (-44.9, 74.5)
United Kingdom	42.1	36.2	33.3	-13.8 (-28.0, .4)	-8.1 (-23.6, 7.3)
Australia	33.7	32.5	24.7	-3.7 (-32.2, 24.8)	-24.0 (-47.2, -.7) *
New Zealand	40.6	37.2	30.6	-8.4 (-61.3, 44.5)	-17.8 (-67.9, 32.2)
All OECD countries	38.8	47.9	35.0	-18.9 (-37.3, -.5) *	-9.9 (-33.4, 13.5)

* Percentage decrease is statistically significant (*P*<.05).

Table 3 Yearly Amenable Mortality Rates (Per 100,000) of Pneumonia for Age <1 in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015

Country	Rate 2001/2005	Rate 2006/2010	Rate 2011/2015	% Change 2006/10 – 2001/05	% Change 2011/15 – 2006/10
Canada	3.3	2.6	1.8	-19.9 (-89.2, 49.5)	-32.5 (-99.2, 34.2)
Chile	41.0	24.1	11.7	-41.2 (-60.0, -22.4) *	-51.2 (-72.7, -29.7) *
United States of America	6.6	5.0	3.8	-23.9 (-37.6, -10.1) *	-23.8 (-39.7, -7.9) *
Israel	2.8	2.2	1.8	-22.3 (-134.6, 77.7)	-20.6 (-143.8, 79.4)
Japan	4.7	4.4	3.5	-6.0 (-43.0, 31.1)	-20.9 (-55.5, 13.7)
Republic of Korea	2.7	2.1	1.5	-22.7 (-87.8, 42.4)	-30.4 (-100.6, 39.8)
Austria	1.3	.5	1.3	-59.9 (-207.0, 40.1)	142.7 (-747.1, 242.7)
Belgium	2.1	2.1	1.4	-.3 (-175.2, 99.7)	-32.4 (-160.8, 67.6)
Czechia	10.2	8.3	4.6	-19.0 (-91.8, 53.9)	-44.9 (-104.7, 14.9)
Denmark	2.2	1.2	1.7	-42.6 (-200.2, 57.4)	38.5 (-368.6, 138.5)
Estonia	16.5	3.9	2.8	-76.5 (-143.6, -9.4) *	-27.3 (-318, 72.7)
Finland	1.8	1.7	1.0	-5.0 (-268.4, 95)	-39.6 (-232.9, 60.4)
France	.8	.6	.2	-22.5 (-113.2, 68.1)	-69.6 (-125, -14.3) *
Germany	1.8	1.5	1.0	-18.1 (-85, 48.8)	-34.5 (-98.1, 29.1)
Greece	15.0	14.6	8.9	-3.1 (-70.1, 63.8)	-38.8 (-88.8, 11.1)
Hungary	16.3	2.1	3.6	-87.2 (-106.1, -68.3) *	70.9 (-231, 170.9)
Iceland	4.8	0	0	-100 (., 0)	N/A
Ireland	5.1	2.0	0	-60.6 (-139.6, 18.3)	-100 (., 0)
Italy	2.3	.9	1.2	-59.5 (-101, -18) *	29.5 (-121.4, 129.5)
Latvia	21.7	11.6	5.0	-46.5 (-128.5, 35.5)	-57.3 (-155.8, 41.3)
Lithuania	37.2	19.8	8.6	-46.8 (-99.5, 6)	-56.8 (-119.7, 6)
Luxembourg	0	3.6	0	N/A	-100 (., 0)
Netherlands	1.4	1.7	.6	24 (-174.9, 124)	-67.3 (-140.7, 6.2)
Norway	1.1	2.3	1.3	121.4 (-548.2, 221.4)	-43 (-199.5, 57)
Poland	14.8	11.8	11.6	-19.9 (-51.4, 11.6)	-1.9 (-42.5, 38.7)
Portugal	7.4	1.2	1.4	-83.3 (-114.7, -52) *	13.4 (-267.7, 113.4)
Slovakia	47.2	41.3	30.8	-12.6 (-62, 36.9)	-25.5 (-71.8, 20.8)
Slovenia	3.4	4.9	3.7	42.9 (-414.5, 142.9)	-23.6 (-248.2, 76.4)
Spain	1.5	1.3	.7	-14.8 (-107.4, 77.9)	-45 (-118.8, 28.8)
Sweden	1.4	2.8	3.2	90.5 (-291.7, 190.5)	14.6 (-161, 114.6)
Switzerland	1.6	1.1	1.7	-35.7 (-217.5, 64.3)	64 (-386.5, 164)
United Kingdom	5.0	3.6	2.5	-29.2 (-64.8, 6.3)	-28.5 (-69.6, 12.6)
Australia	5.3	3.5	2.0	-34 (-88.5, 20.6)	-41.2 (-100.3, 17.9)
New Zealand	11.0	11.5	10.9	4.5 (-107.7, 104.5)	-5.4 (-105, 94.1)
All OECD countries	6.1	4.5	3.1	-25.7 (-74.3, 22.9)	-30.7 (-88.1, 26.7)

* Percentage decrease is statistically significant (*P*<.05).

Table 4 Yearly Amenable Mortality Rates (Per 100,000) of Septicaemia for Age <1 in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015

Country	Rate 2001/2005	Rate 2006/2010	Rate 2011/2015	% Change 2006/10 – 2001/05	% Change 2011/15 – 2006/10
Canada	3.2	3.3	2.0	2.0 (-81.8, 85.9)	-40.6 (-95.2, 14)
Chile	2.6	2.1	1.6	-20.6 (-112.5, 71.4)	-23.4 (-123.2, 76.4)
United States of America	7.2	6.1	4.5	-15.5 (-29.7, -1.2) *	-25.6 (-39.8, -11.4) *
Israel	4.7	2.5	2.6	-47.4 (-113.8, 19)	4.1 (-138.8, 104.1)
Japan	6.2	5.0	4.2	-19.9 (-48.5, 8.7)	-15.4 (-49.4, 18.7)
Republic of Korea	1.8	1.8	.8	3.2 (-96.2, 102.5)	-55 (-111, 1)
Austria	.5	.5	.3	.3 (-439.3, 100.3)	-51.5 (-312, 48.5)
Belgium	2.3	1.6	1.6	-29.2 (-159.7, 70.8)	-2.4 (-193.7, 97.6)
Czechia	1.1	1.9	1.8	82.1 (-348.3, 182.1)	-5.8 (-186.1, 94.2)
Denmark	.9	.9	0	.4 (-358.8, 100.4)	-100 (., 0)
Estonia	7.5	3.9	0	-48.3 (-213.8, 51.7)	-100 (., 0)
Finland	1.4	2.4	1.0	66.3 (-390.5, 166.3)	-56.9 (-187.3, 43.1)
France	1.7	1.2	1.1	-25.6 (-87.9, 36.6)	-7.8 (-92.3, 76.7)
Germany	.9	1.4	1.3	60.7 (-102.3, 160.7)	-8 (-92.6, 76.6)
Greece	7.1	3.7	4.9	-48.3 (-110.2, 13.5)	31.8 (-140.8, 131.8)
Hungary	1.7	0	.2	-100 (., 0)	N/A
Iceland	0	0	4.5	N/A	N/A
Ireland	.7	.3	1.4	-57.8 (-284.2, 42.2)	383.5 (-1937.6, 483.5)
Italy	2.5	4.6	3.7	84.5 (-37.4, 184.5)	-19.4 (-67.2, 28.5)
Latvia	4.9	0	1.0	-100 (., 0)	N/A
Lithuania	6.0	2.6	4.0	-55.9 (-172.1, 44.1)	49.5 (-373.4, 149.5)
Luxembourg	0	0	0	N/A	N/A
Netherlands	2.9	1.8	1.3	-36.4 (-121.5, 48.8)	-32.3 (-147.1, 67.7)
Norway	.7	.7	.7	-5.1 (-421, 94.9)	-.3 (-437.3, 99.7)
Poland	18.2	8.8	2.6	-51.6 (-71.5, -31.7) *	-69.9 (-91.2, -48.6) *
Portugal	3.5	2.9	1.9	-16.7 (-141.4, 83.3)	-33.9 (-157.1, 66.1)
Slovakia	3.5	3.9	1.8	12.4 (-209, 112.4)	-54.3 (-162.3, 45.7)
Slovenia	2.3	0	0	-100 (., 0)	N/A
Spain	2.1	2.0	1.3	-6.4 (-90.6, 77.9)	-37.1 (-102.4, 28.1)
Sweden	1.2	5.5	2.8	344.5 (-526.7, 444.5)	-49.1 (-118.2, 20)
Switzerland	3.6	1.1	0	-70.3 (-144.7, 4)	-100 (., 0)
United Kingdom	4.4	3.2	1.6	-28.1 (-66.3, 10.1)	-50.3 (-84.1, -16.6) *
Australia	2.9	1.8	1.4	-38.4 (-108.6, 31.8)	-21.9 (-123.2, 78.1)
New Zealand	3.2	4.2	2.7	30 (-217, 130)	-34.5 (-161.8, 65.5)
All OECD countries	5.0	4.1	2.5	-18 (-75.5, 39.5)	-39.1 (-94.3, 16.1)

* Percentage decrease is statistically significant (*P*<.05).

Table 5 Yearly Amenable Mortality Rates (Per 100,000) of Nephritis and Nephrosis for Age <1 in 34 OECD Countries, 2001/2005, 2006/2010 and 2011/2015

Country	Rate 2001/2005	Rate 2006/2010	Rate 2011/2015	% Change 2006/10 – 2001/05	% Change 2011/15 – 2006/10
Canada	1.4	.8	.3	-40.1 (-127.2, 47)	-67.6 (-140.9, 5.7)
Chile	1.3	.6	.4	-57.2 (-142.2, 27.7)	-28.9 (-211.4, 71.1)
United States of America	4.0	3.2	2.1	-19.7 (-38.2, -1.3) *	-33.6 (-51.8, -15.4) *
Israel	4.0	.5	.4	-86.9 (-117.5, -56.4) *	-32.5 (-258.3, 67.5)
Japan	.8	.7	.3	-11.1 (-94.9, 72.6)	-60.4 (-112.9, -7.8) *
Republic of Korea	.5	.6	.3	29.4 (-193.7, 129.4)	-50 (-151.5, 50)
Austria	.0	0	0	N/A	N/A
Belgium	.2	.5	0	176 (-1220.6, 276)	-100 (., 0)
Czechia	.4	.5	.2	24.1 (-472.5, 124.1)	-65.5 (-240.2, 34.5)
Denmark	0	0	0	N/A	N/A
Estonia	0	0	0	N/A	N/A
Finland	.4	0	1	-100 (., 0)	N/A
France	.5	.1	.1	-79.1 (-129.5, -28.8) *	-5.1 (-304, 94.9)
Germany	.2	.3	.1	94.3 (-337.9, 194.3)	-64.3 (-155.7, 27.2)
Greece	0	.2	0	N/A	-100 (., 0)
Hungary	.4	0	.9	-100 (., 0)	N/A
Iceland	0	0	0	N/A	N/A
Ireland	.3	.6	.3	68.7 (-836.7, 168.7)	-39.6 (-341.5, 60.4)
Italy	.9	1.2	1	38.5 (-126.4, 138.5)	-14.4 (-112.8, 84)
Latvia	0	0	0	N/A	N/A
Lithuania	0	0	0	N/A	N/A
Luxembourg	0	0	0	N/A	N/A
Netherlands	.3	.1	.2	-63.8 (-246.9, 36.2)	109.4 (-1014.6, 209.4)
Norway	0	.3	.3	N/A	-.3 (-618.4, 99.7)
Poland	.2	.5	.1	126.8 (-461.3, 226.8)	-78.7 (-151.1, -6.2) *
Portugal	1.5	.5	0	-66.7 (-172.0, 33.3)	-100 (., 0)
Slovakia	.4	.4	0	-8.1 (-577.8, 91.9)	-100 (., 0)
Slovenia	0	0	0	N/A	N/A
Spain	.5	.4	.1	-12.1 (-184.4, 87.9)	-78 (-152.7, -3.3) *
Sweden	0	.2	0	N/A	-100 (., 0)
Switzerland	.3	.3	.5	-3.6 (-601.0, 96.4)	87.4 (-918.6, 187.4)
United Kingdom	.6	.5	.2	-20.1 (-133.9, 79.9)	-51.5 (-138.3, 35.2)
Australia	.2	.5	.3	150.0 (-657.3, 250.0)	-46.9 (-192.8, 53.1)
New Zealand	.4	.3	0	-10.0 (-567.8, 90.0)	-100 (., 0)
All OECD countries	1.8	1.4	.6	-19.9 (-114.1, 74.3)	-58.2 (-131.3, 14.9)

* Percentage decrease is statistically significant (*P*<.05).

STROBE 2007 (v4) checklist of items to be included in reports of observational studies in epidemiology*

Checklist for cohort, case-control, and cross-sectional studies (combined)

Section/Topic	Item #	Recommendation	Reported on 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	4
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	6
Objectives	3	State specific objectives, including any pre-specified hypotheses	7
Methods			
Study design	4	Present key elements of study design early in the paper	7
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	8
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	8
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	8
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	*8*
Bias	9	Describe any efforts to address potential sources of bias	8
Study size	10	Explain how the study size was arrived at	8
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9
		(*b*) Describe any methods used to examine subgroups and interactions	8-9
		(*c*) Explain how missing data were addressed	8-9
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed	

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(*e*) Describe any sensitivity analyses	
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	9
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-10
		(b) Indicate number of participants with missing data for each variable of interest	9-10
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	9-10-11
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	
		Cross-sectional study—Report numbers of outcome events or summary measures	
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	9-10-11
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	
Discussion			
Key results	18	Summarise key results with reference to study objectives	12
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	15
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	13-14
Generalisability	21	Discuss the generalisability (external validity) of the study results	13-14-15
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	17

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.
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.