

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<u>http://bmjopen.bmj.com</u>).

If you have any questions on BMJ Open's open peer review process please email <u>info.bmjopen@bmj.com</u>

BMJ Open

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

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
	·

SCHOLARONE[™] Manuscripts

 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

ge 3 of 3	BMJ Open
	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
	glaintaileo.uaintailleo.unicat.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; $\%\Delta$ -11.30%; 95% CI - 18.75%, - 3.85%) and from 2006/2010 to 2011/2015 (from 295.17 to 240.22/100,000; $\%\Delta$ -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.

BMJ Open

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 \geq \$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

BMJ Open

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.

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 \geq 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.

				<1 Year				1–	4 Years	
Country	Yearly A	nenable Mor	tality Rate	% Change	(95% CI)	Yearly A	menable Mort	ality Rate	% Change	e (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 - 200
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
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
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,
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, 2
ЈР	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.
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, -1
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, 5
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,
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, 7
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,
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, 2
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, 4
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, 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, -
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
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,
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
СН	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
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, 1
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,
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,
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, 3
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, 8
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
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,
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, 14
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
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,
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,
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
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,
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, 10
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,
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, 1
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,

Table 1. Yearly Amenable Mortality Rates (Per 100,000) for Ages <1 and 1–4 Years in 34 OECD Countries, 2001/2005, 2006/2010

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

			5	5–9 Years				10	-14 Years	
Country	Yearly Am	enable Mortal	ity Rate	% Change (95% CI)		Yearly Ame	enable Mortali	ty 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)
СН	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)
РТ	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)

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).

* 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, $\%\Delta$ -9.9% [95% CI -18.4%, -1.5%]; 2006/2010 - 2011/2015: from 239.8 to 193.8 per 100,000, $\%\Delta$ -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).

		<1 Year			1–4 Years			5–9 Years			10-14 Years	
Cause of Death		Rank (%)			Rank (%)			Rank (%)	1		Rank (%)	1
	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)

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

BMJ Open

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

BMJ Open

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

Page 17 of 33

BMJ Open

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 notfor-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/childrenreducing-mortality (accessed 3 Oct 2018).

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

- 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

- 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
- 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/onsconsultation-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_d ata/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

BMJ Open

15	Nolte E, N	McKee CM. M	leasuring the	e health of nat	tions: upda	ting an earl	ier analysi	is. Health Aff
	Proj Hope	e 2008; 27 :58–7	1. doi:10.13	377/hlthaff.27.	1.58			
16	World	Bank.	World	Developm	ient	Indicators		DataBank.
	2018.http:	//databank.wo	rldbank.org/	/data/reports.as	spx?source	=world-dev	elopment-	indicators
	(accessed	3 Oct 2018).						
17	World	Health	Organ	nization.	WHO	Mort	ality	Database.
	2018.http:	//www.who.in	t/healthinfo/	mortality_dat	a/en/ (acce	ssed 3 Oct 2	018).	
18	United	Natio	ns.	Demograph	hic	Statistic	S	Database.
	2018.http:	//data.un.org/I	Data.aspx?d=	=POP&f=table	eCode%3A	22 (accessed	d 3 Oct 20	18).
19	Nolte E, N	McKee M. Do	es health co	are save lives?	? Avoidabl	e mortality	revisited.	The Nuffield
	Trust 2004	4. http://researc	chonline.lsh	tm.ac.uk/1553	5/ (accesse	ed 3 Oct 201	8).	
20	Eurostat.	Amenab	le an	d preve	ntable	deaths	of	residents.
	https://ec.e	europa.eu/euro	stat/web/pro	oducts-datasets	s/-/hlth_cd	_apr (access	ed 3 Oct 2	2018).
21	Hildebran	dt M, Bender	R, Gehrma	ann U, <i>et al</i> .	Calculatin	g confidenc	e interval	s for impact
	numbers.	BMC Med Res	Methodol 2	006; 6 :32. doi:	10.1186/14	471-2288-6-	32	
22	Charlton .	JR, Velez R.	Some inte	rnational com	parisons o	of mortality	amenable	e to medical
	interventio	on. Br Med J C	Clin Res Ed	1986; 292 :295-	-301.			
23	Kamarude	en S. Amenat	ole mortality	v as an indicat	tor of healt	hcare qualit	y - a liter	ature review.
	Health Sta	at Q 2010;:66–	80. doi:10.1	057/hsq.2010.	.16			
24	de Jonge A	A, Baron R, W	esterneng M	I, et al. Perina	tal mortalit	y rate in the	Netherlar	nds compared
	to other	European cou	intries: a s	secondary and	alysis of 1	Euro-PERIS	TAT data	a. <i>Midwifery</i>
	2013; 29 :1	011–8. doi:10.	1016/j.midv	v.2013.02.005				
25	Richardus	JH, Graafman	s WC, Verl	oove-Vanhori	ck SP, et a	l. Difference	es in perin	atal mortality
	and subop	timal care betw	ween 10 Eur	ropean regions	s: results of	an internati	ional audi	t. BJOG Int J
	Obstet Gy	naecol 2003;1	10 :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.
- 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.
- 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

BMJ Open

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 \geq 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.

						•		Year	•				•	•		
Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Tot
Canada	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1:
Chile	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
United States of America	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	1
Israel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Japan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Republic of Korea	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Austria	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Belgium	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Czech Republic	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Denmark	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Estonia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Finland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
France	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Germany	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Greece	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Hungary	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Iceland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Ireland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	1
Italy	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Latvia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Lithuania	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Luxembourg	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Netherlands	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Norway	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Poland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Portugal	1	1	1	0	0	0	1	1	1	1	1	1	1	1	0	1
Slovakia	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	1
Slovenia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Spain	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Sweden	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Switzerland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
United Kingdom	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
Australia	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1
New Zealand	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	1
All OECD countries	34	34	34	33	32	33	34	34	34	34	32	34	33	31	28	4

Table S1 Data Availability for the 24 OECD Countries (0 "Net Available") (1 "Available")

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	Аде	Diseases	ICD-9	ICD-10
	Age	Discases	codes	codes
	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
Infectious diseases	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
	0-74	Colorectal cancer	153-4	C18-21
	0-74	Malignant neoplasm of skin	173	C44
	0-74	Breast cancer	174	C50
Cancers	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	0-74	Thyroid disorders	240-6	E00-7
and metabolic diseases	0-49	Diabetes mellitus	250	E10-4
Diseases of the nervous system	0-74	Epilepsy	345	G40-1
	0-74	Rheumatic heart diseases	393-8	I05-9
Diseases of the	0-74	Ischemic heart diseases: 50% of deaths	410-4	I20-5
circulatory system	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	1 1 4	All respiratory diseases (excl.	460-79,	J00-9, J20-
respiratory system	1-14	pneumonia/influenza)	488-519	99
	0-74	Peptic ulcer	531-3	K25-7
Diseases of the digestive	0-74	Appendicitis	540-3	K35-8
system	0-74	Abdominal hernia	550-3	K40-6
	0-74	Cholelithiasis and cholecystitis	574-5	K80-1
	0-74	Maternal deaths	630-76	O00-99
Perinatal mortality	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) *

Page 27 of 33

BMJ Open

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

Orward of Darath																	Cou	ntry																
Cause of Death	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	СН	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
Influenza	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
Intestinal infections other than typhoid, diphtheria (0–14	0.3	0.1	1.7	1.3	1.3	0.5	0.4	0.2	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
phtheria, etanus, pliomyelitis	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Vhooping 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
leasles (1–14 rs)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
olorectal 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
lalignant eoplasm 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
reast 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
and uterine ancer	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
Tryrold 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
Epilepsy	0.1	0.0	0.0	0.6	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.6	0.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.4	0.0	0.0	0.0	0.0	0.0	0.6	0.0	0.6	0.3	0.1	0.6
heumatic heart	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
chemic heart seases: 50% of	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 tiseases	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	0.0	0.0	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/influe nza (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
Cholelithiasis and	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	0.0	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	0.1	0.2
vaternal 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.	83. 9	82. 5	74. 0	79. 8	78. 9	78. 8	79. 1	83. 2	72.	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 ardiovascular nomalies	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
<i>l</i> isadventures to atients during surgical and nedical 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.

1	Onurs of Double																	Co	Intry																
2	Cause of Death	CA	CL	US	IL	JP	KR	AT	BE	CZ	DK	EE	FI	FR	DE	GR	HU	IS	IÉ	IT	LV	LT	LU	NL	NO	PL	PT	SK	SI	ES	SE	СН	GB	AU	NZ
2	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
3 1	Septicemia	6.1	2.7	7.1	7.1	7.8	4.9	0.0	0	4.0	0.0	6 6	0.0	7.7	7.0	2.0	0.9	0 0	5.4	7.5	14. 3	6.3	0.0	0	2.4	5.5	9.2	1.5	0.0	10. 5	0.0	2	6.5	3	8
+ 5	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
6	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
7 8	Intestinal infections other than typhoid, diphtheria (0–14 vrs)	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
9 10	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
11	Whooping cough (0–14 vrs)	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
12 13	Measles (1–14	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
1.4	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
14 1 r	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
15	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
16 17	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
18	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
19	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
20	Leukemia	14. 4	20.	15.	10.	9.5	19. 4	17.	11.	12.	28.	18.	14. 7	19. 4	16. 3	15.	18.	0.0	16. 2	21.	21. 4	15.	0.0	21.	23. 8	10. 7	23.	15. 4	17.	18. 3	29. 2	30. 3	11.	15. 2	14. 9
21	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
22	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
23	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
24	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
25 26	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
27	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
28	Hypertensive	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
29	Nephritis and	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
30	Benign prostatic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	All respiratory diseases, excl.	13. 9	11.	19. 8	12.	14.	12. 9	17.	14.	20.	15.	9.1	17.	12.	12.	7.0	20.	0.0	2.7	12.	7.1	0.0	100.	15.	2.4	2.0	7.7	4.6	5.9	13. 7	10. 8	9.1	19. 1	18. 1	8.5
33	nza (1–14 yrs)		03			0.6	0.5					0.0	0.0		0.0	0.0	- ۵۵	0.0	27	0.2	0.0	0.0			0.0	0.2	0.0	0.0	0.0	0.0		0.0	0.5	0.0	0.0
54	Appendicitis	0.6	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	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.3	0.5	0.0
35	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
36	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
37	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
38	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
39 40	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
41 42	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
43	modical care	1	1	1	1	I	1	1	I		I							· .								I	I	I	I		II				

BMJ Open

For peer review only

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

1	Onune of Death																	Cou	ntry																
2	Cause of Death	CA	CL	US	IL	JP	KR	AT	BE	CZ	DK	EE	FI	FR	DE	GR	HU	IS	ÍE	IT	LV	LT	LU	NL	NO	PL	PT	SK	SI	ES	SE	CH	GB	AU	NZ
2	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
J ⊿	Septicemia	5	2.2	6.2	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	0	0.0	5.7	5.6	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
5	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
6	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	5	1.6	7.1	0.0	4.5	3.9	8.3
7 8	Intestinal infections other than typhoid, diphtheria (0–14	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
9 10	Diphtheria, Tetanus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
11	Poliomyelitis Whooping cough	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	(0–14 yrs) Measles (1–14	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	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
14	Colorectal cancer Malignant	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
15	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
16	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
17	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
18	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
19	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
20	Leukemia	17. 0	47. 5	20. 6	21.	20. 9	39. 4	22. 6	22. 9	27. 9	30. 0	0.0	28. 6	34. 6	25. 3	39.	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
21	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
22	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
23	Epilepsy	4	2	5.7	4	3.7	9	4	7	9.8	0	0.0	3	3	19.	8.5	23. 5	0.0	5.9	6.5	1	8	0.0	19.	20. 0	9.2	8.7	7.7	5	5	9.5	8	8	7	25.
24	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
25 26	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
27	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
28	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
29	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
30 31	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
32 33	All respiratory diseases, excl. pneumonia/influe nza (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
34	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
35	Appendicitis Abdominal hernia	0.0	0.0	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	∠.9 0.0	0.0	0.0	0.4	2.4	0.0	0.0	0.0	0.0
36	Cholelithiasis and	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
37	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
38	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
39 40	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
41 42	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
43		ı	ı		1		ı			F											/ .													I	

BMJ Open

For peer review only

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

1	Cause of Death																	Cou	intry																
2		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	СН	GB	AU	NZ
3	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
4	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
5	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
6	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
7	Intestinal																																		
8	than typhoid, diphtheria (0–14	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
9 10	yrs) Diphtheria																																		
11	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
12	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
13	Measles (1–14	0.0	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
14	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
15	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
16	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
17	Cervical cancer and uterine	0.0	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
18 19	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
20	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
21	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
22	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
23	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
23	Epilepsy	1	8.1	7.3	8.3	6.0	15. 3	6	8	16. 6	8.3	16. 2	22. 2	13. 5	19. 5	2.7	0	3	16. 7	5.8	16. 7	0.0	0.0	16. 2	8.7	12. 5	7.2	7.4	0.0	5.0	0	9.4	0	13. 5	19.
24	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
26	Ischemic heart diseases: 50% of	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
27	Cerebrovascular	4.6	11.	9.0	5.0	14.	12.	5.9	4.3	4.7	8.3	0.0	16.	9.9	8.6	1.4	7.1	0.0	0.0	10.	33.	11.	0.0	5.3	8.7	6.9	9.6	3.7	12.	7.9	13.	18.	4.8	5.6	15.
28	Hypertensive	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	3 0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	8	0.0	0.0	4 0.0
29	Nephritis and	0.0	3.6	10	33	16	28	0.0	21	23	0.0	0.0	0.0	0.0	0.9	27	0.0	0.0	0.0	0.6	0.0	11.	0.0	0.0	0.0	16	0.0	0.0	0.0	0.8	0.0	0.0	12	16	0.0
31	Benign prostatic	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	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
32	hyperplasia All respiratory	0.0	0.0	0.0	0.0				0.0	0.0		0.0	0.0				0.0			0.0	0.0	0.0		0.0	0.0		0.0	0.0	0.0			0.0		0.0	
33	diseases, excl. pneumonia/influe	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
34	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
35	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
36	Abdominal hernia Cholelithiasis and	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
37	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
38	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
30	excl. stillbirths	2.8	1.0	2.3	0.0	0.6	0.0	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
40	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
41 42	Misadventures to patients during surgical and	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
43 44	medical care	I	I	1	I	1	1		I	For p	beer r	eviev	v only	y - ht	tp://k	omjop	ben.b	mj.co	om/si	te/ab	out/	guide	elines.	xhtm			I	1	1						

BMJ Open

For peer review only

BMJ Open

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

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


1 2		
3 4	1	Amenable mortality in children in 34 OECD countries: evidence from a 15–year time trend analysis
5 6	2	
7 8	3	Authors:
9 10	4	Maria Michela Gianino ^a , Jacopo Lenzi ^b , Marco Bonaudo ^a , Maria Pia Fantini ^b , Roberta Siliquini ^a ,
11 12 13	5	Walter Ricciardi ^{cd} , Gianfranco Damiani ^{cd} .
14 15	6	
16 17	7	Maria Michela Gianino, Professor
18 19	8	a) Department of Public Health Sciences and Pediatrics, Università di Torino
20 21 22	9	Via Santena 5 bis - 10126 Turin (Italy)
23 24	10	Tel #: +39(0)116705839 - Fax #: +39(0)116705889
25 26	11	mariola.gianino@unito.it
27 28 20	12	
30 31	13	Jacopo Lenzi, PhD
32 33	14	b) Department of Biomedical and Neuromotor Sciences, Alma Mater Studiorum - Università di
34 35 26	15	Bologna
37 38	16	Via Ugo Foscolo 7 - 40123 Bologna (Italy)
39 40	17	Tel #: +39(0)512094836
41 42 43	18	jacopo.lenzi2@unibo.it
43 44 45	19	
46 47	20	Marco Bonaudo, MSN
48 49	21	a) Department of Public Health Sciences and Pediatrics, Università di Torino
50 51 52	22	Via Santena 5 bis - 10126 Turin (Italy)
53 54	23	Tel #: +39(0)116705839 - Fax #: +39(0)116705889
55 56	24	marco.bonaudo@unito.it
57 58 50	25	
60	26	Maria Pia Fantini, MD, Professor

1 ว		
2 3 4	27	b) Department of Biomedical and Neuromotor Sciences, Alma Mater Studiorum - Università di
5 6	28	Bologna
7 8	29	Via Ugo Foscolo 7 - 40123 Bologna (Italy)
9 10 11	30	Tel #: +39(0)512094836
12 13	31	mariapia.fantini@unibo.it
14 15	32	
16 17 18	33	Roberta Siliquini, Professor
19 20	34	a) Department of Public Health Sciences and Pediatrics, Università di Torino
21 22	35	Via Santena 5 bis - 10126 Turin (Italy)
23 24 25	36	Tel #: +39(0)116705812
25 26 27	37	roberta.siliquini@unito.it
28 29	38	
30 31 22	39	Walter Ricciardi, MD, Professor
32 33 34	40	c) Fondazione Policlinico Universitario 'Agostino Gemelli' IRCCS, Roma, Italia
35 36	41	Largo Agostino Gemelli 8 - 00168 Roma (Italia)
37 38	42	Tel #: +39(0)630154396
39 40 41	43	walter.ricciardi@unicatt.it
42 43	44	and
44 45	45	d) Istituto di Sanità Pubblica, Università Cattolica del Sacro Cuore, Roma, Italia
46 47 48	46	Largo Francesco Vito 1 - 00168 Roma (Italia)
49 50	47	Tel #: +39(0)630154396
51 52	48	walter.ricciardi@unicatt.it
53 54	49	
55 56 57	50	Gianfranco Damiani MD, Professor
58 59	51	c) Fondazione Policlinico Universitario 'Agostino Gemelli' IRCCS, Roma, Italia
60	52	Largo Agostino Gemelli 8 - 00168 Roma (Italia)

1		
2 3 4	53	Tel #: +39(0)630154396
5 6	54	gianfranco.damiani@policlinicogemelli.it
/ 8 9	55	and
10 11	56	d) Istituto di Sanità Pubblica, Università Cattolica del Sacro Cuore, Roma, Italia
12 13	57	Largo Francesco Vito 1 - 00168 Roma (Italia)
14 15 16	58	Tel #: +39(0)630154396
17 18	59	gianfranco.damiani@unicatt.it
19 20	60	
21 22 23	61	Corresponding Author:
24 25	62	Marco Bonaudo, MSN
26 27	63	a) Department of Public Health Sciences and Pediatrics, Università di Torino
28 29 30	64	Via Santena 5 bis - 10126 Turin (Italy)
31 32	65	Tel #: +39(0)116705839 - Fax #: +39(0)116705889
33 34 35	66	marco.bonaudo@unito.it
36 37	67	
38 30	68	Words count paper: 3077
40 41	69	Words count abstract: 274
42 43	70	
44 45 46	71	
47 48	72	
49 50	73	
51 52 53	74	
53 54 55	75	
56 57	76	
58 50	77	
60	78	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; $\%\Delta$ -11.30%; 95% CI -18.75%, - 3.85%) and from 2006/2010 to 2011/2015 (295.17 to 240.22/100,000; $\%\Delta$ -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.

93 Conclusion. The low decline in amenable mortality rates for children aged ≥1 year, the large variation 94 in amenable mortality rates across countries and the insufficient success in reducing mortality from 95 all causes suggest that the heath system should increase its efforts to enhance child survival. 96 Promoting models of co-management between primary care and subspecialty services, encouraging 97 high-quality healthcare and knowledge, financing universal access to healthcare, and adopting best 98 practice guidelines might help reduce amenable child mortality.

- 0 Strengths and limitations of this study:
 - 1. This is the first study to analyse trends in child mortality amenable to healthcare.
 - 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.

1 2	
3 4 105	4. Making international comparisons is difficult due to variations in birth registration laws and
5 6 106	death certification practices.
7 8 107	
9	Kay wanda, Amanahla mantality, shild shildhaad haslthaara haslthaara samiaas OECD sountries
10 108	Key words: Amenable moltanty, child, childhood, heatthcare, heatthcare services, OECD countries
13	
14 15 16	
10 17 18	
19 20	
21 22	
23 24	
25 26	
27 28	
29 30	
31 32	
33 34	
35 36	
37 38	
39 40	
41 42	
43 44	
43 46 47	
48 49	
50 51	
52 53	
54 55	
56 57	
58 59	
60	

INTRODUCTION

5 110 6

114 15 16

4

7

11 12 113

13 14

20 21

23

25

27 28

29 30

32

34 35

36 37

39

41

51

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 116 ₂₂ 117 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 24 118 ²⁶ 119 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] 120 31 121 In the landscape described, the mortality burden conditioned by the performance of the healthcare 33 122 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 123 ₃₈ 124 amenable mortality.

Amenable mortality is defined as deaths that, in the light of medical knowledge and 40 125 42 126 technology at the time of death, could be prevented by timely access to good quality care. The concept 43 44 45¹²⁷ of mortality amenable to healthcare finds its origins in the evolution of the concept of avoidable 46 mortality, developed by Rutstein et al., who created a list of conditions that were considered either 47 128 48 49 treatable or preventable through healthcare services given the current medical knowledge and 129 50 130 technology.[10] Rutstein was the first to introduce the term amenable mortality, differentiating 52 53 54 131 between causes which are responsive to medical intervention through treatment and 55 56 132 secondary/tertiary prevention actions (e.g., cervical cancer, hypertensive disease or appendicitis), and 57 58 133 causes responsive to actions beyond healthcare services (preventable conditions such as lung cancer 59 60 134 and liver cirrhosis).

Page 7 of 35

1

BMJ Open

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 \geq \$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

1

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.

3 4	185	All data were analysed using the Stata software package, version 15 (StataCorp. 2017. Stata
5 6 7	186	Statistical Software: Release 15. College Station, TX: StataCorp LLC). The significance level was
/ 8 9	187	set at .05.
10 11	188	
12 13	189	Ethics statement
14 15 16	190	This descriptive study involved aggregate data that exist in the public domain, where it is not possible
17 18	191	to identify individuals from the information provided. For this reason, this research did not require
19 20 21	192	ethical approval.
22 23	193	
24 25	194	Patient and public involvement
26 27	195	Patients were not involved in this study.
28 29 30	196	
31	197	
52		
33 34	198	RESULTS
33 34 35 36	198 199	RESULTS
32 33 34 35 36 37 38 20	198 199 200	RESULTS All-cause amenable child mortality rates
32 33 34 35 36 37 38 39 40 41	198 199 200 201	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
 32 33 34 35 36 37 38 39 40 41 42 43 	198 199 200 201 202	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
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46	198 199 200 201 202 203	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
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48	198 199 200 201 202 203 204	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, $\%\Delta = -11.3\%$) and from 2006/10 to 2011/15 (295.17 to 240.22 per 100,000, $\%\Delta = -18.6\%$).
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50	198 199 200 201 202 203 204 205	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, $\%\Delta = -11.3\%$) and from 2006/10 to 2011/15 (295.17 to 240.22 per 100,000, $\%\Delta = -18.6\%$). Contrary to the OECD rate of children aged <1 year, in the population aged \geq 1 year the overall OECD
33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 9 50 51 52	198 199 200 201 202 203 204 205 206	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, $\%\Delta = -11.3\%$) and from 2006/10 to 2011/15 (295.17 to 240.22 per 100,000, $\%\Delta = -18.6\%$). 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
32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55	198 199 200 201 202 203 204 205 206 207	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
32 33 34 35 36 37 39 40 41 42 44 45 46 47 48 9 51 52 53 54 55 57	198 199 200 201 202 203 204 205 206 207 208	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, $\%\Delta = -11.3\%$) and from 2006/10 to 2011/15 (295.17 to 240.22 per 100,000, $\%\Delta = -18.6\%$). 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
32 33 35 36 37 38 40 42 44 46 49 51 52 54 55 57 58	198 199 200 201 202 203 204 205 206 207 208 209	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, $\%\Delta = -11.3\%$) and from 2006/10 to 2011/15 (295.17 to 240.22 per 100,000, $\%\Delta = -18.6\%$). 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

1											
2	211										
4	211										
5 6	212	Cause-specific child mortality rates									
7 8 0	213	When we examined the distribution of cause-	specific	mortalit	y rates a	across m	ultiple a	age grou	ps and		
9 10 11	214	study periods, no statistically significant varia	ations in	n the OE	CD pop	oulation	were fo	ound. Th	e only		
12 13	215	exception was a significant decrease in deaths in the first year of life for conditions originating in the									
14 15 16	216	early neonatal period (2001/05 to 2006/10: 266.3 to 239.8 per 100,000, $\%\Delta = -9.9\%$; 2006/10 to									
17 18	217	2011/15: 239.8 to 193.8 per 100,000, $\%\Delta = -1$	9.2%) (see onlin	ne suppl	ementar	y file 4)				
19 20	218	Globally, for the years 2001/05, 2006/	'10 and	2011/15	, there w	vere no	signific	ant diffe	rences		
21 22 23	219	in the age-specific percentage distribution of	causes	of death	ı [<1 ye	ar: Fried	dman te	est(P) =	0.955		
24 25	220	(0.372); 1-4 years: 0.864 (0.607); 5-9 years: 0	.470 (0.	740); 10-	-14 year	s: 1.773	(0.398)]. As sho	own in		
26 27	221	Table 1, the three leading causes of death by	e 1, the three leading causes of death by age groups over the 15-year study period were the								
28 29 30	222	following: conditions originating in the early	neonata	al period,	, conger	nital care	liovascı	ılar anor	nalies,		
31 32	223	and pneumonia for children aged <1 year;	congeni	ital cardi	ovascul	ar anom	nalies, l	eukaemi	a, and		
33 34	224	respiratory diseases (excl. pneumonia/flu) for	all othe	r age groups.							
35 36 27	225 226	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.									
37 38		Cause of Death	200	01/05	200	6/10	201	1/15			
39			Rank	%	Rank	%	Rank	<u>%</u>			
40		<1 Year	(n = 19)	0,169.5)	(n = 1)	/5,008)	(n = 10)	5,210.5)			
41		Conditions originating in the early neonatal period	#1	80.02	#1	81.25	#1	80.09			
42		Pneumonia	#2	14.30	#2	15.15	#2	1 20	-		
43		Senticaemia	#4	1.62	#4	1.39	#4	1.04	-		
44		Intestinal infections other than typhoid diphtheria	#7	0.27	#5	0.60	#5	0.72	-		
45		Cerebrovascular diseases	#6	0.27	#6	0.60	#6	0.72	-		
46		Nenhritis and nenhrosis	#5	0.54	#7	0.00	#7	0.25	-		
47		I eukaemia	#8	0.21	#8	0.15	#8	0.23	-		
48		Fnilepsy	#9	0.21	#0 #0	0.17	#9	0.21	-		
49		Whooning cough	#J #11*	0.17	#J #12*	0.17	#J	0.25			
50		Other causes	-	0.11	-	0.10	-	0.19			
51									-		
52		1–4 Years	(n = 1	4,438)	(n = 1	2,738)	(n = 8)	3491.5)	1		
53		Congenital cardiovascular anomalies	#1	25.67	#1	23.63	#1	25.21	1		
54		Leukaemia	#3	14.55	#3	13.99	#2	14.99	1		
55		All respiratory diseases, excl. pneumonia/influenza	#2	15.60	#2	16.79	#3	14.25	1		
56		Pneumonia	#4	12.35	#4	12.20	#4	12.24	1		
57		Epilepsy	#7	5.16	#7	5.50	#5	7.20	1		

58

59

60

Septicaemia

Cerebrovascular diseases

Conditions originating in the early neonatal period

Intestinal infections other than typhoid, diphtheria

#5

#6

#9

#8

7.57

5.59

2.45

3.86

#5

#6

#9

#8

8.18

5.60

3.05

4.13

#6

#7

#8

#9

6.88

5.06

3.98

3.38

35

37

za	#10	2.16	#10	1.92	#10	2.39
auses	-	5.05	-	5.00	-	4.42
ars	(n =	7705)	(n =	6706)	(n =	4541)
nia	#1	31.72	#1	28.35	#1	27.31
iratory diseases, excl. pneumonia/influenza	#3	12.91	#2	16.28	#2	13.87
ital cardiovascular anomalies	#2	14.91	#3	13.67	#3	13.12
у	#5	7.81	#5	7.86	#4	10.37
onia	#4	8.58	#4	7.90	#5	9.12
vascular diseases	#6	6.87	#6	7.13	#6	6.69
emia	#7	5.15	#7	5.67	#7	5.26
za	#9	1.66	#8	2.54	#8	2.97
ons originating in the early neonatal period	#8	2.25	#9	2.48	#9	2.80
al infections other than typhoid, diphtheria	#13†	0.87	#12†	1.25	#10	2.00
auses	-	7.26	-	6.87	-	6.47
Tears	(n =	9109)	(n =)	7579)	(n =	4921)
nia	#1	31.30	#1	30.01	#1	30.24
iratory diseases, excl. pneumonia/influenza	#3	13.66	#2	15.28	#2	13.66
ital cardiovascular anomalies	#2	14.13	#3	12.17	#3	12.62
у	#5	7.73	#5	7.89	#4	10.36
vascular diseases	#4	8.12	#4	8.99	#5	9.08
onia	#6	7.59	#6	6.73	#6	7.27
emia	#7	4.17	#7	4.92	#7	4.29
s mellitus	#8	2.49	#8	2.31	#8	1.97
za	#11‡	1.15	#9	2.15	#9	1.77
ons originating in the early neonatal period	#10	1.57	#11‡	1.78	#10	1.52
auses	-	8.09	-	7.78	-	7.21
	auses auses irrs nia iratory diseases, excl. pneumonia/influenza ital cardiovascular anomalies y nia vascular diseases emia za ons originating in the early neonatal period al infections other than typhoid, diphtheria auses (ears mia iratory diseases, excl. pneumonia/influenza ital cardiovascular anomalies y vvascular diseases onia emia s mellitus za ons originating in the early neonatal period auses	ra#10auses-urs(n =nia#1iratory diseases, excl. pneumonia/influenza#3ital cardiovascular anomalies#2y#5mia#4vascular diseases#6emia#7ra#9ons originating in the early neonatal period#8al infections other than typhoid, diphtheria#13†auses-(ears(n =mia#1iratory diseases, excl. pneumonia/influenza#3ital cardiovascular anomalies#2y#5wascular diseases#4onia#6emia#7s mellitus#8za#11‡ons originating in the early neonatal period#10auses-	ra #10 2.16 nuses - 5.05 rrs (n = 7705) nia #1 31.72 iratory diseases, excl. pneumonia/influenza #3 12.91 ital cardiovascular anomalies #2 14.91 y #5 7.81 mia #4 8.58 vascular diseases #6 6.87 emia #7 5.15 ra #9 1.66 ons originating in the early neonatal period #8 2.25 al infections other than typhoid, diphtheria #13† 0.87 auses - 7.26 Vascular diseases, excl. pneumonia/influenza #3 13.66 ital cardiovascular anomalies #2 14.13 y #5 7.73 wascular diseases #4 8.12 nia #1 31.306 ital cardiovascular anomalies #2 14.13 y #5 7.73 wascular diseases #4 8.12 nia #6 7.59	a #10 2.16 #10 nuses - 5.05 - urs (n = 7705) (n = 7705) (n = 7705) mia #1 31.72 #1 iratory diseases, excl. pneumonia/influenza #3 12.91 #2 ital cardiovascular anomalies #2 14.91 #3 y #5 7.81 #5 onia #4 8.58 #4 vascular diseases #6 6.87 #6 emia #7 5.15 #7 za #9 1.66 #8 ons originating in the early neonatal period #8 2.25 #9 al infections other than typhoid, diphtheria #13† 0.87 #12† auses - 7.26 - - Means (n = 9109) (n = 9109) (n = 9109) mia #1 31.306 #2 14.13 #3 y #5 7.73 #5 yascular diseases #4 8.12 #4 mia #1.2 #4<	ra #10 2.16 #10 1.92 nuses - 5.05 - 5.00 rrs (n = 7705) (n = 6706) nia #1 31.72 #1 28.35 iratory diseases, excl. pneumonia/influenza #3 12.91 #2 16.28 ital cardiovascular anomalies #2 14.91 #3 13.67 y #5 7.81 #5 7.86 mia mia #4 8.58 #4 7.90 vascular diseases #6 6.87 #6 7.13 emia #7 5.15 #7 5.67 ra #9 1.66 #8 2.54 ons originating in the early neonatal period #8 2.25 #9 2.48 al infections other than typhoid, diphtheria #13 [†] 0.87 #12 [†] 1.25 auses - 7.26 - 6.87 (ears (n = 9109) (n = 7579) mia #1 $31.3.06$ #2 15.28 ita	ra #10 2.16 #10 1.92 #10 nuses - 5.05 - 5.00 - urs (n = 7705) (n = 6706) (n = nia #1 31.72 #1 28.35 #1 iratory diseases, excl. pneumonia/influenza #3 12.91 #2 16.28 #2 ital cardiovascular anomalies #2 14.91 #3 13.67 #3 y #5 7.81 #5 7.86 #4 mia #4 8.58 #4 7.90 #5 vascular diseases #6 6.87 #6 7.13 #6 emia #7 5.15 #7 5.67 #7 ta #9 1.66 #8 2.54 #8 ons originating in the early neonatal period #8 2.25 #9 2.48 #9 al infections other than typhoid, diphtheria #13† 0.87 #12† 1.25 #10 auses - 7.26 - 6.87 -

31 227 * Abdominal hernia was ranked #10 in 2001/05 (0.17%) and 2006/10 (0.13%).

32 228 † Nephritis and nephrosis were ranked #10 in 2001/05 (1.60%) and 2006/10 (1.69%).

33 229 ‡ Nephritis and nephrosis were ranked #9 in 2001/05 (1.79%) and #10 in 2006/10 (1.91%).
34 230

36 231 Country-specific amenable child mortality rates

³⁸ 232 As shown in Figure 1 and online supplementary file 3, the amenable mortality rate for the population 39 40 aged <1 year dropped significantly over the entire study period in 15 countries (United States, Israel, 233 41 42 Japan, South Korea, Czechia, Estonia, Germany, Italy, Latvia, Hungary, Poland, Spain, Austria, 43 234 44 45 235 United Kingdom and Australia). In addition to the decrease in conditions originating in the early 46 47 neonatal period, other causes contributed to a significant reduction in mortality for some of these 236 48 49 ₅₀ 237 countries: septicaemia, pneumonia and nephritis/nephrosis in the United States, septicaemia in 51 52 238 Poland, and congenital cardiovascular anomalies in Japan and Spain. See online supplementary file 53 54 239 4 for country-specific and cause-specific mortality rates in the <1-year population. 55 56

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

18 255

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 50 269 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 57 272 another of our results, highlighting that the causal distribution of the age-specific mortality rates did ⁵⁹ 273 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 Page 13 of 35

1

BMJ Open

(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 282 and public health services work closely together. Models of co-management are essential to promote 283 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 286 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 289 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

1

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 units. [51,52] Finally,

BMJ Open

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. 351 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.

1	
2 3 366 4	DECLARATIONS
5 6 367	Ethics approval and consent to participate
7 8 368 9	Not applicable.
10 369 11	Availability of data and materials
$\frac{12}{13}$ 370	The datasets used and/or analysed during the current study are available from the corresponding
14 15 371 16	author on reasonable request.
17 372 18	Competing interests
¹⁹ 373 20	The authors declare that they have no competing interests.
21 22 374 23	Funding
24 375 25	This research received no specific grant from any funding agency in the public, commercial or not-
26 376 27	for-profit sectors.
28 29 30	Acknowledgements
31 378 32	Data for this study came from the World Health Organization. All analyses, interpretations and
33 379 34	conclusions are credited to the authors of this study, not to the World Health Organization.
³⁵ 380 36 37	Author Contributions
38 38 39	MMG and GD formulated the research goals and supervised the research activity; MMG, GD, JL
40 382 41	defined the design of the methodology; MMG wrote the article; RS, WR and MPF revised the
42 43 44	article; MB collected the data and managed the database; JL utilised statistical techniques to analyse
45 384 46	the study data.
47 385 48	All authors have read and approved the manuscript.
49 50	
51	
52 53	
54	
55 56	
57	
58	
59 60	

2 3	225	DE	
4	386	KE	FERENCES
5 6	387	1	Blum RW, Nelson-Mmari K. The health of young people in a global context. J Adolesc Health
/ 8 0	388		<i>Off Publ Soc Adolesc Med</i> 2004; 35 :402–18. doi:10.1016/j.jadohealth.2003.10.007
9 10 11	389	2	WHO. Children: reducing mortality. http://www.who.int/news-room/fact-sheets/detail/children-
12 13	390		reducing-mortality (accessed 3 Oct 2018).
14 15	391	3	Fraser J, Sidebotham P, Frederick J, et al. Learning from child death review in the USA, England,
16 17 18	392		Australia, and New Zealand. Lancet Lond Engl 2014;384:894-903. doi:10.1016/S0140-
19 20	393		6736(13)61089-2
21 22	394	4	Kyu HH, Stein CE, Pinto CB, et al. Causes of death among children aged 5–14 years in the WHO
23 24 25	395		European Region: a systematic analysis for the Global Burden of Disease Study 2016. Lancet
26 27	396		Child Adolesc Health 2018;2:321-37. doi:10.1016/S2352-4642(18)30095-6
28 29	397	5	Sidebotham P, Fraser J, Covington T, et al. Understanding why children die in high-income
30 31 32	398		countries. The Lancet 2014;384:915-27. doi:10.1016/S0140-6736(14)60581-X
32 33 34	399	6	Alio AP, Richman AR, Clayton HB, et al. An ecological approach to understanding black-white
35 36	400		disparities in perinatal mortality. Matern Child Health J 2010;14:557-66. doi:10.1007/s10995-
37 38	401		009-0495-9
39 40 41	402	7	Gakidou E, Cowling K, Lozano R, et al. Increased educational attainment and its effect on child
42 43	403		mortality in 175 countries between 1970 and 2009: a systematic analysis. Lancet Lond Engl
44 45	404		2010; 376 :959–74. doi:10.1016/S0140-6736(10)61257-3
46 47 48	405	8	Lightfoot TJ, Johnston WT, Simpson J, et al. Survival from childhood acute lymphoblastic
49 50	406		leukaemia: the impact of social inequality in the United Kingdom. Eur J Cancer 2012;48:263–9.
51 52	407		doi:10.1016/j.ejca.2011.10.007
53 54	408	9	Gore FM, Bloem PJN, Patton GC, et al. Global burden of disease in young people aged 10-24
55 56 57	409		years: a systematic analysis. Lancet Lond Engl 2011;377:2093-102. doi:10.1016/S0140-
58 59 60	410		6736(11)60512-6

3 4	411	10	Rutstein DD, Berenberg W, Chalmers TC, et al. Measuring the quality of medical care. A clinical
5 6	412		method. N Engl J Med 1976;294:582-8. doi:10.1056/NEJM197603112941104
7 8 9	413	11	Department of Health. The NHS Outcomes Framework 2011/12.
10 11	414		$2010.https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_d$
12 13 14	415		ata/file/213789/dh_123138.pdf
15 16	416	12	Page A, New Zealand, University of Adelaide, editors. Australian and New Zealand atlas of
17 18 10	417		avoidable mortality. Adelaide, S. Aust.: : Public Health Information Development Unit,
20 21	418	12	University of Adelaide 2006.
22 23	419	13	Honand w.w. European Community atlas of avoidable death. 1991.
24 25 26	420	14	Nolte E, McKee CM. Measuring the health of nations: updating an earlier analysis. <i>Health Aff</i>
20 27	421		<i>Proj Hope</i> 2008; 2 7:58–71. doi:10.1377/hlthaff.27.1.58
20 29 30	422	15	Gay JG, Paris V, Devaux M, et al. Mortality Amenable to Health Care in 31 OECD Countries:
31 32	423		estimates and methodological Issues. Published Online First: 31 January 2011.
33 34	424		doi:https://doi.org/10.1787/5kgj35f9f8s2-en
35 36 27	425	16	Treurniet H, Boshuizen H, Harteloh P. Avoidable mortality in Europe (1980–1997): a comparison
38 39	426		of trends. J Epidemiol Community Health 2004;58:290-5. doi:10.1136/jech.2002.006452
40 41	427	17	Nolte E, McKee M. Variations in amenable mortalitytrends in 16 high-income nations. <i>Health</i>
42 43	428		Policy Amst Neth 2011;103:47-52. doi:10.1016/j.healthpol.2011.08.002
44 45 46	429	18	Mackenbach JP, Hoffmann R, Khoshaba B, et al. Using "amenable mortality" as indicator of
40 47 48	430		healthcare effectiveness in international comparisons: results of a validation study. J Epidemiol
49 50	431		Community Health 2013;67:139-46. doi:10.1136/jech-2012-201471
51 52	432	19	Mackenbach JP, Bouvier-Colle MH, Jougla E. "Avoidable" mortality and health services: a
53 54 55	433		review of aggregate data studies. J Epidemiol Community Health 1990;44:106-11.
56 57	434	20	Gianino MM, Lenzi J, Muça A, et al. Declining Amenable Mortality: Time Trend (2000-2013)
58 59	435		and Geographic Area Analysis. Health Serv Res 2017;52:1908-27. doi:10.1111/1475-
60	436		6773.12563

2 3	437	21	Charlton JR, Velez R. Some international comparisons of mortality amenable to medical
4 5 6	438		intervention. Br Med J Clin Res Ed 1986;292:295–301.
7 8	439	22	James PD, Manuel DG, Mao Y. Avoidable mortality across Canada from 1975 to 1999. BMC
9 10 11	440		Public Health 2006;6:137. doi:10.1186/1471-2458-6-137
12 13	441	23	Pampalon R. Avoidable mortality in Québec and its regions. Soc Sci Med 1993;37:823-31.
14 15 16	442		doi:10.1016/0277-9536(93)90376-F
17 17 18	443	24	Piers LS, Carson NJ, Brown K, et al. Avoidable mortality in Victoria between 1979 and 2001.
19 20	444		Aust N Z J Public Health 2007; 31 :5–12.
21 22	445	25	Fantini MP, Lenzi J, Franchino G, et al. Amenable mortality as a performance indicator of Italian
25 24 25	446		health-care services. BMC Health Serv Res 2012;12:310. doi:10.1186/1472-6963-12-310
26 27	447	26	Tobias M, Jackson G. Avoidable mortality in New Zealand, 1981-97. Aust N Z J Public Health
28 29	448		2001; 25 :12–20. doi:10.1111/j.1467-842X.2001.tb00543.x
30 31 32	449	27	Schoenbaum SC, Schoen C, Nicholson JL, et al. Mortality amenable to health care in the United
33 34	450		States: The roles of demographics and health systems performance. J Public Health Policy
35 36	451		2011; 32 :407–29.
37 38 30	452	28	World Bank. World Development Indicators DataBank.
40 41	453		2018.http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators
42 43	454		(accessed 3 Oct 2018).
44 45 46	455	29	World Health Organization. WHO Mortality Database.
40 47 48	456		2018.http://www.who.int/healthinfo/mortality_data/en/ (accessed 3 Oct 2018).
49 50	457	30	United Nations. Demographic Statistics Database.
51 52	458		2018.http://data.un.org/Data.aspx?d=POP&f=tableCode%3A22 (accessed 3 Oct 2018).
53 54 55	459	31	Nolte E, McKee M. Does health care save lives? Avoidable mortality revisited. The Nuffield
56 57	460		Trust 2004. http://researchonline.lshtm.ac.uk/15535/ (accessed 3 Oct 2018).
58 59	461	32	Eurostat. Amenable and preventable deaths of residents.
60	462		https://ec.europa.eu/eurostat/web/products-datasets/-/hlth_cd_apr (accessed 3 Oct 2018).

Page 21 of 35

1 2			
2 3 4	463	33	Hildebrandt M, Bender R, Gehrmann U, et al. Calculating confidence intervals for impact
5 6	464		numbers. BMC Med Res Methodol 2006;6:32. doi:10.1186/1471-2288-6-32
7 8 0	465	34	Wolfe I, Thompson M, Gill P, et al. Health services for children in western Europe. Lancet Lond
9 10 11	466		Engl 2013; 381 :1224–34. doi:10.1016/S0140-6736(12)62085-6
12 13	467	35	Expert Panel on Effective Ways of Investing in Health. Definition of a frame of Reference in
14 15	468		relation to Primary Care with a special emphasis on Financing Systems and Referral Systems.
16 17 18	469		2014.https://ec.europa.eu/health/expert_panel/sites/expertpanel/files/004_definitionprimarycare
19 20	470		_en.pdf (accessed 2 Mar 2019).
21 22	471	36	Adams J, Woods E. Redesign of chronic illness care in children and adolescents. Curr Opin
23 24 25	472		Pediatr 2016;28:428-33. doi:10.1097/MOP.000000000000368
26 27	473	37	Britto MT, Vockell A-LB, Munafo JK, et al. Improving outcomes for underserved adolescents
28 29	474		with asthma. Pediatrics 2014;133:e418-427. doi:10.1542/peds.2013-0684
30 31	475	38	Mangione-Smith R, Schonlau M, Chan KS, et al. Measuring the effectiveness of a collaborative
33 34	476		for quality improvement in pediatric asthma care: does implementing the chronic care model
35 36	477		improve processes and outcomes of care? Ambul Pediatr Off J Ambul Pediatr Assoc 2005;5:75-
37 38	478		82. doi:10.1367/A04-106R.1
39 40 41	479	39	Hertel-Fernandez AW, Giusti AE, Sotelo JM. The Chilean infant mortality decline: improvement
42 43	480		for whom? Socioeconomic and geographic inequalities in infant mortality, 1990-2005. Bull
44 45	481		World Health Organ 2007; 85 :798–804.
46 47 48	482	40	Rodrigo A, van der Veer R, Vermeer HJ, et al. From foundling homes to day care: a historical
49 50	483		review of childcare in Chile. <i>Cad Saúde Pública</i> ; 30 :461–72.
51 52	484	41	OECD. State of Health in the EU Slovak Republic: Country Health Profile 2017 - European
53 54	485		Observatory on Health Systems and Policies. 2017.
55 56 57	486	42	Katz M, Rubino A, Collier J, et al. Demography of pediatric primary care in Europe: delivery of
58 59 60	487		care and training. <i>Pediatrics</i> 2002; 109 :788–96.

1 2										
- 3 4	488	43	Pearson GA, Ward-Platt M, Harnden A, et al. Why children die: avoidable factors associated with							
5 6	489		child deaths. Arch Dis Child 2011;96:927-31. doi:10.1136/adc.2009.177071							
/ 8 9	490	44	van Esso D, del Torso S, Hadjipanayis A, et al. Paediatric primary care in Europe: variation							
10 11	491		tween countries. Arch Dis Child 2010;95:791–5. doi:10.1136/adc.2009.178459							
12 13	492	45	Williams RL, Chen PM. Identifying the Sources of the Recent Decline in Perinatal Mortality							
14 15 16	493		Rates in California. N Engl J Med 1982;306:207–14. doi:10.1056/NEJM198201283060404							
17 18	494	46	Richardson DK, Gray JE, Gortmaker SL, et al. Declining severity adjusted mortality: evidence							
19 20	495		of improving neonatal intensive care. <i>Pediatrics</i> 1998;102:893–9.							
21 22 23	496	47	Horbar JD, Wright LL, Soll RF, et al. A multicenter randomized trial comparing two surfactants							
24 25	497		for the treatment of neonatal respiratory distress syndrome. National Institute of Child Health and							
26 27	498		Human Development Neonatal Research Network. J Pediatr 1993;123:757-66.							
28 29 20	499	48	Vermont-Oxford Neonatal Network. A multicenter, randomized trial comparing synthetic							
30 31 32	500		surfactant with modified bovine surfactant extract in the treatment of neonatal respiratory distress							
33 34	501		syndrome. <i>Pediatrics</i> 1996; 97 :1–6.							
35 36	502	49	Clark RH, Yoder BA, Sell MS. Prospective, randomized comparison of high-frequency							
37 38 39	503		oscillation and conventional ventilation in candidates for extracorporeal membrane oxygenation.							
40 41	504		J Pediatr 1994; 124 :447–54.							
42 43	505	50	Rastogi A, Akintorin SM, Bez ML, et al. A Controlled Trial of Dexamethasone to Prevent							
44 45	506		Bronchopulmonary Dysplasia in Surfactant-treated Infants. <i>Pediatrics</i> 1996; 98 :204–10.							
40 47 48	507	51	Phibbs CS, Baker LC, Caughey AB, et al. Level and volume of neonatal intensive care and							
49 50	508		mortality in very-low-birth-weight infants. N Engl J Med 2007;356:2165-75.							
51 52	509		doi:10.1056/NEJMsa065029							
53 54 55	510	52	Paneth N. Technology at birth. Am J Public Health 1990;80:791–2.							
56 57	511	53	Alfirevic Z, Neilson JP. Doppler ultrasonography in high-risk pregnancies: systematic review							
58 59 60	512		with meta-analysis. Am J Obstet Gynecol 1995;172:1379–87.							

Page 23 of 35

1 ว			
2 3 4	513	54	Kuchna D, Hovsepyan A, Leonard S. Preventing Newborn Deaths In Romania And Hungary.
5 6	514		Health Aff (Millwood) 2017;36:1160–1160. doi:10.1377/hlthaff.2017.0382
7 8	515	55	Maeda K. Progress of Perinatal Medicine in Japan. J Health Med Inform 2013;s11.
9 10 11	516		doi:10.4172/2157-7420.S11-002
12 13	517	56	Kramer MS, Platt RW, Yang H, et al. Registration artifacts in international comparisons of infant
14 15	518		mortality. <i>Paediatr Perinat Epidemiol</i> 2002; 16 :16–22. doi:10.1046/j.1365-3016.2002.00390.x
16 17 18	519	57	Joseph KS, Liu S, Rouleau J, et al. Influence of definition based versus pragmatic birth
19 20	520		registration on international comparisons of perinatal and infant mortality: population based
21 22	521		retrospective study. The BMJ 2012;344. doi:10.1136/bmj.e746
23 24 25	522	58	Mohangoo AD, Blondel B, Gissler M, et al. International Comparisons of Fetal and Neonatal
26 27	523		Mortality Rates in High-Income Countries: Should Exclusion Thresholds Be Based on Birth
28 29	524		Weight or Gestational Age? PLOS ONE 2013;8:e64869. doi:10.1371/journal.pone.0064869
30 31	525	59	Schwartz E, Kofie VY, Rivo M, et al. Black/white comparisons of deaths preventable by medical
33 34	526		intervention: United States and the District of Columbia 1980-1986. Int J Epidemiol
35 36	527		1990; 19 :591–8. doi:10.1093/ije/19.3.591
37 38	528	60	Macinko J, Elo IT. Black-white differences in avoidable mortality in the USA, 1980-2005. J
39 40 41	529		Epidemiol Community Health 2009;63:715-21. doi:10.1136/jech.2008.081141
42 43	530	61	Riddell CA, Harper S, Kaufman JS. Trends in Differences in US Mortality Rates Between Black
44 45	531		and White Infants. JAMA Pediatr 2017;171:911-3. doi:10.1001/jamapediatrics.2017.1365
46 47 48	532		
40 49			
50			
51 52			
53			
54			
55			
56 57			
58			
59			
60			



BMJ Open

3 ⊿	Table 1 Data A	vailat	oility f	or the	e 34 C	DECD	Cou	ntries	<u>; (0 "N</u>	Not A	vailab	le"/1	"Avai	ilable'	')		
				1					Year								
5																	
0	Country	5)2	33	4)5	90	27	98	60	0	Ξ	2	3	4	15	Total
/		20(200	200	200	200	500	500	200	500	Ś	Ś	Ś	20	20,	20,	
8																	
9	0			4							4				0	0	40
10	Canada	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	13
11	Chile	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
12	United States	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	12
13	of America		4					_	4	_	_						4.5
14	Israel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
15	Japan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
16	Republic of	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
17	Korea																
18	Austria	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
19	Belgium	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
20	Czechia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
21	Denmark	1	1	1	F1	1	1	1	1	1	1	1	1	1	1	1	15
22	Estonia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
23	Finland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
24	France	1	1	1 🖣	1	1	1	1	1	1	1	1	1	1	1	0	14
25	Germany	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
26	Greece	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
27	Hungary	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
28	Iceland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
29	Ireland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	14
30	Italy	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
31	Latvia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
32	Lithuania	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
33	Luxembourg	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
34	Netherlands	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
35	Norway	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
36	Poland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
37	Portugal	1	1	1	0	0	0	1	1	1	1	1	1	1	1	0	11
38	Slovakia	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	13
39	Slovenia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
40	Spain	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
41	Sweden	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
42	Switzerland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
43	United																4.5
44	Kingdom	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
45	Australia	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	14
46	New Zealand	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	13
47	All OECD	<u> </u>	<u> </u>	<u> </u>				~ (~ ~	<u> </u>		~ ~			00	10.1
48	countries	34	34	34	33	32	33	34	34	34	34	32	34	33	31	28	494
	Notos: Causos of	death	are co	dod o	coordir	a to t			uctria	2001.	Groop	- 200 <i>°</i>	1/2012	· Irolar	-d 200	1/2000	S: Itoly

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

	•	D .	ICD-9	ICD-10
Disease category	Age	Diseases	codes	codes
	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
Infectious diseases	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
	0-74	Colorectal cancer	153-4	C18-21
	0-74	Malignant neoplasm of skin	173	C44
	0-74	Breast cancer	174	C50
Cancers	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	0-74	Thyroid disorders	240-6	E00-7
and metabolic diseases	0-49	Diabetes mellitus	250	E10-4
Diseases of the nervous system	0-74	Epilepsy	345	G40-1
	0-74	Rheumatic heart diseases	393-8	105-9
Diseases of the	0-74	Ischemic heart diseases: 50% of deaths	410-4	120-5
circulatory system	0-74	Cerebrovascular diseases	430-8	160-9
	0-74	Hypertensive diseases	401-5	110-3, 115
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
	0-74	Peptic ulcer	531-3	K25-7
Diseases of the digestive	0-74	Appendicitis	540-3	K35-8
system	0-74	Abdominal hernia 🧼	550-3	K40-6
	0-74	Cholelithiasis and cholecystitis	574-5	K80-1
	0-74	Maternal deaths	630-76	O00-99
Perinatal mortality	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.

1
2
3
4
5
6
7
8
9
1
1

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)

	Maard		<1 Year			No or l		1-4 Years		
Country	Yearly A	Rate	ortality	% Change	e (95% CI)	Yearly A	Rate	lortality	% Change	e (959
	2001/05	2006/10	2011/15	2006/10– 2001/05	2011/15– 2006/10	2001/05	2006/10	2011/15	2006/10– 2001/05	201 200
CA	343.10	343.46	332.97	.1	-3.1	4.34	4.09	3.98	-5.7	-2
US	415.80	382.24	350.87	-8.1*	-8.2*	6.00	5.46	5.13	-8.9*	-6
CL	478.56	457.40	427.15	-4.4	-6.6	10.11	7.50	5.90	-25.8*	-2
IL	291.77	221.77	189.73	-24.0*	-14.4*	6.89	4.62	3.86	-32.9	-1
JP	150.76	121.39	97.24	-19.5*	-19.9*	8.78	7.84	7.15	-10.7	-8
KR	334.41	235.84	198.16	-29.5*	-16.0*	8.50	6.69	4.59	-21.3*	-3
DK	285.08	191.17	220.19	-32.9*	15.2	6.16	3.87	3.11	-37.2	-1
IS	134.24	127.50	85.5	-5.0	-32.9	4.74	6.78	2.14	43.2	-6
FI	186.77	151.76	109.42	-18.7	-27.9*	4.46	3.25	2.80	-27.2	-1
NO	207.32	186.37	149.55	-10.1	-19.8	5.77	4.56	3.36	-21.0	-2
SE	178.05	136.44	130.95	-23.4*	-4.0	4.44	4.03	2.82	-9.2	-3
AT	297.83	243.56	198.02	-18.2*	-18.7*	4.72	4.54	3.62	-3.7	-2
BE	244.36	220.91	198.89	-9.6	-10.0	5.25	3.82	4.09	-27.3	7
FR	237.86	216.89	211.19	-8.8*	-2.6	3.98	3.73	2.82	-6.2	-24
DE	245.69	223.48	206.37	-9.0*	-7.7*	5.31	4.27	4.19	-19.6*	-'
LU	218.18	111.42	126.65	-48.9	13.7	0.88	1.76	1.62	98.8	-7
NL	306.18	257.29	234.49	-16.0*	-8.9	4.66	4.63	3.03	8	-3
СН	274.24	272.00	251.67	8	-7.5	4.22	2.95	2.02	-30.2	-3
IE	247.00	198.95	184.09	-19.5*	-7.5	6.28	2.53	3.18	-59.7*	2
GB	346.07	305.01	256.65	-11.9*	-15.9*	6.33	5.65	4.96	-10.7	-1
GR	305.19	218.33	222.92	-28.5*	2.1	5.54	5.36	4.62	-3.4	-1
IT	299.93	256.16	224.78	-14.6*	-12.2*	4.96	4.05	4.15	-18.4	2
PT	300.62	219.72	219.56	-26.9*	1	8.41	3.92	4.19	-53.4*	6
ES	272.67	231.74	204.24	-15.0*	-11.9*	6.23	5.13	3.59	-17.6	-30
CZ	259.40	209.92	166.61	-19.1*	-20.6*	4.74	4.43	3.24	-6.7	-2
EE	394.90	262.22	139.38	-33.6*	-46.8*	6.91	4.89	7.25	-29.3	48
HU	530.50	406.91	348.94	-23.3*	-14.2*	7.03	6.18	5.80	-12.2	-6
LV	561.36	440.42	324.98	-21.5*	-26.2*	7.23	6.54	3.42	-9.5	-4
LT	412.34	342.21	225.15	-17.0	-34.2*	7.14	5.92	5.34	-17.2	-(
PL	488.86	400.92	315.70	-18.0*	-21.3*	7.81	8.35	6.69	6.9	-1
SK	432.24	373.71	345.44	-13.5	-7.6	13.09	11.08	9.26	-15.3	-1
SI	270.48	203.78	143.64	-24.7	-29.5	5.01	3.69	3.87	-26.3	4
AU	290.88	261.16	212.74	-10.2*	-18.5*	5.13	4.43	3.40	-13.6	-2
NZ	317.89	286.41	294.76	-9.9	2.9	5.14 🦯	4.98	6.23	-3.1	24
All	332.78	295.17	240.22	-11.3*	-18.6*	6.27	5.43	4.73	-13.4	-1

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.

			5–9 Years					10–14 Year	S	
Country	Yearly A	Amenable M Rate	lortality	% Chang	e (95% CI)	Yearly	Amenable M Rate	Mortality	% Change	e (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
СН	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

Table 2 Yearly Amenable Mortality Rates (Per 100,000) for Ages 5–9 and 10–14 Years in 34 OECD

Table T Tearry Ameridable Mol	Traility Rates (Fer 100,000) of	Conditions Originating in Early	Neonalal Period for Age <1 in	34 OECD Countries, 2001/2005	5, 2006/2010 and 2011/2015
Country	Rate 2001/2005	Rate 2006/2010	Rate 2011/2015	% Change 2006/10 – 2001/05	% Change 2011/15 – 2006/1
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	230.8	193.8	-99(-184 -15)*	-192(-279-104)*

44 45

46

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

1	Country	Rate 2001/2005	Rate 2006/2010	Rate 2011/2015	% Change 2006/10 – 2001/05	% Change 2011/15 – 2006/10
2	Canada	36.7	34.6	33.0	-5.6 (-29.1, 17.9)	-4.8 (-28.5, 18.9)
3	Chile	91.6	79.8	80.9	-12.9 (-29.6, 3.7)	1.3 (-18.5, 21.2)
4	United States of America	41.6	35.8	33.5	-13.9 (-19.9, -7.9) *	-6.5 (-13.4, .4)
5	Israel	45.3	38.8	37.2	-14.4 (-44.6, 15.9)	-4.0 (-37.9, 29.9)
7	Japan	51.5	39.7	32.0	-22.9 (-32.6, -13.3) *	-19.3 (-30.9, -7.7) *
, 8	Republic of Korea	59.3	38.3	32.1	-35.4 (-47.7, -23.1) *	-16.2 (-35.0, 2.5)
9	Austria	43.1	35.9	31.6	-16.6 (-58.7, 25.5)	-12.1 (-59.6, 35.5)
10	Belgium	40.8	29.1	28.2	-28.6 (-59.7, 2.4)	-2.9 (-47.8, 42)
11	Czechia	34.4	29.5	21.1	-14.2 (-55.6, 27.2)	-28.5 (-66.3, 9.3)
12	Denmark	48.9	25.4	26.1	-47.9 (-79.0, -16.8) *	2.7 (-69.0, 74.3)
13	Estonia	68.9	59.4	26.8	-13.8 (-92.5, 64.9)	-55.0 (-108.8, -1.2) *
14	Finland	37.9	26.6	20.3	-29.8 (-75.4, 15.8)	-23.5 (-80.9, 33.8)
15 16	France	37.3	34.4	29.0	-7.6 (-23.0, 7.9)	-15.8 (-30.8,8) *
10	Germany	44.2	33.6	30.6	-24.0 (-36.9, -11.1) *	-8.9 (-26.0, 8.2)
18	Greece	71.7	43.5	40.9	-39.3 (-61.1, -17.5) *	-6.0 (-45.1, 33.0)
19	Hungary	75.6	69.0	62.6	-8.7 (-39.2, 21.8)	-9.3 (-41.5, 22.9)
20	Iceland	4.8	21.2	13.5	343.2 (-1784.6, 443.2)	-36.5 (-239.8, 63.5)
21	Ireland	46.8	38.9	36.2	-16.9 (-61.1, 27.3)	-6.9 (-57.0, 43.2)
22	Italy	57.1	41.8	36.0	-26.8 (-39.2, -14.4) *	-13.9 (-30.5, 2.6)
23	Latvia	119.2	77.6	42.6	-34.9 (-75.0, 5.2)	-45.1 (-89.9,2) *
24	Lithuania	99.8	79.3	45.4	-20.5 (-63.2, 22.1)	-42.7 (-80.6, -4.8) *
25 26	Luxembourg	15.0	0	13.3	-100 (., 0)	N/A
20	Netherlands	47.6	38.4	28.7	-19.4 (-44.2, 5.5)	-25.3 (-52.3, 1.8)
28	Norway	38.4	23.0	22.0	-39.9 (-80.4, .6)	-4.6 (-76.6, 67.4)
29	Poland	91.5	69.2	67.0	-24.4 (-36.5, -12.2) *	-3.2 (-19.8, 13.4)
30	Portugal	47.7	33.9	32.0	-29.0 (-59.3, 1.3)	-5.5 (-52.3, 41.2)
31	Slovakia	70.2	64.2	67.4	-8.6 (-50.5, 33.4)	5.0 (-42.7, 52.7)
32	Slovenia	55.5	29.1	17.6	-47.5 (-100.8, 5.8)	-39.5 (-117.2, 38.2)
33	Spain	54.1	41.7	31.2	-23.1 (-37.5, -8.6) *	-25.2 (-41.4, -9.1) *
34	Sweden	29.3	20.2	13.0	-31.1 (-69.5, 7.2)	-35.8 (-78.1, 6.5)
35 26	Switzerland	46.4	34.2	39.2	-26.4 (-64.1, 11.3)	14.8 (-44.9, 74.5)
30 37	United Kingdom	42.1	36.2	33.3	-13.8 (-28.0, .4)	-8.1 (-23.6, 7.3)
38	Australia	33.7	32.5	24.7	-3.7 (-32.2, 24.8)	-24.0 (-47.2,7) *
39	New Zealand	40.6	37.2	30.6	-8.4 (-61.3, 44.5)	-17.8 (-67.9, 32.2)
40	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 really Amenable Monally Rales (Per 100,000) of Pheumonia for Age <1 in 34 OECD Countries, 2001/2005, 2006/2010 and 201
--

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)

42 43

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 - 2006/1
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)

Table 5 Yearly	Amenable Mortality	Rates (Per 100 000	of Ne	nhritis and Ne	obrosis for Aa	e <1 in 34 OECD	Countries	2001/2005	2006/2010 and 2011/2015
				01110	printis and ric			Countines	, 2001/2003,	2000/2010 and 2011/2013

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 /	6	100(1141 742)	-58.2 (-131.3, 14.0)

42 43

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	

 BMJ Open

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	
Results	I		
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	I	·	
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 Cooperation and Development (OECD): evidence from a 15year 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				
	·				

SCHOLARONE[™] Manuscripts
2		
3 ⊿	1	Patterns of amenable child mortality over time in 34 member countries of the Organisation for
- 5 6	2	Economic Co-operation and Development (OECD): evidence from a 15-year time trend analysis (2001-
7 8	3	2015)
9 10	4	Authors:
11 12	5	Maria Michela Gianino ^a , Jacopo Lenzi ^b , Marco Bonaudo ^a , Maria Pia Fantini ^b , Roberta Siliquini ^a ,
13 14	6	Walter Ricciardi ^{cd} , Gianfranco Damiani ^{cd} .
15 16 17	7	
18 19	8	Maria Michela Gianino, Professor
20 21	9	a) Department of Public Health Sciences and Pediatrics, Università di Torino
22 23 24	10	Via Santena 5 bis - 10126 Turin (Italy)
25 26	11	Tel #: +39(0)116705839 - Fax #: +39(0)116705889
27 28	12	mariola.gianino@unito.it
29 30 31	13	
32 33	14	Jacopo Lenzi, PhD
34 35	15	b) Department of Biomedical and Neuromotor Sciences, Alma Mater Studiorum - Università di
36 37 38	16	Bologna
39 40	17	Via Ugo Foscolo 7 - 40123 Bologna (Italy)
41 42	18	Tel #: +39(0)512094836
43 44 45	19	jacopo.lenzi2@unibo.it
46 47	20	
48 49	21	Marco Bonaudo, MSN
50 51 52	22	a) Department of Public Health Sciences and Pediatrics, Università di Torino
53 54	23	Via Santena 5 bis - 10126 Turin (Italy)
55 56	24	Tel #: +39(0)116705839 - Fax #: +39(0)116705889
57 58	25	marco.bonaudo@unito.it
60	26	

2 3 4	27
5 6	28
7 8 0	29
9 10 11	30
12 13	31
14 15 16	32
17 18	33
19 20	34
21 22 23	35
24 25	36
26 27	37
28 29 20	38
31 32	39
33 34	40
35 36 27	41
38 39	42
40 41	43
42 43	44
44 45 46	45
47 48	46
49 50 51	47
52 53	48
54 55	49
56 57 58	50
59 60	51

Maria Pia Fantini, MD, Professor

b) Department of Biomedical and Neuromotor Sciences, Alma Mater Studiorum - Università di 28

Bologna 29

- Via Ugo Foscolo 7 40123 Bologna (Italy) 30
- Tel #: +39(0)512094836 31
- mariapia.fantini@unibo.it 32
- 33

1

Roberta Siliquini, Professor 34

a) Department of Public Health Sciences and Pediatrics, Università di Torino 35

36 Via Santena 5 bis - 10126 Turin (Italy)

37 Tel #: +39(0)116705812

roberta.siliquini@unito.it 38

Walter Ricciardi, MD, Professor 40

- c) Fondazione Policlinico Universitario 'Agostino Gemelli' IRCCS, Roma, Italia 41
- Largo Agostino Gemelli 8 00168 Roma (Italia) 42
- 43 Tel #: +39(0)630154396
- 44 walter.ricciardi@unicatt.it
 - and 45
 - d) Istituto di Sanità Pubblica, Università Cattolica del Sacro Cuore, Roma, Italia 46
 - Largo Francesco Vito 1 00168 Roma (Italia) 47

48 Tel #: +39(0)630154396

49 walter.ricciardi@unicatt.it

Gianfranco Damiani MD, Professor 51

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

1		
2	гa	Large Agestine Camelli 9, 00168 Rome (Italia)
4	53	Largo Agostino Gemeni 8 - 00108 Koma (nana)
5	54	Tel #: +39(0)630154396
6 7		
8	55	gianfranco.damiani@policlinicogemelli.it
9		
10	56	and
12	57	d) Istituto di Sanità Pubblica, Università Cattolica del Sacro Cuore, Roma, Italia
13	57	dy isituto di Sunta i dobica, Oniversita Cattorica dei Sacio Cuore, Roma, Italia
14 15	58	Largo Francesco Vito 1 - 00168 Roma (Italia)
16		
17	59	Tel #: +39(0)630154396
18 19	60	sign france demissi Quainst it
20	60	giantranco.damiani@unicatt.it
21	61	
22 23	01	
24	62	Corresponding Author:
25		
26 27	63	Marco Bonaudo, MSN
28	~ •	
29	64	a) Department of Public Health Sciences and Pediatrics, Universita di Torino
30 21	65	Via Santena 5 his - 10126 Turin (Italy)
32	05	via Santena 5 bis 10120 runn (nary)
33	66	Tel #: +39(0)116705839 - Fax #: +39(0)116705889
34 25		
35 36	67	marco.bonaudo@unito.it
37	60	
38	68	
39 40	69	Words count paper: 3077
41	00	
42	70	Words count abstract: 273
45 44		
45	71	
46	72	
47 48	12	
49	73	
50		
51 52	74	
53	75	
54	15	
55 56	76	
57		
58	77	
59 60	70	
00	/ð	

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, 54 101 encouraging high-quality healthcare and knowledge, financing universal access to healthcare, and 56 102 adopting best practice guidelines might help reduce amenable child mortality.

Strengths and limitations of this study:

2 3 105	1. This is the first study to analyse trends in child mortality amenable to healthcare.
4 5 6 106	2. Thirty-four OECD countries were included in the analyses to provide a thorough depiction of
7 8 107	amenable child mortality in high-income economies.
9 10 108 11	3. Mortality was not disaggregated by ethnicity or socioeconomic characteristics.
¹² 13 109	4. Making international comparisons is difficult due to variations in birth registration laws and
14 15 110	death certification practices.
16 17 111 18	
¹⁹ 112 20	Key words: Amenable mortality, child, childhood, healthcare, healthcare services, OECD countries
21 22	
23 24	
25 26	
27 28	
29	
30 31	
32 33	
34 35	
36	
37 38	
39 40	
41 42	
42	
44 45	
46 47	
48	
49 50	
51 52	
53	
54 55	
56 57	
58	
59 60	

113 **INTRODUCTION**

5 114 6

118 15 16

1 2 3

4

7

11 12 117

13 14

20 21

23

25

27 28

29 30

32

34 35

36 37

39

41

51

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 120 ₂₂ 121 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 24 122 ²⁶ 123 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] 124 In the landscape described, the mortality burden conditioned by the performance of the healthcare 31 125 33 126 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 127 ₃₈ 128 amenable mortality.

Amenable mortality is defined as deaths that, in the light of medical knowledge and 40 129 42 130 technology at the time of death, could be prevented by timely access to good quality care. The concept 43 44 45 131 of mortality amenable to healthcare finds its origins in the evolution of the concept of avoidable 46 mortality, developed by Rutstein et al., who created a list of conditions that were considered either 47 132 48 49 treatable or preventable through healthcare services given the current medical knowledge and 133 50 technology.[10] Rutstein was the first to introduce the term amenable mortality, differentiating 134 52 53 54 135 between causes which are responsive to medical intervention through treatment and 55 56 136 secondary/tertiary prevention actions (e.g., cervical cancer, hypertensive disease or appendicitis), and 57 58 137 causes responsive to actions beyond healthcare services (preventable conditions such as lung cancer 59 60 138 and liver cirrhosis).

Page 7 of 35

1 2

BMJ Open

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 \geq \$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

1

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.

BMJ Open

2	
3 189 4	All data were analysed using the Stata software package, version 15 (StataCorp. 2017. Stata
5 6 190	Statistical Software: Release 15. College Station, TX: StataCorp LLC). The significance level was
/ 8 191	set at .05.
9 10 <u>192</u> 11	
¹² 13 193	Ethics statement
14 15 194	This descriptive study involved aggregate data that exist in the public domain, where it is not possible
17 195 18	to identify individuals from the information provided. For this reason, this research did not require
19 20	ethical approval.
21 22 197	
23 24 198 25	Patient and public involvement
²⁶ 199 27	Patients and the public were not involved in the design or planning of the study.
²⁸ 29 200	
30 31 201 32	RESULTS
33 202 34	
³⁵ 203 36	All-cause amenable child mortality rates
37 38 204	The results of the trend analyses conducted over the five-year periods 2001/05, 2006/10 and 2011/15
39 40 205 41	are presented in Figure 1 and in online supplementary file 3. The amenable mortality rate of the
⁴² 206 43	OECD population with <1 year dropped significantly from 2001/05 to 2006/10 (332.78 to 295.17 per
44 45 207	$100,000, \% \Delta = -11.3\%$) and from 2006/10 to 2011/15 (295.17 to 240.22 per 100,000, % \Delta = -18.6\%).
46 47 208 48	Contrary to the OECD rate of children aged <1 year, in the population aged \geq 1 year the overall OECD
49 209 50	rate did not decrease significantly. From 2001/05 to 2006/10 and from 2006/10 to 2011/15, the
51 52 210	mortality rates decreased by 13.4% and 13.0%, respectively, in the 1-4 age group; by 11.9% and
53 54 211 55	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
56 212 57	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
⁵⁸ 213 59	100,000 for the 10-14 age group.
~~	

,

2		
3	215	
4	215	
5		
6	216	
7		
, 8	217	
0		
9		
10	218	
11		
12	219	
13		
14		
15	220	
16		
17	221	
18		
19		
20	222	
20		
21	223	
22	-	
23	~~ ~	
24	224	
25		
26	225	
27		
28	220	
29	226	
30		
31	227	
32		
33	220	
31	220	
25	229	
22		
30		
37		
38		
39		
40		
41		
42		
43		
44		
45		
46		
۰.0 47		
رب ۱۵		
40		
49		
50		
51		
52		
53		
54		
55		
56		
57		
58		
59		

1

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

 $^{5}_{222}$ (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.

	2001/05		2006/10		2011/15	
Cause of Death	Rank	%	Rank	%	Rank	%
<1 Year	(n = 19	0,169.5)	(n = 175,008)		(n = 10	5,210.5)
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	Epilepsy #9 0.17 Whooping cough #11* 0.11		#9	0.17	#9	0.23
Whooping cough			#12*	0.10	#10	0.19
Other causes	-	0.46	-	0.46	-	0.39
1–4 Years	(n = 1	4,438)	(n = 1	2,738)	(n = 8	491.5)
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

1	
2	
3	
4	
5	
6	
7	
8	
9	
1	
1	
1	
1	
1	

35 36

37 38

39 40

42

44 45

46 47

49

51 52

53 54

56

58

60

		1	1	1		1
5–9 Years	(n = 7705) $(n = 6706)$		(n = 4541)			
Leukaemia	#1	31 72	#1	28 35	#1	$\frac{10}{2}$
All respiratory diseases, excl. pneumonia/influenza	#3	12.91	#2	16.28	#2	1
Congenital cardiovascular anomalies	#2	14.91	#3	13.67	#3	1
Epilepsy	#5	7.81	#5	7.86	#4	1
Pneumonia	#4	8.58	#4	7.90	#5	9
Cerebrovascular diseases	#6	6.87	#6	7.13	#6	(
Septicaemia	#7	5.15	#7	5.67	#7	4
Influenza	#9	1.66	#8	2.54	#8	2
Conditions originating in the early neonatal period	#8	2.25	#9	2.48	#9	2
Intestinal infections other than typhoid, diphtheria	#13†	0.87	#12†	1.25	#10	2
Other causes	-	7.26	-	6.87	-	(
10–14 Years	(n =	9109)	(n = '	7579)	(n =	492
Leukaemia	#1	31.30	#1	30.01	#1	3
All respiratory diseases, excl. pneumonia/influenza	#3	13.66	#2	15.28	#2	1
Congenital cardiovascular anomalies	#2	14.13	#3	12.17	#3	1
Epilepsy	#5	7.73	#5	7.89	#4	1
Cerebrovascular diseases	#4	8.12	#4	8.99	#5	9
Pneumonia	#6	7.59	#6	6.73	#6	1
Septicaemia	#7	4.17	#7	4.92	#7	4
Diabetes mellitus	#8	2.49	#8	2.31	#8]]
Influenza	#11‡	1.15	#9	2.15	#9	1
Conditions originating in the early neonatal period	#10	1.57	#11‡	1.78	#10	1
Other causes	-	8.09	-	7.78	-	5

* 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%). 30 231

₃₁ 232 * Nephritis and nephrosis were ranked #9 in 2001/05 (1.79%) and #10 in 2006/10 (1.91%). ₃₂ 233

Country-specific amenable child mortality rates 34 234

As shown in Figure 1 and online supplementary file 3, the amenable mortality rate for the population 235 aged <1 year dropped significantly over the entire study period in 15 countries (United States, Israel, 236 Japan, South Korea, Czechia, Estonia, Germany, Italy, Latvia, Hungary, Poland, Spain, Austria, 41 237 43 238 United Kingdom and Australia). In addition to the decrease in conditions originating in the early 239 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 48 240 Poland, and congenital cardiovascular anomalies in Japan and Spain. See online supplementary file 50 241 242 4 for country-specific and cause-specific mortality rates in the <1-year population.

₅₅ 243 Although the overall OECD rate did not decrease significantly in the population aged ≥ 1 year, 57 244 some country-specific data exhibited significant trends (Figure 1). However, no country showed a ⁵⁹ 245 significant linear decline in mortality over the entire study period for all age groups (Figure 1).

247 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 248 Countries, 2001/2005, 2006/2010 and 2011/2015 (See Online Supplementary File 1 for Country-Level Data 249 Availability) 250

251 * Percentage decrease is statistically significant (P<.05). 252 253

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,

10 255 Sweden; CH, Switzerland; GB, United Kingdom; AU, Australia; NZ, New Zealand. 11 256

13 257 DISCUSSION

1 2 3

4

5

6

7

8

9 254

12

17

19

21 22

23 24

26

28 29

30 31

32 33

35

37 38

39 40

42

44

18 259 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 20 260 261 the other age groups. These results confirm the trend shown by previous studies conducted on six ₂₅ 262 OECD countries that had been selected to provide a variety of forms of healthcare delivery between 27 263 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. 264

These results are driven by the fact that the only significantly reduced cause of death was 265 conditions originating in the early neonatal period in the <1-year group. Surprisingly, the decline was 34 266 ³⁶ 267 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 268 countries are Japan, which showed an improvement in its performance despite starting from low 41 269 values in 2001/05, and Hungary and the US, which showed high amenable mortality rates in 2001/05. 43 270

45 The results concerning country-specific amenable child mortality rates showed that the 271 46 47 ₄₈ 272 reductions in the age-specific rates were not evenly distributed across OECD countries. There was 49 not a single cause for which the age-specific mortality rates declined in the countries studied, and the 50 273 51 ⁵² 274 success in reducing mortality rates was not consistent for all causes. These achievements corroborate 53 54 275 another of our results, highlighting that the causal distribution of the age-specific mortality rates did 55 56 57 276 not vary over the period examined and that, namely, the conditions originating in the early neonatal 58 ⁵⁹ 277 period, congenital cardiovascular anomalies, pneumonia, leukaemia, and all respiratory diseases 60 278 (excl. pneumonia/influenza) were consistently top-ranked. Because these are the main causes related Page 13 of 35

BMJ Open

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 284 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 286 ongoing communication and coordination between primary care and subspecialty services. It would 287 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 290 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 293 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

1

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 325 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 326 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, 329 a third line of evidence referring to improving high-risk obstetric care has been associated with 330 decreases in neonatal mortality.[46,53]

Page 15 of 35

1

BMJ Open

2 3	331
4 5 5	332
7	222
9	555
10 11	334
12 13	335
14 15	336
16 17	337
18 19	338
20 21 22	339
23 24	340
25 26	341
27 28	
29 30	342
31 32	343
33	344
35 35	345
37 38	346
39 40	347
41 42	3/18
43 44	340
45 46	349
47 48	350
49 50	351
51 52	352
53 54	353
55	354
57 58 59	355
50	256

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 356

> 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.

For peer review only - http://bmjopen.bmj.com/site/about/guidelines.xhtml

1	
2 3 369 4	DECLARATIONS
5 6 370	Ethics approval and consent to participate
/ 8 371 9	Not applicable.
10 372 11	Availability of data and materials
12 13 14	The datasets used and/or analysed during the current study are available from the corresponding
14 15 374 16	author on reasonable request.
17 375 18	Competing interests
¹⁹ 376 20	The authors declare that they have no competing interests.
21 22 377 23	Funding
24 378 25	This research received no specific grant from any funding agency in the public, commercial or not-
26 379 27 28	for-profit sectors.
20 29 380	Acknowledgements
30 31 381 32	Data for this study came from the World Health Organization. All analyses, interpretations and
33 382 34	conclusions are credited to the authors of this study, not to the World Health Organization.
³⁵ 36	Author Contributions
37 38 384 39	MMG and GD formulated the research goals and supervised the research activity; MMG, GD, JL
40 385 41	defined the design of the methodology; MMG wrote the article; RS, WR and MPF revised the
42 43 44	article; MB collected the data and managed the database; JL utilised statistical techniques to analyse
44 45 387 46	the study data.
47 388 48 49 50 51 52 53 54 55 55	All authors have read and approved the manuscript.
50 57	
58	
59 60	

2 3 3 4	389	RE	FERENCES
5 6 3	390	1	Blum RW, Nelson-Mmari K. The health of young people in a global context. J Adolesc Health
7 8 3	391		Off Publ Soc Adolesc Med 2004;35:402-18. doi:10.1016/j.jadohealth.2003.10.007
9 10 3 11	392	2	WHO. Children: reducing mortality. http://www.who.int/news-room/fact-sheets/detail/children-
12 13	393		reducing-mortality (accessed 3 Oct 2018).
14 15 3	394	3	Fraser J, Sidebotham P, Frederick J, et al. Learning from child death review in the USA, England,
16 17 3 18	395		Australia, and New Zealand. Lancet Lond Engl 2014;384:894-903. doi:10.1016/S0140-
19 20	396		6736(13)61089-2
21 22 3	897	4	Kyu HH, Stein CE, Pinto CB, et al. Causes of death among children aged 5–14 years in the WHO
23 24 3 25	398		European Region: a systematic analysis for the Global Burden of Disease Study 2016. Lancet
26 3 27	399		Child Adolesc Health 2018;2:321-37. doi:10.1016/S2352-4642(18)30095-6
28 29 4	100	5	Sidebotham P, Fraser J, Covington T, et al. Understanding why children die in high-income
30 31 4 32	101		countries. The Lancet 2014;384:915-27. doi:10.1016/S0140-6736(14)60581-X
33 4 34	102	6	Alio AP, Richman AR, Clayton HB, et al. An ecological approach to understanding black-white
³⁵ 4 36	103		disparities in perinatal mortality. Matern Child Health J 2010;14:557-66. doi:10.1007/s10995-
37 38 4	104		009-0495-9
39 40 4 41	105	7	Gakidou E, Cowling K, Lozano R, et al. Increased educational attainment and its effect on child
42 43	106		mortality in 175 countries between 1970 and 2009: a systematic analysis. Lancet Lond Engl
44 45 4	107		2010; 376 :959–74. doi:10.1016/S0140-6736(10)61257-3
46 47 4 48	108	8	Lightfoot TJ, Johnston WT, Simpson J, et al. Survival from childhood acute lymphoblastic
49 50	109		leukaemia: the impact of social inequality in the United Kingdom. <i>Eur J Cancer</i> 2012; 48 :263–9.
51 52 4	10		doi:10.1016/j.ejca.2011.10.007
53 54 4 55	111	9	Gore FM, Bloem PJN, Patton GC, et al. Global burden of disease in young people aged 10-24
55 56 4 57	112		years: a systematic analysis. Lancet Lond Engl 2011;377:2093-102. doi:10.1016/S0140-
⁵⁸ 4	113		6736(11)60512-6
60			

3 1	414	10 Rutstein DD, Berenberg W, Chalmers TC, et al. Measuring the quality of medical care. A clinical										
4 5 6	415		method. N Engl J Med 1976;294:582-8. doi:10.1056/NEJM197603112941104									
7 8 9	416	11	Department of Health. The NHS Outcomes Framework 2011/12.									
10 11	417		$2010.https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_dattachme$									
12 13	418		ata/file/213789/dh_123138.pdf									
14 15 16	419	12	Page A, New Zealand, University of Adelaide, editors. Australian and New Zealand atlas of									
17 18	<i>avoidable mortality</i> . Adelaide, S. Aust.: : Public Health Information Developmen University of Adelaide 2006.											
19 20 21												
22 23	422	13	Holland WW. European Community atlas of "avoidable death." 1991.									
24 25	423	14	Nolte E, McKee CM. Measuring the health of nations: updating an earlier analysis. <i>Health Aff</i>									
26 27 28	424		<i>Proj Hope</i> 2008; 27 :58–71. doi:10.1377/hlthaff.27.1.58									
29 30	425	15	Gay JG, Paris V, Devaux M, <i>et al.</i> Mortality Amenable to Health Care in 31 OECD Countries:									
31 32	426		estimates and methodological Issues. Published Online First: 31 January 2011.									
33 34 35	427	16	doi:https://doi.org/10.1/8//5kgj35f9f8s2-en									
36 37	428	16	freurniet H, Boshuizen H, Hartelon P. Avoidable mortality in Europe (1980–1997): a comparison									
38 39	429	17	Nolta E. Makaa M. Variations in amonable martality, trands in 16 high income nations. <i>Health</i>									
40 41 42	430	1/	Policy Amet Nath 2011:103:47, 52, doi:10.1016/j.beslthpol.2011.08.002									
43 44	431	18	Mackenhach IP. Hoffmann R. Khoshaba B. <i>et al.</i> Using "amenable mortality" as indicator of									
45 46 47	432	10	healthcare effectiveness in international comparisons: results of a validation study. <i>I Epidemiol</i>									
48 49	433		Community Health 2013;67:139–46. doi:10.1136/jech-2012-201471									
50 51	435	19	Mackenbach JP Bouvier-Colle MH Jougla E "Avoidable" mortality and health services: a									
52 53 54	436	17	review of aggregate data studies. <i>J Epidemiol Community Health</i> 1990:44:106–11.									
55 56	437	20	Gianino MM, Lenzi J, Muca A, <i>et al.</i> Declining Amenable Mortality: Time Trend (2000-2013)									
57 58	438		and Geographic Area Analysis. <i>Health Serv Res</i> 2017; 52 :1908–27. doi:10.1111/1475-									
59 60	439		6773.12563									
	-											

2 3	440	21	Charlton JR, Velez R. Some international comparisons of mortality amenable to medical										
4 5 6	441		intervention. Br Med J Clin Res Ed 1986;292:295–301.										
7 8	442	22	James PD, Manuel DG, Mao Y. Avoidable mortality across Canada from 1975 to 1999. BMC										
9 10 11	443		Public Health 2006;6:137. doi:10.1186/1471-2458-6-137										
12 13	444	23	Pampalon R. Avoidable mortality in Québec and its regions. Soc Sci Med 1993;37:823-31.										
14 15	445		oi:10.1016/0277-9536(93)90376-F										
16 17 18	446	24	iers LS, Carson NJ, Brown K, et al. Avoidable mortality in Victoria between 1979 and 2001.										
19 20	447		lust N Z J Public Health 2007; 31 :5–12.										
21 22 22	448 25 Fantini MP, Lenzi J, Franchino G, <i>et al.</i> Amenable mortality as a performance indicator of Ita												
23 24 25	449		health-care services. BMC Health Serv Res 2012;12:310. doi:10.1186/1472-6963-12-310										
26 27	450	26	Tobias M, Jackson G. Avoidable mortality in New Zealand, 1981-97. Aust N Z J Public Health										
28 29	451		2001; 25 :12–20. doi:10.1111/j.1467-842X.2001.tb00543.x										
30 31 32	452	27	Schoenbaum SC, Schoen C, Nicholson JL, et al. Mortality amenable to health care in the United										
33 34	453		States: The roles of demographics and health systems performance. J Public Health Policy										
35 36 27	454		2011; 32 :407–29.										
37 38 39	455	28	World Bank. World Development Indicators DataBank.										
40 41	456		2018.http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators										
42 43	457		(accessed 3 Oct 2018).										
44 45 46	458	29	World Health Organization. WHO Mortality Database.										
47 48	459		2018.http://www.who.int/healthinfo/mortality_data/en/ (accessed 3 Oct 2018).										
49 50	460	30	United Nations. Demographic Statistics Database.										
51 52 53	461		2018.http://data.un.org/Data.aspx?d=POP&f=tableCode%3A22 (accessed 3 Oct 2018).										
54 55	462	31	Nolte E, McKee M. Does health care save lives? Avoidable mortality revisited. The Nuffield										
56 57	463		Trust 2004. http://researchonline.lshtm.ac.uk/15535/ (accessed 3 Oct 2018).										
58 59 60	464	32	Eurostat. Amenable and preventable deaths of residents.										
00	465		https://ec.europa.eu/eurostat/web/products-datasets/-/hlth_cd_apr (accessed 3 Oct 2018).										

Page 21 of 35

BMJ Open

1 2			
3 4	466	33	Hildebrandt M, Bender R, Gehrmann U, et al. Calculating confidence intervals for impact
5 6	467		numbers. BMC Med Res Methodol 2006;6:32. doi:10.1186/1471-2288-6-32
7 8	468	34	Wolfe I, Thompson M, Gill P, et al. Health services for children in western Europe. Lancet Lond
9 10 11	469		Engl 2013; 381 :1224–34. doi:10.1016/S0140-6736(12)62085-6
12 13	470	35	Expert Panel on Effective Ways of Investing in Health. Definition of a frame of Reference in
14 15	471		relation to Primary Care with a special emphasis on Financing Systems and Referral Systems.
16 17	472		2014.https://ec.europa.eu/health/expert_panel/sites/expertpanel/files/004_definitionprimarycare
19 20	473		_en.pdf (accessed 2 Mar 2019).
21 22	474	36	Adams J, Woods E. Redesign of chronic illness care in children and adolescents. Curr Opin
23 24	475		Pediatr 2016;28:428-33. doi:10.1097/MOP.000000000000368
25 26 27	476	37	Britto MT, Vockell A-LB, Munafo JK, et al. Improving outcomes for underserved adolescents
28 29	477		with asthma. Pediatrics 2014;133:e418-427. doi:10.1542/peds.2013-0684
30 31	478	38	Mangione-Smith R, Schonlau M, Chan KS, et al. Measuring the effectiveness of a collaborative
32 33 34	479		for quality improvement in pediatric asthma care: does implementing the chronic care model
35 36	480		improve processes and outcomes of care? Ambul Pediatr Off J Ambul Pediatr Assoc 2005;5:75-
37 38	481		82. doi:10.1367/A04-106R.1
39 40	482	39	Hertel-Fernandez AW, Giusti AE, Sotelo JM. The Chilean infant mortality decline: improvement
41 42 43	483		for whom? Socioeconomic and geographic inequalities in infant mortality, 1990-2005. Bull
44 45	484		World Health Organ 2007; 85 :798–804.
46 47	485	40	Rodrigo A, van der Veer R, Vermeer HJ, et al. From foundling homes to day care: a historical
48 49 50	486		review of childcare in Chile. Cad Saúde Pública;30:461-72.
51 52	487	41	OECD. State of Health in the EU Slovak Republic: Country Health Profile 2017 - European
53 54	488		Observatory on Health Systems and Policies. 2017.
55 56	489	42	Katz M, Rubino A, Collier J, et al. Demography of pediatric primary care in Europe: delivery of
57 58 59 60	490		care and training. <i>Pediatrics</i> 2002; 109 :788–96.

1 2												
2 3 4	491	43	Pearson GA, Ward-Platt M, Harnden A, et al. Why children die: avoidable factors associated with									
5 6	492		child deaths. Arch Dis Child 2011;96:927-31. doi:10.1136/adc.2009.177071									
/ 8 9	493	44	van Esso D, del Torso S, Hadjipanayis A, et al. Paediatric primary care in Europe: variation									
10 11	494		etween countries. Arch Dis Child 2010;95:791–5. doi:10.1136/adc.2009.178459									
12 13	495	45	Villiams RL, Chen PM. Identifying the Sources of the Recent Decline in Perinatal Mortality									
14 15 16	496		Rates in California. N Engl J Med 1982;306:207–14. doi:10.1056/NEJM198201283060404									
17 18	497	46	Richardson DK, Gray JE, Gortmaker SL, et al. Declining severity adjusted mortality: evidence									
19 20	498		of improving neonatal intensive care. <i>Pediatrics</i> 1998;102:893–9.									
21 22 23	499	47	Horbar JD, Wright LL, Soll RF, et al. A multicenter randomized trial comparing two surfactants									
24 25	500		for the treatment of neonatal respiratory distress syndrome. National Institute of Child Health and									
26 27	501		Human Development Neonatal Research Network. J Pediatr 1993;123:757-66.									
28 29	502	48	Vermont-Oxford Neonatal Network. A multicenter, randomized trial comparing synthetic									
30 31 32	503		surfactant with modified bovine surfactant extract in the treatment of neonatal respiratory distress									
33 34	504		syndrome. <i>Pediatrics</i> 1996; 97 :1–6.									
35 36	505	49	Clark RH, Yoder BA, Sell MS. Prospective, randomized comparison of high-frequency									
37 38 30	506		oscillation and conventional ventilation in candidates for extracorporeal membrane oxygenation.									
40 41	507		J Pediatr 1994; 124 :447–54.									
42 43	508	50	Rastogi A, Akintorin SM, Bez ML, et al. A Controlled Trial of Dexamethasone to Prevent									
44 45	509		Bronchopulmonary Dysplasia in Surfactant-treated Infants. Pediatrics 1996;98:204-10.									
40 47 48	510	51	Phibbs CS, Baker LC, Caughey AB, et al. Level and volume of neonatal intensive care and									
49 50	511		mortality in very-low-birth-weight infants. N Engl J Med 2007;356:2165-75.									
51 52	512		doi:10.1056/NEJMsa065029									
53 54 55	513	52	Paneth N. Technology at birth. Am J Public Health 1990;80:791–2.									
56 57	514	53	Alfirevic Z, Neilson JP. Doppler ultrasonography in high-risk pregnancies: systematic review									
58 59 60	515		with meta-analysis. Am J Obstet Gynecol 1995;172:1379–87.									

Page 23 of 35

BMJ Open

1			
2 3 4	516	54	Kuchna D, Hovsepyan A, Leonard S. Preventing Newborn Deaths In Romania And Hungary.
5 6	517		Health Aff (Millwood) 2017;36:1160–1160. doi:10.1377/hlthaff.2017.0382
7 8	518	55	Maeda K. Progress of Perinatal Medicine in Japan. J Health Med Inform 2013;s11.
9 10 11	519		doi:10.4172/2157-7420.S11-002
12 13	520	56	Kramer MS, Platt RW, Yang H, et al. Registration artifacts in international comparisons of infant
14 15	521		mortality. Paediatr Perinat Epidemiol 2002;16:16-22. doi:10.1046/j.1365-3016.2002.00390.x
16 17 18	522	57	Joseph KS, Liu S, Rouleau J, et al. Influence of definition based versus pragmatic birth
19 20	523		registration on international comparisons of perinatal and infant mortality: population based
21 22	524		retrospective study. The BMJ 2012;344. doi:10.1136/bmj.e746
23 24 25	525	58	Mohangoo AD, Blondel B, Gissler M, et al. International Comparisons of Fetal and Neonatal
25 26 27	526		Mortality Rates in High-Income Countries: Should Exclusion Thresholds Be Based on Birth
28 29	527		Weight or Gestational Age? PLOS ONE 2013;8:e64869. doi:10.1371/journal.pone.0064869
30 31	528	59	Schwartz E, Kofie VY, Rivo M, et al. Black/white comparisons of deaths preventable by medical
32 33 34	529		intervention: United States and the District of Columbia 1980-1986. Int J Epidemiol
35 36	530		1990; 19 :591–8. doi:10.1093/ije/19.3.591
37 38	531	60	Macinko J, Elo IT. Black-white differences in avoidable mortality in the USA, 1980-2005. J
39 40	532		Epidemiol Community Health 2009;63:715-21. doi:10.1136/jech.2008.081141
41 42 43	533	61	Riddell CA, Harper S, Kaufman JS. Trends in Differences in US Mortality Rates Between Black
44 45	534		and White Infants. JAMA Pediatr 2017;171:911-3. doi:10.1001/jamapediatrics.2017.1365
46 47	535		
48 49			
50			
51			
52 53			
54			
55			
56			
57			
28 29			
60			



BMJ Open

3 ⊿	Table 1 Data A	vailat	oility f	or the	e 34 C	DECD	Cou	ntries	<u>; (0 "N</u>	Not A	vailab	le"/1	"Avai	ilable'	')		
				1					Year								
5																	
0	Country	5	02	33	4)5	90	27	98	60	0	Ξ	2	3	4	15	Total
/		20(200	200	200	200	500	500	200	500	Ś	Ś	Ś	20	20,	20,	
8																	
9	0			4							4				0	0	40
10	Canada	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	13
11	Chile	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
12	United States	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	12
13	of America							_	4	_	_						4.5
14	Israel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
15	Japan	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
16	Republic of	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
17	Korea																
18	Austria	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
19	Belgium	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
20	Czechia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
21	Denmark	1	1	1	F1	1	1	1	1	1	1	1	1	1	1	1	15
22	Estonia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
23	Finland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
24	France	1	1	1 🖣	1	1	1	1	1	1	1	1	1	1	1	0	14
25	Germany	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
26	Greece	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
27	Hungary	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
28	Iceland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
29	Ireland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	0	14
30	Italy	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
31	Latvia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
32	Lithuania	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
33	Luxembourg	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
34	Netherlands	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
35	Norway	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
36	Poland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
37	Portugal	1	1	1	0	0	0	1	1	1	1	1	1	1	1	0	11
38	Slovakia	1	1	1	1	1	1	1	1	1	1	0	1	1	1	0	13
39	Slovenia	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
40	Spain	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
41	Sweden	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
42	Switzerland	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
43	United																4.5
44	Kingdom	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	15
45	Australia	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	14
46	New Zealand	1	1	1	1	1	1	1	1	1	1	1	1	1	0	0	13
47	All OECD	<u> </u>	<u> </u>	<u> </u>				~ (~ ~	<u> </u>		~ ~			00	10.1
48	countries	34	34	34	33	32	33	34	34	34	34	32	34	33	31	28	494
	Notos: Causos of	death	are co	dod o	coordir	a to t			uctria	2001.	Groop	- 200 <i>°</i>	1/2012	· Irolar	-d 200	1/2000	S: Itoly

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

	•	D .	ICD-9	ICD-10
Disease category	Age	Diseases	codes	codes
	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
Infectious diseases	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
	0-74	Colorectal cancer	153-4	C18-21
	0-74	Malignant neoplasm of skin	173	C44
	0-74	Breast cancer	174	C50
Cancers	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	0-74	Thyroid disorders	240-6	E00-7
and metabolic diseases	0-49	Diabetes mellitus	250	E10-4
Diseases of the nervous system	0-74	Epilepsy	345	G40-1
	0-74	Rheumatic heart diseases	393-8	105-9
Diseases of the	0-74	Ischemic heart diseases: 50% of deaths	410-4	120-5
circulatory system	0-74	Cerebrovascular diseases	430-8	160-9
	0-74	Hypertensive diseases	401-5	110-3, 115
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
	0-74	Peptic ulcer	531-3	K25-7
Diseases of the digestive	0-74	Appendicitis	540-3	K35-8
system	0-74	Abdominal hernia 🧼	550-3	K40-6
	0-74	Cholelithiasis and cholecystitis	574-5	K80-1
	0-74	Maternal deaths	630-76	O00-99
Perinatal mortality	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.

1	
2	
3	
4	
5	
6	
7	
8	
9	
1	(
1	

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	Yearly A	menable M Rate	lortality	% Change	e (95% CI)	Yearly A	Amenable M Rate	% Change (95%		
•	2001/05	2006/10	2011/15	2006/10– 2001/05	2011/15– 2006/10	2001/05	2006/10	2011/15	2006/10– 2001/05	201 200
CA	343.10	343.46	332.97	.1	-3.1	4.34	4.09	3.98	-5.7	-2
US	415.80	382.24	350.87	-8.1*	-8.2*	6.00	5.46	5.13	-8.9*	-6
CL	478.56	457.40	427.15	-4.4	-6.6	10.11	7.50	5.90	-25.8*	-2
IL	291.77	221.77	189.73	-24.0*	-14.4*	6.89	4.62	3.86	-32.9	-1
JP	150.76	121.39	97.24	-19.5*	-19.9*	8.78	7.84	7.15	-10.7	-8
KR	334.41	235.84	198.16	-29.5*	-16.0*	8.50	6.69	4.59	-21.3*	-3
DK	285.08	191.17	220.19	-32.9*	15.2	6.16	3.87	3.11	-37.2	-1
IS	134.24	127.50	85.5	-5.0	-32.9	4.74	6.78	2.14	43.2	-6
FI	186.77	151.76	109.42	-18.7	-27.9*	4.46	3.25	2.80	-27.2	-1
NO	207.32	186.37	149.55	-10.1	-19.8	5.77	4.56	3.36	-21.0	-2
SE	178.05	136.44	130.95	-23.4*	-4.0	4.44	4.03	2.82	-9.2	-3
AT	297.83	243.56	198.02	-18.2*	-18.7*	4.72	4.54	3.62	-3.7	-2
BE	244.36	220.91	198.89	-9.6	-10.0	5.25	3.82	4.09	-27.3	7
FR	237.86	216.89	211.19	-8.8*	-2.6	3.98	3.73	2.82	-6.2	-24
DE	245.69	223.48	206.37	-9.0*	-7.7*	5.31	4.27	4.19	-19.6*	-
LU	218.18	111.42	126.65	-48.9	13.7	0.88	1.76	1.62	98.8	-7
NL	306.18	257.29	234.49	-16.0*	-8.9	4.66	4.63	3.03	8	-3
CH	274.24	272.00	251.67	8	-7.5	4.22	2.95	2.02	-30.2	-3
IE	247.00	198.95	184.09	-19.5*	-7.5	6.28	2.53	3.18	-59.7*	2
GB	346.07	305.01	256.65	-11.9*	-15.9*	6.33	5.65	4.96	-10.7	-1
GR	305.19	218.33	222.92	-28.5*	2.1	5.54	5.36	4.62	-3.4	-1
IT	299.93	256.16	224.78	-14.6*	-12.2*	4.96	4.05	4.15	-18.4	2
PT	300.62	219.72	219.56	-26.9*	1	8.41	3.92	4.19	-53.4*	6
ES	272.67	231.74	204.24	-15.0*	-11.9*	6.23	5.13	3.59	-17.6	-3(
CZ	259.40	209.92	166.61	-19.1*	-20.6*	4.74	4.43	3.24	-6.7	-2
EE	394.90	262.22	139.38	-33.6*	-46.8*	6.91	4.89	7.25	-29.3	48
HU	530.50	406.91	348.94	-23.3*	-14.2*	7.03	6.18	5.80	-12.2	-6
LV	561.36	440.42	324.98	-21.5*	-26.2*	7.23	6.54	3.42	-9.5	-4
LT	412.34	342.21	225.15	-17.0	-34.2*	7.14	5.92	5.34	-17.2	-0
PL	488.86	400.92	315.70	-18.0*	-21.3*	7.81	8.35	6.69	6.9	-1
SK	432.24	373.71	345.44	-13.5	-7.6	13.09	11.08	9.26	-15.3	-1
SI	270.48	203.78	143.64	-24.7	-29.5	5.01	3.69	3.87	-26.3	4
AU	290.88	261.16	212.74	-10.2*	-18.5*	5.13	4.43	3.40	-13.6	-2
NZ	317.89	286.41	294.76	-9.9	2.9	5.14 🦯	4.98	6.23	-3.1	24
All	332.78	295.17	240.22	-11.3*	-18.6*	6.27	5.43	4.73	-13.4	-1

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.

			5–9 Years		10–14 Years						
Country	Yearly A	Amenable M Rate	lortality	% Chang	e (95% CI)	Yearly	Amenable M Rate	Mortality	% Change	e (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	
СН	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	

 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)

Table T Tearry Ameridable Mol	Traility Rates (Fer 100,000) of	Conditions Originating in Early	Neonalal Period for Age <1 in	34 OECD Countries, 2001/2005	5, 2006/2010 and 2011/2015
Country	Rate 2001/2005	Rate 2006/2010	Rate 2011/2015	% Change 2006/10 – 2001/05	% Change 2011/15 – 2006/1
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	230.8	193.8	-99(-184 -15)*	-192(-279-104)*

42 43

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

1	Country	Rate 2001/2005	Rate 2006/2010	Rate 2011/2015	% Change 2006/10 – 2001/05	% Change 2011/15 – 2006/10
2	Canada	36.7	34.6	33.0	-5.6 (-29.1, 17.9)	-4.8 (-28.5, 18.9)
3	Chile	91.6	79.8	80.9	-12.9 (-29.6, 3.7)	1.3 (-18.5, 21.2)
4	United States of America	41.6	35.8	33.5	-13.9 (-19.9, -7.9) *	-6.5 (-13.4, .4)
5	Israel	45.3	38.8	37.2	-14.4 (-44.6, 15.9)	-4.0 (-37.9, 29.9)
7	Japan	51.5	39.7	32.0	-22.9 (-32.6, -13.3) *	-19.3 (-30.9, -7.7) *
, 8	Republic of Korea	59.3	38.3	32.1	-35.4 (-47.7, -23.1) *	-16.2 (-35.0, 2.5)
9	Austria	43.1	35.9	31.6	-16.6 (-58.7, 25.5)	-12.1 (-59.6, 35.5)
10	Belgium	40.8	29.1	28.2	-28.6 (-59.7, 2.4)	-2.9 (-47.8, 42)
11	Czechia	34.4	29.5	21.1	-14.2 (-55.6, 27.2)	-28.5 (-66.3, 9.3)
12	Denmark	48.9	25.4	26.1	-47.9 (-79.0, -16.8) *	2.7 (-69.0, 74.3)
13	Estonia	68.9	59.4	26.8	-13.8 (-92.5, 64.9)	-55.0 (-108.8, -1.2) *
14	Finland	37.9	26.6	20.3	-29.8 (-75.4, 15.8)	-23.5 (-80.9, 33.8)
15 16	France	37.3	34.4	29.0	-7.6 (-23.0, 7.9)	-15.8 (-30.8,8) *
10	Germany	44.2	33.6	30.6	-24.0 (-36.9, -11.1) *	-8.9 (-26.0, 8.2)
18	Greece	71.7	43.5	40.9	-39.3 (-61.1, -17.5) *	-6.0 (-45.1, 33.0)
19	Hungary	75.6	69.0	62.6	-8.7 (-39.2, 21.8)	-9.3 (-41.5, 22.9)
20	Iceland	4.8	21.2	13.5	343.2 (-1784.6, 443.2)	-36.5 (-239.8, 63.5)
21	Ireland	46.8	38.9	36.2	-16.9 (-61.1, 27.3)	-6.9 (-57.0, 43.2)
22	Italy	57.1	41.8	36.0	-26.8 (-39.2, -14.4) *	-13.9 (-30.5, 2.6)
23	Latvia	119.2	77.6	42.6	-34.9 (-75.0, 5.2)	-45.1 (-89.9,2) *
24	Lithuania	99.8	79.3	45.4	-20.5 (-63.2, 22.1)	-42.7 (-80.6, -4.8) *
25 26	Luxembourg	15.0	0	13.3	-100 (., 0)	N/A
20	Netherlands	47.6	38.4	28.7	-19.4 (-44.2, 5.5)	-25.3 (-52.3, 1.8)
28	Norway	38.4	23.0	22.0	-39.9 (-80.4, .6)	-4.6 (-76.6, 67.4)
29	Poland	91.5	69.2	67.0	-24.4 (-36.5, -12.2) *	-3.2 (-19.8, 13.4)
30	Portugal	47.7	33.9	32.0	-29.0 (-59.3, 1.3)	-5.5 (-52.3, 41.2)
31	Slovakia	70.2	64.2	67.4	-8.6 (-50.5, 33.4)	5.0 (-42.7, 52.7)
32	Slovenia	55.5	29.1	17.6	-47.5 (-100.8, 5.8)	-39.5 (-117.2, 38.2)
33	Spain	54.1	41.7	31.2	-23.1 (-37.5, -8.6) *	-25.2 (-41.4, -9.1) *
34	Sweden	29.3	20.2	13.0	-31.1 (-69.5, 7.2)	-35.8 (-78.1, 6.5)
35 26	Switzerland	46.4	34.2	39.2	-26.4 (-64.1, 11.3)	14.8 (-44.9, 74.5)
30 37	United Kingdom	42.1	36.2	33.3	-13.8 (-28.0, .4)	-8.1 (-23.6, 7.3)
38	Australia	33.7	32.5	24.7	-3.7 (-32.2, 24.8)	-24.0 (-47.2,7) *
39	New Zealand	40.6	37.2	30.6	-8.4 (-61.3, 44.5)	-17.8 (-67.9, 32.2)
40	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 really Amenable Monally Rales (Per 100,000) of Pheumonia for Age <1 in 34 OECD Countries, 2001/2005, 2006/2010 and 201
--

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)

42 43

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 - 2006/1
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)

Table 5 Yearly	Amenable Mortality	Rates (Per 100 000	of Ne	nhritis and Ne	obrosis for Aa	e <1 in 34 OECD	Countries	2001/2005	2006/2010 and 2011/2015
					printis and ric			Countines	, 2001/2003,	2000/2010 and 2011/2013

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 /	6	100(1141 742)	-58.2 (-131.3, 14.0)

42 43

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	

 BMJ Open

		Cross-sectional study—If applicable, describe analytical methods taking account of sampling strategy	
		(e) Describe any sensitivity analyses	
Results	I		
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	I	·	
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.