

Research Article

Population-Based Study of Child Mortality (0-4) and Income Inequality in Japan and the Developed world 1989-91 v 2012-14: Any Excess Deaths Between the Most Unequal Countries?

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Abstract

Introduction: Parental child 'neglect' is usually linked to parents but can apply to nations using the criteria explicit in UNICEF statement "*in the last analysis Child-Mortality-Rates (CMR) indicates how well a nation meets the needs of its children*". Hence under-five (0-4) CMR rates of Japan and twenty Other Developed Countries (ODC) are compared within the context of relative poverty. Method: WHO data yields CMR rates per million (pm), analysed between 1989-91 and 2012-14 to compare Japan against ODC. World Bank Income Inequality data used as a measure of relative poverty. Excess deaths calculated by matching the most unequal Income Inequality country's CMR with the most equal nation. Results: All countries reduced CMR substantially. The highest CMR was in USA 1383 pm, followed by three English-speaking countries. Japan at 597pm was 19th of 21. USA and New Zealand were double Japan's CMR, whilst twelve ODC had rates 25% higher than Japan. Most unequal Income Inequality USA at 15.9 times, Japan the most equal at 4.5 times. Income Inequality and CMR were strongly correlated (+0.6188 $p < 0.005$). The countries with the lowest Income Inequality, had lowest CMR namely Finland Japan, Norway and Sweden. America not matching Japan's CMR, meant an average excess of 16,838 US children's deaths annually. Discussion: The strong statistical association between higher CMR and Income Inequality, suggests that one factor in Japan's results is the lower social inequality, unlike Canada, New Zealand, the UK and USA. Does Japan's results indicate cultural factors suggesting Japan is more child orientated than English-speaking countries?

Keywords: child mortality; relative poverty; japan international

Introduction

Child neglect is usually associated with parents who comparative and relative to, other parents in their society, fail to meet the needs of their children. At the extreme this can lead to a dead child [1-3]. This can also be true for nations made explicit in the UNICEF statement "in the last analysis Child Mortality Rates (CMR) are an indication of how well a nation meets the needs of its children" [4]. This idea was further stressed in the UN Millennium Development Goals which was to reduce 0-4 CMR by 2%

pa [5,6]. All twenty-one Western countries, including Japan and the USA, were signatories to achieving this UN Millennium objective [5,6]. Taking the UNICEF statement as the criteria for child neglect, theoretically therefore any country that has statistically higher CMR than comparable nations are failing to 'meet the needs of its children' and might be described as relatively neglecting their children.

The WHO Millennium Goals however were also set

context of reducing child poverty, both absolute and relative [5,6]. This is the major socio-economic contextual factor related to all forms of child mortality, as studies from around the Western world have found that relative poverty is associated with a range of poorer outcomes: education, crime, unemployment but especially in regard to child health and mortality [7-18]. This new analysis of the latest WHO data on CMR for under-fives (0-4) are examined within the context of the World Bank's measure of Income Inequality, which is taken as a surrogate measure of relative poverty [19,20]. Each of the twenty-one Developed countries is analysed to determine how well Japan compared to the Other Developed Countries (ODC) in meeting 'the needs of their children'. After all it is axiomatic that the first duty of a state is to protect the lives of its citizens, especially its children.

There are three working null-hypothesis.

1. That between 1989-91 v 2012-14 there will be no significant differences between Japan and the Other Developed Countries (ODC);
2. There will be no statistical association between CMR and Income Inequality at national levels, and,
3. There will be no comparative excess of CMR between the two most unequal countries.

Methodology

To enable comparisons to be made between countries of differing sizes, we extrapolate WHO data for total child mortality, which we report in rates per million (pm) based upon the numbers of actual deaths of <1 and 1-4 year olds from within their national populations, from which a CMR (0-4) is calculated [19]. Each nation is compared against itself over the period and any percentage of change determined.

The comparative baseline years will be the averages for 1989-91, compared with the average index years 2012-14, which is the latest available comparative international data (up-dated December 2016) [19]. A few countries have slightly different index and baseline years, for example, later baseline years for Germany 1990-92, or, earlier index years for Canada and New Zealand (2010-12) and for Belgium, Ireland, France and the UK (2011-13). The variations are noted in the tables.

Child mortality rates (CMR)

Child Mortality Rates are the total death rate of each country under reviews coded 0050-0080 [19]. A country with statistically higher CMR infers a form of relative national neglect or failure. Therefore, a country whose CMR is one standard deviation (1 s.d) above the mean is relatively neglecting/ failing its children. Both infant (<1 year) (the age-band in which most children die) and the combined <1 and 1-4 CMR (0-4) are analysed, from

which standard deviations (1 s.d) are calculated.

Relative poverty

Relative poverty is known throughout the Western world to be associated with poorer child health outcomes and is a major socio-economic context in which all children and child health services operate [7-18]. However, it is recognized that relative poverty is a very broad category and the actual mechanism of how it influences child mortality is not fully understood. However there are a number of specific factors found to be related to adverse child health outcomes such as low birth weight parental smoking, drug and alcohol misuse, living in deprived and polluted areas, social inequalities, low education achievement, poorer anti and post-natal care and belonging to an ethnic minority, all these factors are related to relative poverty [7,17, 21-29].

It is readily acknowledged that there is a long-standing debate about definitions of poverty, crucially between 'relative' poverty in Western countries, as opposed to the 'absolute' poverty of the developing world [7,30-33]. There are USA specific measures of relative poverty, based upon the Orshansky model from 1965 which are periodically updated [32,33]. One measure of relative poverty is the World Bank Income Inequality' ratio, which is the difference between the top and bottom 10% of incomes in each country, which we take as a surrogate measure of Western relative poverty [20]. Moreover, the World Bank's measure of Income Inequalities is international and has a strong similarity to the Orshansky so it was thought more appropriate to use the uniform World Bank measure in an international review [20]. The benefit of using this ratio is that it is country-specific; thereby reflecting the relative positions of poorer families within that specific society and avoids an artificial levelling when averages are used. For example, in 2016 the UK's average income was approximately £28,000 p.a., yet nearly 60% of the population received under £20,000 p.a., showing that the mode income is far lower than the mean. However, the World Bank acknowledged that there is no internationally agreed precise definition of relative poverty, each country determines a 'relevant welfare measure' juxtaposed against a selected poverty line for that country in relation to its total population [20]. This is similar to the US concept of relative poverty which is an income proportionate to national average income, so a family income 60% below the average is designated as living in relative poverty [30-35].

Excess deaths

To discuss child deaths in terms of rates and percentages can appear a little too detached. To highlight the reality of the differences between the more and least unequal countries in terms of Income Inequality. We

examine whether there are excess deaths between the countries with the widest and narrowest Income Inequality. This is based upon the differences in CMR, and using the actual numbers of deaths of the most unequal country, we contrast for each year of this century – 2000-2014 what the difference would have been if the unequal country had matched the most equal country's CMR.

Statistics

Standard deviations (s.d.) are calculated, to identify any country above or below the mean of the 21 nations as an indicator of how well a nation met the needs of its children. It is reiterated a country that is 1s.d above the mean of the Western CMR average, is considered to be neglecting/ failing its children compared to the other countries.

Japan is compared against each ODC current CMR from which a Japan: ODC ratio is calculated, shown in the final column of table [1]. Any ratio of more than 1:1.30 suggests the ODC has substantially a disproportionately higher CMR compared to Japan.

Spearman Rank Order (Rho) correlations are calculated to explore any statistical link with relative poverty and child mortality rates of the 21 developed countries.

Results

Total Child Mortality Rates [CMR] 1989-91 v 2012-014

It should be noted that over the period every country reduced its child mortality more than 40% except Canada.

Infants (<1)

In regard to current infant <1 CMR four English speaking countries had the highest rates, the USA 6143 pm, New Zealand 5201 pm, Canada 4692 pm and the UK 4102 pm, moreover all these countries were 1s.d above the mean. Thus in relation to infant deaths, they were failing to meet their children's needs. The lowest were Finland 2068 pm, Japan 2119 pm, Sweden 2183 pm and Norway 2387 pm and all were 1 s.d below the mean.

CMR 0-4years

The current highest 0-4 CMR was the USA at 1383 pm, followed by New Zealand 1303 pm, Canada 1106 pm and the UK at 967pm. Again Canada, New Zealand and the USA failed the Millennium goal object and there afore are relatively neglecting nations. The lowest were Finland 518pm, Norway 568pm and Japan 570pm. The current ODC average (minus Japan) was 785pm (with 1s.d = 222pm), which yields an odds ratio of Japan: ODC average of 1:1.36.

The final column that shows Japan's current CMR compared to that ODC from which odds ratios are calculated finds that the USA and New Zealand had double the

rate of Japan and a further twelve countries had rates 25% higher, only Norway and Finland had a lower CMR than Japan and then only marginally. Three countries failed to meet the UN Millennium target of reducing 0-4 CMR by 2% p.a., Canada, New Zealand and the USA who all were 1s.d above the mean, further indicating that these countries 'failed to meet the need of their children'. Finland was 1s.d below the mean (Table 1).

Income inequalities- relative poverty

The Income Inequality ratio is the gap between the top and bottom 10% of incomes. The widest ratio is the USA at 15.9times, and of the five highest ranked countries, four are English-speaking countries, the UK 13.8 times, Australia 12.5, and New Zealand 12.4. The narrowest Income Inequality is in Japan 4.5times, Finland 5.6, Norway 6.1 and Sweden 6.2 and these countries also had the lowest CMR of the twenty-one nations.

The total Western average Income Inequality was 9.5 (with 1s.d = 3.0). Thus the USA, Portugal, the UK and Australia had level of Income Inequality 1s.d above the mean and Japan, Finland, Norway and Sweden being 1s.d below the mean (Table 2).

Income inequalities and child mortalities

There was a strong positive correlation between Income Inequality and 0-4 CMR (Rho= +0.6318 p<0.005).

Excess Numbers of Deaths: If USA had Japan Rates

The mortality rates were transposed back into actual numbers of deaths of the country with the widest Income Inequality, the USA was compared with the most equal, Japan whose CMR was 579pm and the USA 1383pm. As is shown in Table 3 as the USA failed to match or even to be close to Japan's CMR over this century, there was on average an annual excess' of American child deaths of 16,838. Whilst if the USA had at least matched the Western average of 791pm, throughout this century annually there would have been 11,145 fewer USA under-five deaths.

It is notable that calculating from the current CMR (0-4) of the other three highest English-speaking countries, if these countries had matched Japan CMR then out of 2,115 Canadian child deaths there would have been 1,015 fewer; for New Zealand out of 388, there would have been 1,541 fewer grieving parents (Table 3).

Discussion

Whilst there are inherent difficulties in comparative international mortality studies [36], the data from the WHO is the most consistent and reliable in the field, because it is uniform and consistently collated over the years and enables us to examine differences between the

Table 1. Child Mortality (0-4), Relative Poverty and GDP Expenditure-on-Health in Japan and the Developed world 1989-91 v 2012-14.

Country, Current Rank & latest years	<1 CMR 89-91 – 12-14	% of Change	0-4 CMR 1989-91 - 2012-14	% of Change	Japan0-4 ODC:Ratio
1. USA #	9719 –6143 #	-37%	2420 - 1383 #	-43%	1:2.39
2. New Zealand 2010-12 #	8772-5201 #	-41%	2361 - 1303 #	-45%	1:2.25
3. Canada 2010-12 #	6898-4692 #	-32%	1740 - 1106 #	-36%	1:1.91
4.U. K 2011-13	8093-4102 #	-49%	1929 - 967	-50%	1:1.67
5. Belgium 2011-13	8082-3744	-54%	2013 - 910	-55%	1:1.57
6. Switzerland 2011-13	6276-3797	-49%	1783 - 872	-51%	1:1.51
7. Australia	7914-3592	-55%	1886 - 823	-56%	1:1.42
8. France 2011-13	7455-3445	-54%	1740 - 815	-52%	1:1.41
9. Netherlands	7297-3728	-49%	1729 - 812	-53%	1:1.40
10. Ireland 2011-13	8543-3181	-63%	1659 - 795	-52%	1:1.37
11. Denmark	6779-3397	-50%	1993 - 793	-60%	1:1.37
12. Italy 2010-12	8179-3239	-60%	1895 - 756	-60%	1:1.31
13. Austria	7966-3141	-61%	1944 - 748	-61%	1:1.29
14. Greece 2011-13	9508-2845	-70%	2039 - 730	-64%	1:1.26
15. Portugal	11419-2860	-75%	2993 - 702	-77%	1:1.21
16. Germany	7239-3319	-55%	1611 - 659	-59%	1:1.14
17. Spain	7475-2688	-64%	1790 - 657	-63%	1:1.13
18. Sweden	6158-2183 #	-65%	1520 - 587	-61%	1:1.01
19. Japan	4645-2119#	-54%	1218 - 579	-52%	1:1.00
20. Norway	7143-2387#	-67%	2005 - 568	-72%	1;0.98
21. Finland #	5892-2068#	-65%	1463 - 518 #	-65%	1:0.89
Western Average CMR (-USA).	7587-3286	-57%	1866 - 785	0.42	1:1.76
Current 1s.d	1 s.d= 792pm		1 s.d= 222pm		

indicates 1 s.d above or below the mean.

nations' mortality rates [19]. Equally, whilst there are debates about poverty, the World Bank income inequality data is probably the best comparative international measure available, not least because the income inequality measure is country-specific [20,30-35]. The main limitation of the study is that we cannot explain the differences between countries, which would require country-specific research. Nor can the study ascribe specific causes for Japan's results, other than to place them and the other twenty developed countries within the context of relative poverty. Nonetheless, this international comparative population based methodology has proved to be valid across a range of areas, including studies on cancer, child abuse, suicide and neurology [37-40].

Main Findings

The null hypotheses that there would be no statistical difference between Japan and the other countries in reducing child mortality is broadly rejected. Every country has reduced its Child Mortality Rate for infant (<1) and 0-4, and, every country except Canada, New Zealand and the USA, met the UN Millennium Goal challenge of reducing CMR by 2% pa [5,6]. Moreover, Canada, New Zealand and the USA CMR (0-4) were 1s.d.above the mean and are judged to be relatively 'neglecting' their children.

The fact that the highest current CMR was in the USA, followed by three other English-speaking countries, New Zealand, Canada and the UK, and all four of these coun-

Table 2. Income Inequality: Top 10% Times Bottom 10% of Income.

Country & Rank	Top v Bottom 10% Incomes
1.USA	15.9
2.Portugal	15.0
3.UK	13.8
4. Australia	12.5
5.New Zealand	12.4
6.Italy	11.6
7.Spain	10.3
8.Greece	10.2
9=. Ireland	9.4
9=.Canada	9.4
11.Netherland	9.2
12.France	9.1
13.Switzerland	9.0
14.Belgium	8.2
15.Denmark	8.1
16=.Germany	6.9
16=.Austria	6.9
18.Sweden	6.2
19. Norway	6.1
20.Finland	5.6
21.Japan	4.5
Total Average (1s.d .0)	9.5times
Correlating CMR 0-4 with Income Inequality CMR Rho= +0.5870 p<0.005.	
Correlating CMR <1 with Income Inequality Rho=+0.5825 p<0.005.	
Correlating CARD with Income Inequality Rho= -0.0738 n.sig	
Correlating UnDwith Income Inequality Rho=+0.2837 n.s.	

tries had 1 s.d. above the mean for infant deaths (<1year) may suggest that there are also cultural as well as structural factors influencing CMR.

More importantly however, is the significant juxtaposition of CMR and relative poverty. This reflects many clinical and practice studies from across the Western world, which have consistently shown an association with poorer health outcomes of children from lower socio-economic groups [7-18].

Moreover, the USA, the UK and New Zealand occupied three of the five highest CMR and had the five widest Income Inequalities; whilst conversely the four countries with the lowest Income Inequality, Japan, Finland, Norway and Sweden also had the lowest CMR for infants and the under-fives.

One possible explanation for the variation in results might be related to how health services are configured

and what the nations spent on health, as possibly Japan might be one of the Western world's high-spenders.

To explore this idea we draw upon recent study, based upon World Bank figures for %GDP-Expenditure-on-Health (%GDPEH) since 1980 to 2014, when over the period Japan %GDPEH averaged 7.3%; compared to 9.4% for France, 9.5% for Germany and 12.6% for the USA, only three ODC averaged less than Japan.

Currently Japan is equal seventeenth of the twenty-one, spending 10.2%, whereas France, Germany and the USA spent 11.6%, 11.5% and 17.1% respectively [41,42]. So clearly Japan's comparative success is not particularly based upon %GDPEH (Table 4).

When studying child mortality researchers usually calculate in rates, in part to maintain a degree of detachment in what is inherently a highly emotional topic. However, in one sense rates and percentages can seem too detached, which was the rationale for exploring whether there was an excess of deaths between the two most unequal countries, to have a stronger notion of what relative failure looks like in terms of any excess deaths of children.

The results are indeed stark when the numbers 'excess' of child deaths are realised as compared to Japan, America averaged more than sixteen thousand 'excess deaths' in each year from 2000 until 2014. Moreover, the other English-speaking countries compared to Japan had an excess of under-five year old deaths and fourteen of the other twenty developed countries had CMR 25% higher than Japan.

It is however, readily acknowledged that this study cannot be definitive about the causes for the differences found, but should be a stimulus for future research for a better explanation and a reduction in any excess of child mortality. Apart from Japan being a more equal society, what might be other factors contributing to Japan's success?

This study cannot determine what may be the cultural and structural factors operating in Japanese society but wonder whether perhaps Japan is more child-orientated than many of its contemporary developed countries?

Nonetheless, we can never be complacent, especially when the continued link between poorer child health outcomes, including mortality continues to be linked with relative poverty in every country of the Western and developing world.

The prophetic judgement of the great American William Penn appear highly appropriate when he said "It is a reproach to Government and Religion to suffer such poverty and excess", which clearly continues to be true in the 21st century. Therefore is it time for the less successful countries, especially the USA to hear the clarion call of American researchers that the only way to make a substantial inroads into USA child mortality rates is to

Table 3. Annual Numbers of USA Excess Deaths of 0-4year olds USA Failing to Match Japanese rates per million (pm) for Year2000 to 2014.

Years	Japan CMR rpm	USA CMR	Excess Death Numbers
2000	899	1722	15,684
2001	845	1687	15,357
2002	821	1677	16,774
2003	787	1667	17,485
2004	754	1636	17,669
2005	739	1635	18,257
2006	723	1624	18,237
2007	708	1618	18,953
2008	701	1604	18,366
2009	750	1471	17,997
2010	644	1433	15,904
2011	689	1401	14,398
2012	608	1391	15,594
2013	563	1384	16,230
2014	579	1383	15,686
Average 2000-14	721pm	1556pm	16,838

Table 4. % Gross-Domestic-Product Expenditure on Health 1980 -2014 (% rounded-up).

Country & Percent Public Source GDPEH	Total 1980	Total 2000	% Pubic of Total GDP 2014	Total GDP 2014	Average GDPEH 1980-14	Japan: OCD GDP Ratio
1. USA	9.0	13.4	46%	17.1	12.6	1: 1.73
2. Germany	8.4	10.1	77%	11.3	9.6	1:1.32
3= France	7.0	10.3	77%	11.5	9.5	1:1.30
3= Switzerland	7.3	10.2	59%	11.7	9.5	1:1.30
5. Canada	7.0	8.8	70%	10.4	9.3	1:1.29
6= Netherlands	7.4	8.0	63%	10.9	8.7	1:1.19
6=. Sweden	8.9	8.2	82%	11.9	8.7	1:1.19
8. Austria	7.4	9.0	77%	11.2	8.5	1:1.16
9. Belgium #	6.3	9.0	n/a #	10.6	8.3	1:1.14
10. Norway	7.0	8.4	85	9.7	8.1	1:1.11
11.Australia	6.1	8.0	67%	11.2	8.0	1:1.10
12=. Italy	7.0	8.1	78%	9.2	7.9	1:1.10
12=. Denmark	8.9	8.3	83%	10.8	7.9	1.110
14= New Zealand	5.9	7.7	80%	11.0	7.8	1:1.07
14= Finland	6.3	7.2	77%	9.5	7.8	1:1.07
16. Portugal	5.3	8.8	72%	9.5	7.5	1:1.03
17=. Ireland]	8.2	6.1	77%	7.8	7.3	1:1.00
17=. Japan	6.5	7.7	82%	10.2	7.3	1:1.00
19 Greece	5.9	7.9	58%	8.1	7.2	1:0.99
20. Spain	5.3	7.2	82%	9.0	7.1	1:0.97
21 U.K	5.6	7.0	82%	9.1	7.0	1:0.96
Other Countries Average	7.2	8.3	71%	10.2%	8.2	1:1.12
Japan: OCD Ratio	1:1.11	1:1.08	1:0.87	1:1.00	1:1.12	

reduce poverty [16,17]. Whilst for Japan and the other more equal countries such as Finland, Norway and Sweden, they need to seek to continue to improve but alert their general populations to take pride in what their nation has achieved as their societies have something special and are a model for the rest of the developed world.

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