Chapter 9

Measurement Conundrums: Explaining Child Health Population Outcomes in MOCHA Countries

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Abstract

The 30 MOCHA (Models of Child Health Appraised) countries are diverse socially, culturally and economically, and differences exist in their healthcare systems and in the scope and role of primary care. An economic analysis was undertaken that sought to explain differences in child health outcomes between countries. The conceptual framework was that of a production function for health, whereby health outputs (or outcomes) are assumed affected by several 'inputs'. In the case of health, inputs include personal (genes, health behaviours) and socio-economic (income, living standards) factors and the structure, organisation and workforce of the healthcare system. Random effects regression modelling was used, based on countries as the unit of analysis, with data from 2004 to 2016 from international sources and published categorisations of healthcare system. The chapter describes the data deficiencies and measurement conundrums faced, and how these were addressed. In the absence of consistent indicators of child health outcomes across countries, five mortality measures were used: neonatal, infant, under five years, diabetes (0–19 years) and epilepsy (0–19 years). Factors found associated with reductions in mortality were as follows: gross domestic product per capita growth (neonatal, infant, under five years), higher density of paediatricians (neonatal, infant, under five years), less out-of-pocket expenditure (neonatal, diabetes 0–19), state-based service provision (epilepsy 0–19) and lower proportions of children in the population, a proxy for family size (all outcomes). Findings should be

interpreted with caution due to the ecological nature of the analysis and the limitations presented by the data and measures employed.

Keywords: Child health; primary care; European countries; regression modelling; mortality outcomes; Gross Domestic Product

Introduction

The Models of Child Health Appraised (MOCHA) countries (e.g. the 30 European Union and European Economic Area countries at the time of the study) are diverse socially, culturally and economically, and differences exist in their healthcare systems and in the scope and role of primary care (see Chapter 2). An economic analysis was undertaken that sought to explain differences in child health outcomes across the MOCHA countries.

Methods

The conceptual framework for the analysis was that of a production function for health, whereby health outputs (or outcomes) are assumed affected by several 'inputs' consistent with those reviewed in Chapter 2. Traditional production function approaches explain outputs of goods and services in terms of the resources that are used in their production, primarily natural resources, labour, capital and technology. In the case of health, those factors translate into the healthcare workforce (discussed further in Chapter 13), the capital equipment and technology that is used in the diagnosis and treatment of patients, and the drugs, devices and other consumables that are prescribed for managing medical conditions. Health, however, is also the product of other factors, including personal characteristics of the population (genes and health behaviours), socio-economic variables (such as income levels and living standards) and the structure and organisation of the healthcare system that delivers care.

The aim of the economic analysis was to explore the relationships between a range of health system variables, including the strength of primary care (a key variable of interest for the MOCHA project) and child health outcome indicators in the MOCHA countries, controlling for confounding country-level factors. The methodology was quantitative, namely, regression modelling to explore the relationship between explanatory factors and outcomes, based on countries as the unit of analysis. Data deficiencies, however, constrained the scope of the work. This chapter explains the measurement conundrums that were faced and how they were addressed. The results of the modelling are presented, but should be interpreted with caution due to the data-related compromises that were made.

Data and Methods

Child Health Outcome Indicators

The importance of population-level measures of child health for identifying progress, problems and priorities is well recognised, and proposals have been

advanced for holistic national-level indicator sets that reflect quality in the care of specific conditions and more general indicators of health (Gill, O'Neill, Rose, Mant, & Harnden, 2014; Rigby, Köhler, Blair, & Metchler, 2003). The data to enable the use of such indicators in cross country analysis, however, are very limited, as discussed in Chapter 7. The range of outcome measures for children available from international health data sources are mostly focussed on a variety of vaccination and mortality rates. Information on other, more health-centred outcomes may be gathered in individual countries, but cross-national comparisons are only possible if sufficient numbers of countries can provide data, and there is agreement on the definitions that they use.

The outcome indicators used in this study are selected mortality rates that are reported across the MOCHA countries. Child mortality rates in Europe are generally low, but variability between countries does occur, providing an opportunity for investigating potential contributing factors. Being the inverse of health, the use of mortality indicators represents a compromise resulting from a lack of other data. Moreover, it is arguable that mortality is a poor indicator of quality of primary care. Vaccination rates were rejected as an alternative outcome for use in the analysis because they are delivered outside of primary care in some countries and are also influenced by legislation in some jurisdictions that requires parents (under threat of sanctions in some cases) to comply (Wells, 2017).

Five mortality measures were chosen for analysis: three relating to early years (neonatal, i.e. first 28 days; infant, i.e. first year; and under five years of age mortality per 1,000 live births) and two relating to mortality of children 19 years and younger per 100,000 population from two ambulatory care-sensitive conditions (diabetes and epilepsy). Emergency admissions to hospital by people with a range of ambulatory care-sensitive conditions are widely used as indicators of the quality of primary care (Tian, Dixon, & Gao, 2012). In the absence of hospitalisation data across MOCHA countries for children, mortality rates were used as a proxy.

Explanatory Variables

Two broad groups of factors were considered as potential influences on child mortality outcomes: socio-economic and socio-demographic characteristics of the countries, and healthcare system features. The choice of variables was constrained by data availability, and the variables available had limitations.

Three broad country-specific factors reported in international data sources were included in the analysis. First, gross domestic product (GDP) per capita was used as an indicator of income levels and economic strength of a country and hence its ability to spend on health care. This is the most widely used measure of a nation's living standards, although it has some significant limitations, including that it does not take account of the distribution of income in a country, which may be very inequitable (Amadeo, 2018). Secondly, the proportion of the population living in urban (rather than rural) areas was used to explore any potential influence this might have on the child mortality indicators. Lastly, the proportion of the country's population aged 19 years or less was included as a proxy for family size.

Among healthcare system factors that might affect health outcomes, health expenditure per capita is a likely key determinant. This, however, is represented by GDP per capita since these variables are highly correlated (see Chapter 13). Including both in the regression modelling would create statistical problems of multicollinearity. Other potential healthcare system influences on mortality that were sought for inclusion in the analysis related to access to health care, the healthcare workforce, the healthcare financing mechanism, how services are provided and the strength of primary care. Data reflecting each of these features were obtained, although some limitations applied.

Point-of-care charges might limit access to health care, and to proxy this, out-of-pocket (OOP) expenditure on health care as a proportion of total health care expenditure was incorporated. OOP expenditure data, however, have the drawback that they refer to a country's population as a whole, and not just to the use of health care by children. Information obtained from the MOCHA country agents (see Chapter 1) indicated complex systems of charging for children in many countries with exemptions in place depending on a variety of factors including age, family income, the nature of the condition and the type of medication. Only three countries (Norway, Sweden and United Kingdom) said there were no charges for children.

The workforce (size and composition) is a major component in the delivery of health care, and the number of general paediatricians (includes neonatologists, but excludes paediatric specialties such as psychiatry, cardiology, oncology, surgery etc.), general practitioners (GPs) and nurses per 100, 000 of the population are available in international datasets and were included as potential influences on activity levels and outcomes. In the context of an assessment of primary health care for children, however, these variables have drawbacks. In particular, the data are aggregated such that the work of GPs and nurses with children (rather than adults) cannot be isolated, and the allocation of nurses to the primary (rather than secondary) care sector is not provided.

Countries were classified according to (1) how their healthcare system was predominantly financed and (2) how care was predominantly provided. These classifications were based on the work of Böhm (Böhm, 2012; Böhm, Schmid, Götze, Landwehr, & Rothgang, 2013) which argues that financing and provision arrangements in a healthcare system create mechanisms and incentives that affect the way in which the actors (government, societal/non-governmental organisations and private individuals) in the system behave. For example, the service provision arrangements may affect the way in which doctors are paid (capitation vs fee-for-service or performance related) and this may affect their treatment decisions, with implications for the outcomes and experiences of patients (see Chapter 16; Wells, 2017). The financing dimension is broken down into state (raising money for health care through taxes or national insurance schemes), societal (social insurance) and private (private insurance or direct payments). Similarly, care is either provided by the public (state), non-governmental/societal organisations or the private sector. There are no examples of predominantly private financing or societal provision in the MOCHA countries (Table 9.1). The problem with these variables is that health systems are complex and financing

Table 9.1. Financing and service delivery classifications.

Country	Financing	Service Provision
Austria	Societal	Private
Belgium	Societal	Private
Bulgaria*	Societal	Private
Croatia*	Societal	Private
Cyprus*	State	State
Czech Rep.	Societal	Private
Denmark	State	State
Estonia	Societal	Private
Finland	State	State
France	Societal	Private
Germany	Societal	Private
Greece*	Societal	Private
Hungary	Societal	Private
Iceland	State	State
Ireland	State	private
Italy	State	Private
Latvia*	State	State
Lithuania*	State	Private
Luxembourg	Societal	Private
Malta*	State	State
Netherlands	Societal	Private
Norway	State	State
Poland	Societal	Private
Portugal	State	State
Romania		
Slovakia	Societal	Private
Slovenia	Societal	State
Spain	State	State
Sweden	State	State
UK	State	State

Source: Based on Böhm 2013, except countries marked *.
*Classified by Authors based on the European Observatory on Health Systems and Policies report (downloaded 2016).

and provision within countries is often through a blend of methods thus creating uncertainties in the categorisation, and in turn giving rise to issues for the interpretation of the results of any analysis.

A measure of the strength of primary care in each country was taken from the Primary Care Activity Monitor for Europe (PHAMEU) (Kringos, Boerma, van der Zee, & Groenewegen, 2013). The PHAMEU method scored primary care on seven dimensions, each being made up of a number of indicators. Three dimensions are related to structures (governance, economic conditions and workforce development) and four to processes (access, continuity, coordination and comprehensiveness). An overall primary care system strength was assigned by PHAMEU on the basis of the dimension scores (strong, medium and weak), and this measure was used as an explanatory variable in the regression modelling (Table 9.2). The limitation of this variable is that the dimensions, and underlying indicators, were defined with care of the general population in mind and different factors may be important in care of children. A full description of all variables included in the analysis is given in Table 9.3.

Analysis

The data for the quantitative variables were obtained for the 30 MOCHA countries for the 13-year period from 2004 to 2016 (maximum of 390 observations per variable, if there was no missing information) from the World Health Organization, World Bank and Eurostat. Summary descriptive statistics are provided in Table 9.4. The values of variables are shown by country for the last year for which data were available (Table 9.5). Categorical variables (primary care strength, financing and service provision) were fixed across all years (as in Tables 9.1 and 9.2).

A random effects model was estimated to examine the contribution of the primary care system, other healthcare system variables and country covariates to each mortality outcome measure. Random effects models are used in the analysis of hierarchical or panel data when it is assumed the variables are random, and there are no fixed on non-random factors. A Hausman test was performed to confirm the random effects estimator was consistent (Prob > χ^2 = 0.9028). Missing data could not be regarded as randomly missing and were not imputed as they were greater than 25% of the data, reducing the number of countries included in the modelling. The model was re-run with GDP per capita, the proportion of the population in urban areas, OOP expenditure and workforce variables lagged by two years since changes in those factors may take time to have an effect on mortality. As is customary, GDP per capita was entered into the modelling in logarithmic form, making the coefficient equivalent to a growth rate.

Findings

Results of the random effects regression analyses are found in Table 9.6. They are presented separately for each outcome measure without any lagged variables and with a two-year time lag to capture the medium-term effects of changes in

Table 9.2. PHAMEU scoring system for the strength of the countries' primary care system (Kringos et al., 2013).

Country	The Structure of Primary Care			The Service-delivery Process of Primary Care				Overall Primary Care System Strength
	Primary Care Governance	Economic Conditions of Primary Care	Primary Care Workforce Development	Access to Primary Care	Continuity of Primary Care	Coordination of Primary Care	Comprehensiveness of Primary Care	
Austria	Medium	Medium	Weak	Medium	Weak	Weak	Weak	Weak
Belgium	Medium	Strong	Medium	Weak	Strong	Medium	Strong	Strong
Bulgaria	Medium	Weak	Weak	Weak	Medium	Weak	Strong	Weak
Croatia								
Cyprus	Weak	Weak	Weak	Weak	Medium	Weak	Weak	Weak
Czech Republic	Medium	Weak	Weak	Strong	Strong	Medium	Weak	Medium
Denmark	Strong	Medium	Strong	Strong	Strong	Strong	Medium	Strong
Estonia	Strong	Weak	Medium	Medium	Strong	Medium	Medium	Strong
Finland	Medium	Strong	Strong	Medium	Medium	Medium	Strong	Strong
France	Medium	Medium	Medium	Weak	Medium	Medium	Strong	Medium
Germany	Medium	Strong	Medium	Medium	Strong	Weak	Medium	Medium
Greece	Medium	Weak	Weak	Weak	Weak	Strong	Weak	Weak
Hungary	Weak	Medium	Medium	Strong	Medium	Weak	Weak	Weak
Iceland	Weak	Weak	Weak	Medium	Strong	Weak	Medium	Weak
Ireland	Weak	Weak	Strong	Weak	Strong	Weak	Medium	Weak
Italy	Strong	Strong	Medium	Medium	Weak	Medium	Weak	Medium
Latvia	Medium	Medium	Weak	Weak	Strong	Medium	Medium	Medium
Lithuania	Strong	Medium	Medium	Strong	Weak	Strong	Strong	Strong
Luxembourg	Weak	Weak	Weak	Weak	Weak	Medium	Medium	Weak

Table 9.2. (*Continued*)

Country	The Structure of Primary Care			The Service-delivery Process of Primary Care				Overall Primary Care System Strength
	Primary Care Governance	Economic Conditions of Primary Care	Primary Care Workforce Development	Access to Primary Care	Continuity of Primary Care	Coordination of Primary Care	Comprehensiveness of Primary Care	
Malta	Weak	Weak	Strong	Weak	Weak	Strong	Medium	Weak
Netherlands	Strong	Strong	Strong	Strong	Weak	Strong	Medium	Strong
Norway	Strong	Weak	Medium	Medium	Medium	Weak	Strong	Medium
Poland	Weak	Weak	Weak	Strong	Medium	Strong	Weak	Medium
Portugal	Strong	Medium	Strong	Strong	Medium	Medium	Strong	Strong
Romania	Strong	Strong	Medium	Medium	Medium	Weak	Weak	Medium
Slovak Rep.	Weak	Medium	Weak	Medium	Strong	Weak	Weak	Weak
Slovenia	Strong	Strong	Strong	Strong	Weak	Strong	Weak	Strong
Spain	Strong	Strong	Strong	Strong	Strong	Strong	Strong	Strong
Sweden	Medium	Medium	Medium	Medium	Weak	Strong	Strong	Medium
UK	Strong	Strong	Strong	Strong	Medium	Strong	Strong	Strong

Note: Indicators making up each dimension:
Governance of the primary care system: (1) health (care) goals, (2) policy on equity in access, (3) (de)centralisation of management and service development, (4) quality management infrastructure, (5) appropriate technology, (6) patient advocacy, (7) ownership of practices and (8) integration of primary care in the healthcare system.
Economic conditions of the primary care system: (1) healthcare expenditure, (2) primary care expenditures, (3) healthcare funding system, (4) employment status of primary care workforce, (5) remuneration system of primary care workforces and (6) income of primary care workforce.
Primary care workforce development: (1) profile of workforce, (2) recognition and responsibilities of disciplines, (3) education and retention, (4) professional associations, (5) academic status of primary care disciplines and (6) future development of workforce.
Access to primary care services: (1) availability of primary care services, (2) geographic access, (3) accommodation of accessibility (including physical access), (4) affordability, (5) acceptability, (6) utilisation and (7) equality in access.
Continuity of care: (1) longitudinal, (2) informational, (3) relational and (4) management.
Coordination of care: (1) gatekeeping system, (2) practice and team structure, (3) skill-mix in primary care, (4) integration of primary and secondary care and (5) integration of primary and public health.
Comprehensiveness of care: (1) medical equipment available, (2) first contact for common health problems, (3) treatment and follow-up of diseases, (4) medical technical procedures and preventive care, (5) mother/child/reproductive health care and (6) health promotion.

Table 9.3. Description of dependent and independent variables used in the analysis.

Variable	Description	Source	Years Available
Infant mortality	Number of deaths of children under one year of age per 1,000 live births	WHO global burden of disease	2004–2015
Neonatal mortality	Number of deaths of children within the first 28 days of life per 1,000 live births	WHO global burden of disease	2004–2015
Under-five years mortality	Number of deaths of children below the age of five per 1,000 live births	WHO global burden of disease	2004–2015
Diabetes mortality	Number of deaths from diabetes of children/young people below the age of 20 per 100,000 of population	WHO global burden of disease	2004–2016
Epilepsy mortality	Number of deaths from diabetes of children/young people below the age of 20 per 100,000 of population	WHO global burden of disease	2004–2016
GDP per capita, PPP	Gross domestic product per capita based on purchasing power parity (PPP). GDP is converted to international dollars using purchasing power parity rates. Data are in constant 2011 international dollars	World Health Organization's global health expenditure database	2004–2016
Out-of-pocket expenditure as % total health expenditure	Any direct outlay by households, including gratuities and in-kind payments, to health practitioners and suppliers of pharmaceuticals, therapeutic appliances, and other goods and services. It is a part of private health expenditure	World Health Organization's Global Health Expenditure database	2004–2016
% of total population living in urban areas	Proportion of people living in urban areas in a country in a given year, weighted average	The United Nations Population Division's World Urbanization Prospects	2004–2016

Table 9.3. (*Continued*)

Variable	Description	Source	Years Available
General paediatricians/100,000 of population	General paediatricians per 100,000 of the population. Inclusion – Paediatricians; Neonatologists; Medical interns or residents specialising in paediatrics. Exclusion- Paediatric specialties (e.g. child psychiatry, child/paediatric surgery, child/paediatric gynaecology, paediatric cardiology, paediatric oncology)	European health information gateway	2004–2014
General practitioners/100,000 of population	General practitioners per 100K population. Inclusion – General practitioners – District medical doctors – therapists – Family medical practitioners ('family doctors') – Medical interns or residents specialising in general practice. Exclusion – Paediatricians – Other generalist (non-specialist) medical practitioners	European health information gateway	2004–2015
Nurses/100, 000	Nurses per 100,000 population – Nursing professionals; nursing associate professionals and Midwives	European health information gateway	2004–2015
Population ages 0–19 as % of total population	Percentage of children and young people in population aged 19 years and under	Eurostat	2004–2016
Financing classification	Böhm classification of each country according to financing system; 0 = predominantly societal or social-based financing and 1 = predominantly state or tax financing	Böhm 2013	
Service provision classification	Böhm classification of each country according to service provision types; 0 = predominantly private service provision; 1 = predominantly state service provision	Böhm 2013	
Strength of primary care	Kringos classification of each country according to strength of primary care system (overall score): 0 = weak; 1 = strong; 2 = medium	Kringos 2013	

Table 9.4. Summary descriptive statistics of quantitative variables included in the analysis for the 30 MOCHA countries, 2004–2016 ($N = 390$ is complete data for all countries and all years).

Variables	*N*	Mean	Standard Deviation	Min	Max
Mortality rate/1,000 live births, neonatal	360	3.204	1.804	0.900	12.30
Mortality rate/1,000 live births, infant	360	4.629	2.730	1.500	19.50
Mortality rate/1,000 live births, under five years	360	5.519	3.098	1.900	22.40
Mortality rate <= 19 years/100,000 population, diabetes	390	0.0708	0.0474	0.0184	0.260
Mortality rate <= 19years/100,000 population, epilepsy	390	0.381	0.155	0.149	0.920
GDP per capita, $ PPP	390	35,096	15,243	11,736	97,864
% of population in urban areas	390	73.41	12.51	49.63	97.90
Population aged 0–19 years as % of total population	390	22,23	2.538	18.05	29.64
Out-of-pocket expenditure as % total health expenditure	330	20.44	9.769	5.221	49.70
General paediatricians/100,000 of population	265	14.28	6.236	3.900	30.09
General practitioners/100,000 of population	227	70.94	28.55	13.28	170.00
Nurses/100,000 of population	232	977.6	497.4	29	2,675

GDP growth per capita, out-of-pocket expenditure, urban living and the health-care workforce on child mortality.

Looking at the neonatal, infant and under-five years mortality, the significant negative coefficients indicate that GDP growth per capita is associated with reductions in mortality rates. For infant mortality, for example, the coefficient of the log of GDP (−2.02) represents a change in mortality associated with a 100% growth rate. Hence, a 1% increase in GDP growth per capita would be associated with a reduction of about 0.02 infant deaths per 1,000 live births, with this effect increasing slightly when a two-year lag is included. There is a similar, albeit smaller effect for neonatal mortality, and a larger effect for under-five years mortality. Hence, in a representative country with (say) 750,000 live births per annum, a 1% GDP growth rate would be associated with $0.02 \times 750{,}000/1{,}000 = 15$ fewer infant deaths per annum. Coefficients relate to

Table 9.5. Values of quantitative variables by country – last year for which data were available.

Country	Outcome Measures: Mortality Rates					Explanatory Variables						
	/1,000 Live Births, Neonatal, 2015	/1,000 Live Births, Infant, 2015	/1,000 Live Births, Under Five Years, 2015	<=19 Years/ 100,000 Population, Diabetes, 2016	<=19 Years/ 100,000 Population, Epilepsy, 2016	GDP Per Capita, $ PPP, 2016	% of Population in Urban Areas, 2016	Population Aged 0–19 Years as % of Total Population, 2016	Out-of-pocket Expenditure as % Total Health Expenditure, 2014	Paediatricians/ 100,000 of Population, 2013	General Practitioners/ 100,000 of Population, 2013	Nurses/ 100,000 of Population, 2013
Austria	2.1	2.9	3.5	0.04	0.27	44,143.70	66.0	19.22	16.15	16.21	76.95	803.09
Belgium	2.2	3.3	4.1	0.03	0.37	41,945.69	97.9	22.57	17.81	12.65	111.67	–
Bulgaria	5.6	9.3	10.4	0.11	0.59	17,709.08	74.3	18.27	44.19	19.93	62.93	491.82
Croatia	2.6	3.6	4.3	0.02	0.56	21,408.55	59.3	20.28	11.21	18.52	53.72	658.48
Cyprus	1.5	2.5	2.7	0.12	0.19	31,195.51	66.8	23.44	48.71	–	–	512.92
Czech Republic	1.8	2.8	3.4	0.04	0.33	31,071.75	73.0	19.43	14.33	12.33	70.13	841.28
Denmark	2.5	2.9	3.5	0.05	0.26	45,686.48	87.8	22.83	13.36	7.02	–	1,685.66
Estonia	1.5	2.3	2.9	0.07	0.45	27,735.14	67.5	20.57	20.72	13.43	70.33	587.94
Finland	1.3	1.9	2.3	0.05	0.21	39,422.65	84.4	21.81	18.23	12.93	–	–
France	2.2	3.5	4.3	0.03	0.27	38,058.87	79.8	24.11	6.34	12.09	160.11	999.73
Germany	2.1	3.1	3.7	0.04	0.45	44,072.39	75.5	18.05	13.20	12.38	66.66	1,323.07
Greece	2.9	3.6	4.6	0.03	0.16	24,263.88	78.3	19.33	34.86	30.33	23.36	353.68
Hungary	3.5	5.3	5.9	0.04	0.41	25,381.29	71.7	19.48	26.59	–	–	659.65
Iceland	0.9	1.6	2	0.02	0.26	45,276.45	94.2	26.64	17.48	4.63	58.07	1,626.8
Ireland	2.3	3	3.6	0.04	0.34	62,828.34	63.5	27.57	17.66	9.86	73.17	–
Italy	2.1	2.9	3.5	0.05	0.17	34,620.13	69.1	18.31	21.19	29.01	75.05	634.19
Latvia	5.2	6.9	7.9	0.11	0.30	23,712.09	67.4	19.46	35.13	12.67	–	508.09

Lithuania	2.5	3.3	5.2	0.10	0.33	27,904.10	66.5	20.19	31.27	26.91	86.28	785.28
Luxembourg	0.9	1.5	1.9	0.02	0.33	97,018.66	90.4	22.40	10.60	14.91	85.95	1,230.12
Malta	4.4	5.1	6.4	0.07	0.22	35,694.04	95.5	19.83	28.86	13.93	80.30	744.16
Netherlands	2.4	3.2	3.8	0.04	0.40	47,128.31	91.0	22.53	5.22	9.54	78.50	–
Norway	1.5	2	2.6	0.08	0.34	63,810.79	80.7	24.06	13.61	13.92	78.05	1,720.93
Poland	3.1	4.5	5.2	0.03	0.26	26,003.01	60.5	19.90	23.46	13.17	21.75	587.46
Portugal	2	3	3.6	0.05	0.26	27,006.87	64.0	19.13	26.84	17.80	56.83	629.31
Romania	6.3	9.7	11.1	0.07	0.56	21,647.81	54.7	20.75	18.87	10.97	56.95	552.42
Slovak Rep.	4.2	5.8	7.3	0.05	0.47	29,156.09	53.5	20.44	22.54	–	–	607.81
Slovenia	1.4	2.1	2.6	0.02	0.15	29,803.45	49.6	19.33	12.07	26.22	49.78	838.08
Spain	2.8	3.5	4.1	0.03	0.21	33,261.08	79.8	19.34	23.99	25.53	75.15	532.40
Sweden	1.6	2.4	3	0.05	0.21	46,441.21	86.0	22.46	14.06	10.48	64.53	1,192.12
UK	2.4	3.5	4.2	0.05	0.47	38,901.05	82.8	23.30	9.73	15.10	79.57	867.61

Source: WHO global burden of disease (columns 2–6); WHO global health expenditure database (columns 7–10); European Health Information Gateway (columns 11–13).

Table 9.6. Results of regression modelling.

Variables	Neonatal Mortality/ 1,000 Live Births		Infant Mortality/ 1,000 Live Births		Under-five Years Mortality/ 1,000 Live Births		Mortality from Diabetes, Age 19 Years and Under/ 100,000 Population		Mortality from Epilepsy, Age 19 Years and Under/ 100,000 Population	
		Two-year lag		Two-year lag		Two-year lag		Two-year lag		Two-year lag
Log GDP per capita PPP	−1.255***	−1.565***	−2.012***	−2.441***	−2.388***	−2.848***	0.018	−0.026	0.091	−0.083
	[0.363]	[0.361]	[0.555]	[0.548]	[0.665]	[0.635]	[0.019]	[0.017]	[0.067]	[0.062]
Out-of-pocket as % total health expenditure	0.027**	0.036***	0.014	0.036*	0.023	0.058**	0.002**	0.002***	0.004	0.005*
	[0.014]	[0.014]	[0.021]	[0.021]	[0.025]	[0.025]	[0.001]	[0.001]	[0.003]	[0.003]
% of population in urban areas	−0.026*	−0.005	−0.033	0.008	−0.050*	−0.014	−0.001	−0.001	0.002	0.003
	[0.016]	[0.015]	[0.024]	[0.024]	[0.028]	[0.027]	[0.001]	[0.001]	[0.003]	[0.002]
Paediatricians/100,000 population	−0.017**	−0.019***	−0.032***	−0.035***	−0.037***	−0.039***	−0.000	−0.001*	−0.000	−0.002*
	[0.007]	[0.007]	[0.010]	[0.010]	[0.012]	[0.012]	[0.000]	[0.000]	[0.001]	[0.001]
GPs/100,000 population	−0.008*	−0.013***	−0.019***	−0.031***	−0.021***	−0.027***	−0.000**	−0.000	−0.002***	−0.002**
	[0.004]	[0.004]	[0.006]	[0.007]	[0.008]	[0.008]	[0.000]	[0.000]	[0.001]	[0.001]
Nurses/100,000 population	0.000	−0.000	0.000	0.000	0.000	0.000	−0.000	0.000	−0.000	0.000
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Non-lagged variables										
% of population <= 19 years	0.421***	0.321***	0.651***	0.534***	0.763***	0.589***	0.013***	0.011***	0.033***	0.033***
	[0.031]	[0.033]	[0.047]	[0.051]	[0.056]	[0.058]	[0.002]	[0.002]	[0.006]	[0.006]

Financing (state=1 vs societal=0)	−0.008	0.060	0.149	0.120	0.084	0.078	−0.001	−0.004	−0.004	−0.031
	[0.660]	[0.602]	[1.030]	[0.953]	[1.147]	[1.020]	[0.021]	[0.017]	[0.090]	[0.077]
Service provision (state=1 vs private=0)	−1.072	−0.994	−2.075*	−2.007*	−2.254*	−1.994*	−0.022	−0.014	−0.215**	−0.164*
	[0.723]	[0.662]	[1.128]	[1.047]	[1.259]	[1.123]	[0.023]	[0.019]	[0.099]	[0.085]
Primary care overall score (strong=1 vs weak=0)	0.229	0.178	0.413	0.538	0.556	0.549	0.049**	0.037*	0.216**	0.176**
	[0.693]	[0.637]	[1.080]	[1.005]	[1.208]	[1.082]	[0.023]	[0.019]	[0.096]	[0.083]
Primary care overall score (medium=1 vs weak=0)	0.148	0.281	0.229	0.670	0.219	0.593	0.027	0.025	0.144	0.130
	[0.682]	[0.627]	[1.063]	[0.989]	[1.189]	[1.064]	[0.023]	[0.019]	[0.095]	[0.082]
Constant	9.194	13.131	15.295	19.474	18.966	24.404	−0.320	0.111	−1.414	0.271
	[4.402]	[4.379]	[6.742]	[6.692]	[8.002]	[7.658]	[0.222]	[0.197]	[0.780]	[0.717]
Observations	166	164	166	164	166	164	166	166	166	166
Number of countries	23	23	23	23	23	23	23	23	23	23

Note: Standard errors in brackets; ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

marginal changes that only apply to the sample averages, with confidence intervals increasing away from the average.

The results also indicate that medical workforce density has a significant effect in reducing mortality rates. For neonatal mortality, for example, an increase in the number of general paediatricians (includes neonatologists) by 1 per 100,000 of the population is associated with, on average, a decrease in neonatal deaths of 0.017 per 1,000 live births. Likewise, an increase in the number of GPs by 1 per 100,000 population is associated with a decrease in neonatal deaths of 0.008 per 1,000 live births. Significant effects are also seen for infant and under-five years mortality; the effects are slightly larger with two-year lagged variables in the models. The average number of paediatricians in the MOCHA countries is about 14 per 100,000 of the population (Table 9.4). An increase in one paediatrician per 100,000 of the population in a country with 750,000 live births per annum would be associated with a reduction in neonatal deaths per 1,000 live births of 750,000/1,000*0.017 = 12.75 fewer deaths per annum. This calculation assumes no constraints on the availability of the technologies required for caring for newborns.

For ambulatory care-sensitive conditions in children and young people of 19 years or younger, however, growth in GDP per capita and density of general paediatricians show no significant effect on mortality rates. An increase in the number of GPs per 100,000 of the population has an effect on mortality, but it is very small, and not significant in the lagged diabetes model.

An increase in OOP expenditure as a percentage of total health expenditure is seen to significantly increase neonatal mortality rates and mortality from diabetes in children and young people aged 19 years and younger than 19 years. A 1% point increase in OOP payments as a percentage of total health expenditure, on average, is associated with an increase in diabetes deaths in the 0–19 age group by 0.002 deaths per 100,000 of the population, other things held constant; lower OOP expenditures are associated with lower mortality. This effect is also seen in neonatal and the under-five years mortality lagged model and marginally on mortality from epilepsy. In the neonatal model, a 1% point decrease in OOP expenditures as a percentage of total health expenditure is associated, on average, with a 0.027 fewer deaths per 1,000 live births.

Strength of primary care does not have a statistically significant effect on neonatal, infant and under-five years mortality. However, for diabetes and epilepsy mortality rates in children and young people aged 0–9 years, strong primary care systems, compared to weak systems, are associated with higher mortality rates. A country having a primary care system rated as strong is predicted to have higher mortality from diabetes of 0.049 per 100,000 of the population, compared to countries whose primary care system is rated as weak; the effect is 0.216 per 100,000 of the population in the epilepsy un-lagged model. When service provision is predominantly by the state rather than private enterprise, mortality rates from epilepsy ages 0–19 years are predicted to be lower by 0.215 per 100,000 of the population. Diabetes, neonatal, infant and under-five years mortality rates, however, are not affected by mode of service provision. The method of financing health care is unrelated to any mortality variable.

A higher proportion of a country's population in the 0–19 age group exerts a worsening effect on all types of mortality. For example, for infant mortality, a 1% point increase in the proportion of the population aged 0–19 years is associated, on average, with an increase in infant mortality by 0.651 per 1,000 live births. A 1% point increase in population of the population aged 0–19 is associated, on average, with an increase in deaths from diabetes in children and young people aged 0–19 years by 0.013 per 100,000 of the population.

Discussion

The results of the analysis suggest that mortality in the early years is lower in MOCHA countries where the GDP per capita is higher. GDP per capita is an indicator of average income levels and is closely correlated with expenditure on health care. Many other studies have consistently shown a significant positive effect of a country's GDP per capita and health expenditures on the health and well-being of the population (Swift, 2011) and on infant mortality in particular (Erdogan, Ener, & Arica, 2013; Nixon & Ulmann, 2006; Rad et al., 2013). Within MOCHA countries, lower mortality in early years is also associated with a larger medical workforce (GPs and general paediatricians) per 100,000 of the population. More GPs per 100,000 of the population is also a predictor of lower mortality among children and young people aged 0–19 years from epilepsy and diabetes.

Consistent across all mortality indicators was the independent effect of the number of children and young people in the population. As this increased, mortality rates rose, suggesting that larger family size is a risk factor. Higher OOP expenditure on health was associated with higher neonatal mortality and mortality from diabetes in the 0–19 age group, but not with other mortality indicators.

Healthcare system variables were mostly found to not significantly influence mortality. Countries with primary care systems that were classified as strong (compared to weak) were associated with higher mortality from diabetes and epilepsy in children and young people, although the strength of primary care was unrelated to mortality in the early years. State provision of health care rather than private was associated with lower epilepsy mortality, but no other mortality outcome. Financing mechanism was insignificant for all outcomes.

There are many drawbacks with the analysis that limit the inferences that can be drawn from it. As explained above, data deficiencies constrained the choice of both outcome measures and explanatory variables. The absence of consistent reporting of child *health* outcomes across countries necessitated the use of mortality indicators, which are inadequate measures of quality of primary care. Of the available explanatory variables, time series were incomplete, particularly with respect to workforce data, thereby reducing the number of countries included in the analysis and opening up the possibility of bias. Many quantitative and qualitative factors contribute to health outcomes, and the relationships are complex (Nixon & Ulmann, 2006). The model of health production that was used in this study is likely to have excluded many factors.

The key focus of the MOCHA project was on the quality of primary care for children, but available expenditure, workforce and outcome data are gathered for countries as a whole and information related to children and the primary care sector cannot be separated out. The use of the primary care quality indicator derived in the PHAMEU study (Kringos et al., 2013) in the analysis produced a counter-intuitive finding that stronger primary care systems are associated with higher mortality than in countries with systems classified as weaker. This may be because the criteria were selected for assessing primary care in general, and not specifically for evaluating the quality of primary care for children. In addition, the three-level overall score (strong, medium and weak) used in the analysis (an average of seven different dimensions) may have been insufficiently sensitive to reflect mortality differences. Other studies using a more disaggregated description of primary care have found associations with health outcomes (Macinko, Starfield, & Shi, 2003). Similarly, mortality rates were generally not affected by differences in healthcare system financing and service provision features between countries, possibly due to the breadth of the categories and within country variability.

Conclusion

This study presents one of the few cross-sectional, time series analyses that explores the association between healthcare system features, primary care quality and child mortality outcomes. Keeping in mind the ecological nature of the analysis, and the limitations presented by the data and measures employed, several tentative conclusions can be drawn. National health expenditure and the general medical workforce density appear to reduce mortality among infants and children and young people with conditions thought to be sensitive to primary care. OOP expenditure exerts pressure on the resources of families and worsens some indicators, while potentially deepening health inequalities.

References

Amadeo, K. (2018). *Standard of living*. Retrieved from http://www.thebalance.com/standard-of-living-3305758

Böhm, K. (2012). *Classifying OECD healthcare systems: A deductive approach*. Retrieved from http://www.socium.uni-bremen.de/f/4912881dfe.pdf

Böhm, K., Schmid, A., Götze, R., Landwehr, C., & Rothgang, H. (2013). Five types of OECD healthcare systems: Empirical results of a deductive classification. *Health Policy*, *113*(3), 258–269. doi:10.1016/j.healthpol.2013.09.003

Budhdeo, S., Watkins, J., Atun, R., Williams, C., Zeltner, T., & Maruthappu, M. (2015). Changes in government spending on healthcare and population mortality in the European union, 1995–2010: A cross-sectional ecological study. *Journal of the Royal Society of Medicine*, *108*(12), 490–498. doi:10.1177/0141076815600907

Erdogan, E., Ener, M., & Arica, F. (2013). The strategic role of infant mortality in the process of economic growth: An application for high income OECD countries. *Social and Behavioural Sciences*, *99*, 19–25. doi:10.1016/j.sbspro.2013.10.467

Gill, P., O'Neill, B., Rose, P., Mant, D., & Harnden, A. (2014). Primary care quality indicators for children. *British Journal of General Practice*, *64*(629), e752–e757. doi:10.3399/bjgp14X682813

Kringos, D. S., Boerma, W., van der Zee, J., & Groenewegen, P. (2013). Europe's strong primary care systems are linked to better population health but also to higher health spending. *Health affairs*, *32*(4), 686–694. doi:10.1377/hlthaff.2012.1242

Macinko, J., Starfield, B., & Shi, L. (2003). The contribution of primary care systems to health outcomes within Organization for Economic Cooperation and Development (OECD) countries, 1970–1998. *Health Services Research*, *38*(3), 831–865.

Nixon, J., & Ulmann, P. (2006). The relationship between health care expenditure and health outcomes. *The European Journal of Health Economics*, *7*(1), 7–18. doi:10.1007/s10198-005-0336-8

Rad, E. H., Vahedi, S., Teimourizad, A., Esmaeilzadeh, F., Hadian, M., & Pour, A. T. (2013). Comparison of the effects of public and private health expenditures on the health status: A panel data analysis in eastern Mediterranean countries. *International Journal of Health Policy and Management*, *1*(2), 163–167. doi:10.15171/ijhpm.2013.29

Rigby, M. J., Köhler, L. I., Blair, M. E., & Metchler, R. (2003). Child health indicators for Europe: A priority for a caring society. *European Journal of Public Health(Suppl)*, *13*(3), 38–46.

Swift, R. (2011). The relationship between health and GDP in OECD countries in the very long run. *Health Economics*, *20*. doi:10.1002/hec.1590

Tian, Y., Dixon, A., & Gao, H. (2012). *Emergency hospital admissions for ambulatory care sensitive conditions*. Data briefing, The Kings Fund. Retrieved from https://www.kingsfund.org.uk/sites/default/files/field/field_publication_file/data-briefing-emergency-hospital-admissions-for-ambulatory-care-sensitive-conditions-apr-2012.pdf

Wells, H. (2017). Contribution to Blair, M., Rigby, M., Alexander, D. *Final report on current models of primary care for children* (Part I, Chapter 8). Retrieved from www.childhealthservicemodels.eu/wp-content/uploads/2017/07/MOCHA-WP1-Deliverable-WP1-D6-Feb-2017-1.pdf