



## Short report

## Maternal leave policies and vaccination coverage: A global analysis

Mark Daku<sup>a,b,\*</sup>, Amy Raub<sup>b</sup>, Jody Heymann<sup>a,b,c</sup><sup>a</sup> Department of Political Science, McGill University, Canada<sup>b</sup> Institute for Health and Social Policy, McGill University, Canada<sup>c</sup> Department of Epidemiology, Biostatistics and Occupational Health, McGill University, Canada

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## ABSTRACT

Childhood vaccination is a proven and cost-effective way to reduce childhood mortality; however, participation in vaccination programs is not universal even where programs are free or low cost. Studies in diverse countries have reported work conflicts as limiting parents' ability to vaccinate their children. Using policy data for 185 UN member countries, we explore the hypothesis that an increased opportunity for parents to bring children to vaccination sites will translate into higher childhood vaccination rates. To do so, we use OLS regression to examine the relationship between the duration of adequately paid maternal leave and the uptake of vaccines. We find that a higher number of full-time equivalent weeks of paid maternal leave is associated with higher childhood vaccination rates, even after controlling for GDP per capita, health care expenditures, and social factors. Further research is needed to assess whether this association is upheld in longitudinal and intervention studies, as well as whether other forms of leave such as paid leave to care for the health of family members is effective at increasing the ability of parents to bring children for needed preventive care.

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## Introduction

The health benefits of childhood vaccination are clear, however even in places where vaccinations are free and widely available, uptake is not universal (Creese & Henderson, 1980; Soares, 2007; Trunz, Fine, & Dye, 2006). While physical availability of vaccines, mass media campaigns, and maternal education are important factors for improving vaccination outcomes, perceived distance to clinics, poverty, transportation and parents' work schedules all create barriers to access (Danis, Georgakopoulou, Stavrou, Laggas, & Panagiotopoulos, 2010b; Niederhauser & Markowitz, 2007; Paschal, Maryman, & Oler-Manske, 2009; Pérez-Cuevas et al., 1999; Racine and Joyce 2007; Semali, 2010; Shefer et al., 1999). Parental work schedules are a common concern, and diverse studies from the United States, Haiti and Indonesia report 'conflicting work schedules' as one reason why parents do not vaccinate their children (Coreil, Augustin, Halsey, & Holt, 1994; McCormick, Bartholomew, Lewis, Brown, & Hanson, 1997; Niederhauser & Markowitz, 2007; Paschal et al., 2009). Herein, we assess whether sufficiently long paid maternal leave can provide families with the opportunity to

vaccinate their children without necessitating a trade-off between earning income and providing preventive health care for infants.

## Background

Paid maternal leave can remove the conflict between work and child health, and increases in leave availability and duration have been positively correlated with child health, specifically with breastfeeding outcomes and variations in child development (Baker & Milligan, 2006; Chuang et al., 2010; Ruhm, 2000; Staehelin, Bertea, & Stutz, 2007). Ruhm (2000) finds that the most likely reason for this correlation is the increase in available time that parents can direct towards young children.

As vaccines must be administered at specific times (see Table 1), we expect that maternal leave which offers support which covers these timelines will result in higher vaccination uptake due to a reduction in work conflicts.

Existing evidence linking maternal leave duration and childhood vaccination rates is limited. There is some evidence that an early return to work negatively impacts later DPT and Polio vaccinations, though this research is limited to the United States and examines when mothers return to work, not the amount of leave available for them to take (Berger, Hill, & Waldfogel, 2005). Tanaka (2005) examined duration of leave in OECD countries and did not find a relationship with vaccination uptake. To date a global

\* Corresponding author.

E-mail addresses: [mark.daku@mail.mcgill.ca](mailto:mark.daku@mail.mcgill.ca) (M. Daku), [amy.raub@mcgill.ca](mailto:amy.raub@mcgill.ca) (A. Raub), [jody.heyman@mcgill.ca](mailto:jody.heyman@mcgill.ca) (J. Heymann).

**Table 1**  
WHO recommendations for routine childhood vaccinations.

Antigen	Age of 1st dose	Interval between doses	
		1st and 2nd	2nd and 3rd
Bacillus Calmette-Guérin (BCG)	As soon as possible after birth		
Diphtheria, pertussis and tetanus (DPT)	6 weeks (minimum)	4 weeks (minimum)	4 weeks (minimum)
Polio	6 weeks (minimum)	4 weeks (minimum)	4 weeks (minimum)
Measles	39 weeks (minimum)		

(Adapted from WHO, 2009).

analysis of the relationship between paid maternal leave and vaccination outcomes has not been performed. Moreover, an analysis which incorporates the impact of both duration and wage replacement rate (WRR) has not been conducted. As maternal leave of adequate duration and pay may increase the ability to access health services, its effect on vaccination outcomes is worth further examination.

## Methods

First, the current state of maternal leave relative to vaccination schedules is examined globally. Second, the impact of variation in paid maternal leave on vaccination rates is assessed using ordinary least squares (OLS) regression.

## Hypotheses

Vaccinations are grouped according to the length of time required to complete the vaccination schedule, creating two categories: early and later vaccinations. It is expected that most mothers would take leave for the first few days after pregnancy, regardless of official policies. Thus, we expect that paid maternal leave will not affect BCG vaccination. As lengthier unpaid leaves are less affordable than shorter ones, we anticipate later vaccines to be affected most by paid maternal leave.

**Hypothesis 1:** Paid maternal leave will have a smaller effect on the two vaccines that are recommended to be fully administered immediately or shortly after birth: BCG and the first dose of DPT.

**Hypothesis 2:** Vaccines that are recommended to be administered later in the child's first year of life will demonstrate a greater increase in uptake due to increases in paid maternal leave. The final doses of DPT, Polio and Measles are included in this group.

**Hypothesis 3:** An adequate WRR is critical to the ability of women to make full use of maternal leave. As a result, a measure of maternal leave that captures both duration and WRR will better predict vaccination rates than duration alone.

**Table 2a**  
Distribution of paid maternal leave and minimum WRR by Region.<sup>a</sup>

	Mean Weeks	0–6 Weeks	6.1–14 Weeks	14.1–39 Weeks	> 39 weeks	WRR	N
Americas	15.30 (10.41)	1	24	7	2	84.27 (19.10)	34/33 <sup>b</sup>
East Asia & Pacific	15.03 (14.52)	4	15	5	2	67.8 (30.53)	26/20
Europe & Central Asia	67.28 (55.58)	0	2	21	29	85.73 (19.63)	52/49
Middle East & North Africa	11.44 (3.47)	1	15	3	0	85.74 (23.38)	19/19
South Asia	13.20 (2.72)	0	5	2	0	97.67 (5.72)	7/6
Sub-Saharan Africa	11.68 (4.06)	4	40	3	0	88.38 (21.64)	47/42
Global	28.48 (38.78)	10	101	41	33	84.41 (22.42)	185/169

<sup>a</sup> World Bank regional categories, standard deviations in parentheses.

<sup>b</sup> The first number reflects the number of observations for paid maternal leave, the second for the minimum WRR.

## Data sources

Maternal leave policy data are drawn from the World Legal Rights Data Centre (WoRLD) hosted at the Institute for Health and Social Policy (IHSP) at McGill University (Heymann & Earle, 2010; IHSP, 2010). Data was collected from national labor codes and legislation using the International Labor Organization's (ILO) NAT-LEX database. Additional legislation was gathered through individual country websites, and the law libraries of Harvard University, McGill University and the ILO. National labor policies were supplemented by data from the Social Security Programs Throughout the World (SSPTW) database. Data was collected by multiple research team members, double coded, reconciled, and cross-checked with other sources including the ILO Maternity Protection Database and the ILO Working Time Database. Data was sought for all UN member states, with sufficient data on maternal leave policy available for 185 countries.

## Measures

### Maternal leave duration (2006)

'Maternal leave' is defined as the sum of leave which is specifically for the mother (maternity leave) and gender-neutral leave that is available for the mother to take (parental leave).

### Maternal leave FTE weeks (2006)

Duration alone does not capture opportunity, and as seen in Table 2a there is significant variation for both the WRR and length of leave. If paid maternal leave is guaranteed for 26 weeks, but only at 10% of full-time wages, taking the full amount of time available would represent large financial costs. Thus, we construct a variable that captures how many weeks of full-time wage replacement are available in each country.

The full-time equivalent (FTE) weeks measure is the product of a country's policy duration and its WRR. Where a flat amount is paid in lieu of a percentage, FTE weeks are calculated by dividing the amount by the average wages of full-time female employees in the country. Where mothers are entitled to a percentage of wages up to a specified earnings cap, the percentage was used unless the cap is below the average wages of full-time female employees.

We employ a log measure of FTE weeks of maternal leave. The logged FTE weeks variable places more importance on gains on the lower end of the spectrum and is expected to be a better predictor than a linear measure, as most vaccines are scheduled to occur in the first 4–6 months of life.

### Immunization rates

Using 2007 data from UNICEF, the following vaccines are examined, reflecting coverage for all one-year-olds: Bacillus Calmette-Guérin (BCG), diphtheria, pertussis and tetanus (DPT), Polio and Measles (UNICEF, 2009). UNICEF provides measures for

the first (DPT1) and final (DPT3) doses of DPT, both of which are employed in this analysis. Globally, earlier vaccines have very high coverage, with the mean BCG and DPT1 rates being 91% (standard deviation of 11.6) and 93% (standard deviation of 8.9), respectively. The later vaccines have lower coverage, with DPT3, Polio and Measles all exhibiting means of 87% (standard deviations of 14.2, 13.9 and 14.1, respectively).

#### Control variables

The following control variables are included due to their posited relation to vaccination outcomes. As governments with more resources (indicated by GDP), a greater commitment to health (indicated by health expenditures and birth attendance), and greater gender equality (indicated by female education and labor force participation) may also be more likely to invest in maternal leave, it is particularly important to control for these factors in the regression analysis.

#### Total health expenditures (2006)

Taken from the WHO Statistical Information System (WHOSIS) for, this variable measures the total expenditures on health care as a percentage of gross domestic product (WHO, 2007). This measure includes both government and private sector funding.

#### Government health expenditure (2006)

Also taken from WHOSIS (WHO, 2007), this variable measures government expenditures on health as a percentage of total expenditures on health services and programs, and thus provides a useful estimate for the relative importance of government provision of health services.

GDP per capita (2007) is taken from the World Bank's World Development Indicators (WDI) Online (World Bank, 2010). GDP is adjusted for constant international dollars, and is measured in terms of purchasing power parity (PPP). We use a log transformation of per capita GDP instead of a linear term as we assume changes at the higher end of the income spectrum have less impact than changes at the lower end.

#### Attendance of a skilled health practitioner at birth (2006)

This variable captures the percentage of births presided over by a doctor, a nurse, or a midwife, and is taken from WHOSIS (WHO, 2007). Access to a skilled health practitioner may mean delivery in a location that provides access to initial vaccinations. Furthermore, there is evidence that information about specific vaccines, and knowledge about the appropriate vaccination schedule transmitted by the health provider, can positively impact vaccination rates (Babalola & Lawan, 2009; Bhuiya, Bhuiy, & Chowdhury, 1995; Ray et al., 2004; Wood et al., 1998).

#### Percentage of women in the formal labor force (2006)

It is important to control for how much of each country's labor force is composed of women. This variable is taken from the WDI dataset and reflects the percentage of a country's total work force that are women.

#### Female literacy rate (2006)

Data on female literacy is provided by the World Bank. We include female literacy as there is evidence that maternal education is related to childhood immunization, and that not knowing the benefits of vaccination, or not knowing where one could be vaccinated, are determinants of poor vaccination rates in children (Bhuiya et al., 1995; Bondy, Thind, Koval, & Speechley, 2009; Danis, Georgakopoulou, Stavrou, Laggas, & Panagiotopoulos, 2010a; Luman, McCauley, Shefer, & Chu, 2003).

## Results

The first part of our analysis examined current levels of maternal leave globally and how their duration relates to common immunization timing (BCG at 0 weeks, DPT1 at 6 weeks or more, DPT3 at 14 or more weeks, Polio at 14 or more weeks and Measles at 39 or more weeks).

Globally, 95% of countries provide enough paid maternal leave weeks to allow for DPT1 vaccination and 40% provide enough for DPT3 and Polio. Only 18% of countries provide sufficient paid maternal leave for the Measles vaccinations. As seen in Table 2a, while the mean levels of paid maternal leave are fairly consistent, globally there is significant variation in leave duration and WRRs (A country-by-country breakdown is available as an online Appendix). Table 2b details the variation in the distribution of FTE weeks across regions.

The second part of our analysis employed a multivariate analysis to examine the association between maternal leave and vaccination rates after controlling for economic, systemic and social factors. Increased duration of paid maternal leave in FTE weeks was associated with statistically significant increases of vaccination rates for each immunization studied (see Tables 3 and 4). For the early vaccines, after transforming the logged variables to percentages, a 10% increase in FTE weeks is associated with a 16.3 and a 15.0 percent increase for BCG and DPT1, respectively. For example, a country with 80% BCG coverage would be predicted to increase to 96.3% with a 10% increase in FTE weeks. Duration alone is not significantly associated with early immunization rates.

The duration of paid maternal leave is significant for each later vaccination examined, however its effect is substantively less than that demonstrated by FTE weeks. Each 10% increase in FTE weeks is associated with 22.4, 25.3 and 22.2 percent increases in DPT3, Measles and Polio vaccination rates, respectively.

## Discussion

In many countries there is a gap between the amount of maternal leave available and the amount that would allow for mothers to use leave as a time when their children can be fully vaccinated. While 159 countries provide enough FTE weeks to cover the first DPT vaccination, only 78 provide enough time for the completion of either the DPT or the Polio regimens, and only 19 countries provide enough time for children to be fully vaccinated against Measles.

By employing a global dataset, this research goes beyond Berger et al.'s single country study (2005) to demonstrate a significant association globally between later vaccination outcomes and paid maternal leave. We also find that there is a benefit to increasing FTE weeks of paid maternal leave even for those vaccines administered soon after birth (DPT1 and BCG). The positive impact on DPT1 is likely due to the fact that in the absence of paid maternal leave women may need to return to work prior to the first DPT

**Table 2b**  
Distribution of FTE weeks by region.<sup>a</sup>

	Mean Weeks	0–6 Weeks	6.1–14 Weeks	14.1–39 Weeks	> 39 Weeks	N
Americas	12.63(7.15)	2	23	8	1	34
East Asia & Pacific	8.93 (8.10)	11	9	5	0	25
Europe & Central Asia	33.75 (21.87)	0	6	25	18	49
Middle East & North Africa	10.23 (3.76)	3	14	2	0	19
South Asia	12.12 (2.07)	0	5	1	0	6
Sub-Saharan Africa	10.25 (4.36)	6	37	2	0	45
Global	17.05 (16.19)	22	94	43	19	185

<sup>a</sup> World Bank regional categories, standard deviations in parentheses.

**Table 3**  
Maternal leave, early vaccinations.

	BCG		DPT1 (First Dose)	
	Model 1	Model 2	Model 1	Model 2
Logged Duration of Paid Maternal Leave	0.505 (0.541)	–	0.874 (0.165)	–
Log of FTE Weeks	–	1.715* (0.077)	–	1.575** (0.031)
Total Health Expenditure	0.483 (0.248)	0.389 (0.35)	0.604** (0.048)	0.594** (0.049)
Government Health Expenditure	0.295 (0.548)	0.032 (0.515)	0.053 (0.199)	0.052 (0.212)
Attendance of a skilled health practitioner at birth	0.205*** (0.001)	0.218*** (0.000)	0.101* (0.051)	0.111** (0.032)
% of Women in the Labor Force	–0.076 (0.439)	–0.083 (0.373)	–0.131 (0.108)	–0.121 (0.128)
Female Literacy Rate	0.040 (0.525)	0.043 (0.495)	0.052 (0.344)	0.047 (0.403)
GDP per capita (PPP)	–1.113 (0.391)	–1.411 (0.276)	–0.275 (0.777)	–0.208 (0.831)
Observations	113	109	130	126
R-squared	0.382	0.429	0.337	0.369

*p*-values in parentheses.

\*significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

immunization, while the positive impact on BCG may reflect the fact that skilled birth attendants are not present for 34% of births worldwide, making immediate post-natal BCG vaccination less likely (WHO, 2011). For vaccinations provided months after birth, the relationship between paid maternal leave and vaccination rates which was observed may be due to the increased opportunity that paid maternal leave affords mothers to access vaccinations for their children, lending additional support to the hypothesis that increases in opportunity to access care can lead to better childhood health outcomes. We also demonstrate that countries that have low levels of paid leave stand to benefit substantially in terms of vaccination outcomes.

While the cross sectional nature of available data allows us to establish only a significant association, there are mechanisms that make the case for a causal link between the length of maternal leave and immunization plausible. We took a number of steps in this study to address the potential confounders. While sample size and global data availability limit the number of covariates which can be included, these models have controlled for major contributors including health care delivery as indicated by expenditures,

gender equity as indicated by female literacy, and national resources as indicated by GDP per capita. However, there are other factors that may confound results. The cost to families of obtaining immunizations (including clinic visits, transportation, and time away from work if off-hours vaccines are not offered) can be a barrier to access and may also be a product a government's commitment to public health. While we control for health expenditures, we do not have information on specific government policies and subsidies that support childhood vaccination. Other forms of paid leave such as days off to attend children's health needs are likely to also have a positive effect on vaccination rates. While it would be valuable to know the relative effect of paid paternal leave, far fewer countries offer paid paternal leave of long enough duration that it could affect vaccination rates, so we are unable to test this question quantitatively. Furthermore, two vaccinations were not included due to data limitations: data on Haemophilus influenza type b (HIB3) was available for less than half of the countries, and data on Hepatitis B vaccination rates were not accompanied by a universally recommended schedule and country specific schedules were unavailable.

This new policy dataset allows for the first time global studies that examine the association between national maternal leave policies and immunization rates. The critical next step will be linking this data on national policies to household-level survey data on individual outcomes for multi-level modeling, and the examination of the impact of changes in maternal leave on vaccination rates in longitudinal studies, as well as intervention trials to better assess causality. A number of nations exhibit within-country variation in access to leave, depending on the amount of time worked, or the industry one is employed in. Analyzing individual mothers' access to paid maternal leave and the vaccination outcomes of their children would have the dual benefit of accounting for within-country variation while strengthening the case for a causal relationship. Future studies should also be directed at assessing the efficacy of additional mechanisms which can increase opportunities to access health care services, such as paid leave for child health, paternal leave and paid sick leave.

While increasing vaccination rates alone would not be a reason to extend maternal leave if alternatives are available, the benefits of paid maternal leave go well beyond the improved vaccination outcomes demonstrated here. Maternal leave has been positively associated with breastfeeding uptake and improvements in child

**Table 4**  
Maternal leave, later vaccinations.

	DPT3 (Final Dose)		Measles (First Dose)		Polio (Final Dose)	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Logged Duration of Paid Maternal Leave	1.533* (0.089)	–	1.986** (0.038)	–	1.694** (0.050)	–
Log of FTE Weeks	–	2.350** (0.023)	–	2.653** (0.017)	–	2.330** (0.019)
Total Health Expenditure	0.583 (0.179)	0.576 (0.176)	0.298 (0.516)	0.262 (0.563)	0.322 (0.436)	0.305 (0.453)
Government Health Expenditure	0.053 (0.371)	0.052 (0.376)	0.066 (0.292)	0.058 (0.355)	0.077 (0.174)	0.072 (0.200)
Attendance of a skilled health practitioner at birth	0.214*** (0.004)	0.236*** (0.001)	0.143* (0.067)	0.167** (0.032)	0.161** (0.023)	0.186*** (0.008)
% of Women in the Labor Force	–0.120 (0.302)	–0.098 (0.382)	–0.126 (0.305)	–0.099 (0.408)	–0.165 (0.136)	–0.141 (0.189)
Female Literacy Rate	0.067 (0.398)	0.048 (0.547)	0.184** (0.029)	0.172** (0.044)	0.120 (0.113)	0.102 (0.179)
GDP per capita (PPP)	0.312 (0.822)	0.583 (0.673)	–0.600 (0.682)	–0.370 (0.802)	0.504 (0.703)	0.793 (0.548)
Observations	130	126	130	126	130	126
R-squared	0.447	0.482	0.411	0.439	0.475	0.509

*p*-values in parentheses.

\* significant at 10%; \*\* significant at 5%; \*\*\* significant at 1%.

development, reduced morbidity and mortality rates in children, and better health of mothers (Baker & Milligan, 2008; Chuang et al., 2010; McGovern et al., 1997; Ruhm, 2000; Staehelin et al., 2007). While costs for improving paid leave will vary depending on factors such as wage levels and the number of women in the workforce, this analysis provides an additional reason to pursue stronger leave policies and extends the evidence of the role that social policies outside of health care can play in influencing health care outcomes.

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## Appendix. Supplementary material

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.socscimed.2011.10.013.

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