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The global scale and implications of delivering multiple interventions through integrated child health events

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ABSTRACT

Introduction Delivering child health services through integrated child health events (ICHEs) has been a useful and popular strategy implemented in many in low-income and middle-income countries (LMICs) to accelerate the reduction of child mortality. The study aims to portray the scope of ICHEs and examine the association between the number of child health-nutrition interventions and types of ICHE packages delivered through these campaigns with vitamin A supplementation (VAS) and measles vaccination.

Methods Secondary data analysis was conducted using Unicef global campaign database (1999–2010), where 597 ICHEs from 76 countries were analysed. Panel random effects regression models were used to explore the association between the number of interventions and coverage for VAS and measles vaccination, and non-parametric Kruskal-Wallis test to explore the association between different intervention packages and VAS coverage.

Results An average of 100 ICHEs were conducted per year between 2005 and 2010, highest in sub-Saharan Africa (60%). By 2010, 40 ICHEs out of 66 (60%) across 24 countries delivered 5 or more interventions during 1 ICHE. No statistically significant effect of the number of ICHE interventions on VAS coverage was found (–0·76, p=0·185). There was a small significant effect on measles coverage (–1·81, p=0·057), which was not robust to model specifications removing outlier observations with measles coverage lower than 40%. The Kruskal-Wallis test did not suggest a significant association between different intervention packages and VAS coverage at 5% significance level (p=0·07).

Conclusion ICHEs were found to be a widely used strategy to deliver essential child health-nutrition interventions in LMICs. ICHEs appear to represent a commonly used platform with the capacity to incorporate multiple interventions without compromising coverage of some key interventions as VAS and measles vaccination. More research is required to better understand what operational factors may affect the coverage outcomes delivered together through ICHEs.

Key questions

What is already known?

- In low-income and middle-income countries (LMICs), where access to health services is problematic and the health system is weak, a nationwide campaign outreach approach is a predominant child health service delivery strategy to reach as many children as possible in a relatively short period of time.
- There has been a dramatic increase in the number of key child health and nutrition interventions delivered through integrated child health events (ICHEs), where up to 96 events in 2010 from 2 events in 1999, with 73 countries having carried out these campaigns by 2010.

What are the new findings?

- The study demonstrated that ICHEs are a frequently used platform, often delivering multiple interventions without compromising coverage outcomes of some key interventions delivered through the campaigns.
- This study provides a comprehensive analysis of ICHEs exploring at a much wider range of child health campaign models implemented globally by combining both Child Health Days and immunisation-focused campaigns.

What do the new findings imply?

- This study illustrates the continued prominence of campaign-mode of health service delivery (specifically ICHEs), suggesting that their role as a means of delivering multiple child health services in LMICs should be re-thought in line with health system strengthening.
- This study may open up choices for policymakers and project managers to potentially add-on more interventions when delivering child health and nutrition services through campaigns. However, systematic collection and analysis of operational data related to ICHE are critical to better understand the determinants of their effectiveness.

INTRODUCTION

Expanding access to cost-effective child health services through integrated child health events (ICHEs) has been recognised as a viable strategy and implemented in many settings to accelerate the reduction of child mortality in low-income and middle-income countries (LMICs). Pursuing multiple delivery of interventions through ICH campaigns is considered an important driver to accelerate progress to reduce child mortality towards the Sustainable Development Goals. This has occurred in parallel to other mainstream models of delivery of key child health interventions where access to health services is problematic and the health system is weak, particularly in many countries in sub-Saharan Africa. A nationwide campaign approach has been used in over 73 countries, with 154 events conducted in 2010 alone, with an average of 100 campaigns conducted globally per year.[1] However, the relationship between the number of interventions delivered or with the different packages of interventions and coverage outcomes of specific interventions, such as vitamin A supplementation (VAS) and measles, has been underexplored.

ICHEs—a terminology developed for this study—can be broadly defined as any campaign-style events that deliver two or more maternal and child health and nutrition services at any given time during any given year. These campaigns are manifested in various forms and are referred to as by different names (table 1). This new terminology encompasses the wide variety of campaigns revealed in various forms. Creating the ICHE terminology enabled the exploration of these interventions from a broader perspective rather than examining Child Health Days (CHDs) or immunisation campaigns separately, as there are many commonalities and overlaps as well as differences between these. Having a common terminology for these integrated campaigns enabled a comprehensive analysis and provided an overall picture of how these types of events function.

This analysis focused on the combinations of two main types of ICHEs: (1) *CHDs* and (2) *immunisation-focused campaigns*. The main difference between ICHEs and CHDs is that ICHE is an overarching terminology that includes CHD and immunisation-focused campaigns. CHDs are conducted twice a year, usually 6 months apart and always include VAS. The two immunisation-focused campaigns analysed are measles supplementary immunisation activities (SIAs) and polio national immunisation days (NIDs) (box 1 for the definition of key terminologies). Other types of disease prevention campaigns were not fully captured in the data set used in this study.

Many LMICs have been able to provide additional health service packages using the campaign-style delivery approaches to take advantage of available resources and 'piggy-back' on existing delivery mechanisms.[2 3] A growing body of evidence has suggested that the delivery of child health and nutrition interventions through immunisation delivery channels has helped to achieve rapid, high and equitable coverage[4 5] at low cost.[6–8] There are also indications that integrated delivery, such as CHDs and SIAs, contribute to improved immunisation coverage.[9 10] Other studies showed SIAs improving access and efficiency[11] and reducing disease outbreaks,[12] and CHDs greatly enhancing VAS and other intervention coverage outcomes.[13 14] Even where routine immunisation is strong, immunisation contacts were found to serve as excellent vehicles for delivering additional interventions.[15 16]

Table 1 Different manifestations of integrated child health events

Name	Countries
Child Health Days	
Child Days Plus	Uganda
Child Health Days	Botswana, Ghana, Guinea-Bissau, Liberia, Mali, Mauritania, Senegal, Sierra Leone, Somalia, Swaziland and Togo
Child Health Week	Mozambique and Zambia
Child Survival Campaign	Central Africa Republic, Chad, the Democratic Republic of the Congo, Guinea and Senegal
Enhanced Outreach Strategy	Ethiopia
Maternal and Child Health Week	Sierra Leone
Maternal and Neonatal Child Health Week	Nigeria
Mother and Child (Health) Week	Burundi, Madagascar, Pakistan and Rwanda
National Child Health and Nutrition Week	Eritrea
National Health Days	Angola
National Micronutrient Days	Burkina Faso and Niger
National Vitamin A Supplementation and Deworming Days	Congo, the Democratic Republic of the Congo, India, Myanmar, Nepal and Togo
Sustained Outreach Services	Indonesia
Disease-prevention priority campaigns	
Immunisation week/ campaigns	Afghanistan and Papua New Guinea
Measles/polio supplementary immunisation activities	Over 28 countries in LMICs (2014), such as Afghanistan, the Democratic Republic of the Congo, Haiti, Kenya, the Republic of the Congo, Zambia, etc
National immunisation days	Angola, Benin, Burkina Faso, Cameroon, Central African Republic, Chad, Cote d'Ivoire, the Democratic Republic of the Congo, Equatorial Guinea, Gabon, Gambia, Ghana, Guinea Bissau, Mauritania, Niger, Nigeria, the Republic of the Congo and Senegal

LMICs, low-income and middle-income countries.

Countries are increasingly adding to the package of interventions delivered throughout these campaigns,[17] though the magnitude and scope of the existence and utilisation of ICHEs to deliver multiple child health interventions in LMICs has yet to be portrayed. Drawing on the literature based on existing studies, many of which analyse vertical modes of delivery,[18 19] the hypothesis is that increasing the number of interventions delivered through ICHE may negatively affect the coverage of these interventions. It can be presumed that the increased volume of services delivered at one time could lead to higher financial and human resource burden on districts and health workers; therefore, affecting performance and coverage of the interventions.

This study aimed to explore the scope and magnitude of the application of ICHEs in delivering multiple child health interventions in LMICs, to examine the association between the number of interventions delivered through ICHEs and VAS and measles coverage outcomes, and to analyse the association between VAS coverages and the different intervention packages delivered through ICHEs.

This study advances the knowledge beyond the only other analysis by Palmer *et al*[20]—which draws on the same Unicef CHD database but focuses on CHDs only—taking a new angle by considering multiple types of campaigns, including CHDs, SIAs and NIDs. It calculates the number of interventions delivered through these campaigns and analyses the association with coverage outcomes. This study complements Wallace, Ryman and Dietz's systematic reviews on integrated immunisation campaigns (2009, 2012), which looked at the delivery of additional maternal–child health services using immunisation programmes and the compatibility of integrating services. They found that when additional services are carefully selected for compatibility and the integrated delivery operations receive adequate support, coverage of these interventions may improve, provided that immunisation coverage is already high. This study goes further by statistically exploring the potential effects of delivering multiple interventions during these integrated campaigns, and provides a comprehensive scope to the extent that integrated campaigns are used to deliver multiple health and nutrition services in LMICs.

METHODS

Data description

The original global Unicef CHD database was obtained with permission from Unicef Health and Nutrition sections at New York headquarters in 2010, and an updated version from 2013 was used in this analysis. The CHD database (box 2) contains information of integrated events from 83 countries from 1999 to 2010. In the CHD database, VAS estimates were taken from administrative campaign coverage results, and measles SIA coverage was obtained from WHO/Unicef joint reporting form (JRF) immunisation database, which is also derived from administrative results in addition to surveys reported annually by each country. Due to the different structure in the VAS database and JRF records, coverage records were matched by the month that campaigns occurred. It is important to note that the Unicef's VAS and the WHO/Unicef JRF immunisation database, from which the CHD database was created, represented the most complete source of information available on VAS and immunisation campaign coverage at the time of the study. Unicef CHD database was also the only database available that has assembled information on multiple child health campaigns on a global scale.

The ICHE database used for the analysis is a revised version of the original Unicef CHD database, modified by the authors for this analysis. The different vaccines delivered were recounted as separate interventions instead of grouping them together under 'immunisation' as was the case in the original CHD database, resulting in a more accurate number of interventions for each event. As complete information on event composition was available only from 2005 to 2010, data from 1999 to 2004 were excluded from this analysis. This totalled to 597 ICHEs that were held within 2005–2010, in a total of 73 countries. The revised database is referred to as the ICHE database in this paper.

Out of 597 events included in the ICHE database, 97% (577 events) had VAS coverage data, and 24% (142 cases in 50 countries) also indicated measles as a co-delivered intervention, among which 55% had measles coverage information. Additional measles coverage data points were not permitted by Unicef to be incorporated into the data set, though additional measles SIA events may have occurred, due to the close vigilance of measles coverage indicators by Unicef and WHO. Therefore, for this analysis, 577 events were used to analyse the correlations for VAS and 78 events for measles.

Data analysis

Descriptive statistics were used to measure types of intervention delivered, number of interventions co-delivered during ICHEs and different package of interventions. Under coverage outcomes, the relationship between VAS and measles coverage with the different numbers of interventions was explored through panel regression. Given that in each country vaccination campaigns can occur twice a year, 'semester' was used as a time variable rather than 'year'. A random effects regression model with country and time effects was specified for country i at semester t (model 1):

$$\mathit{Intervention\ coverage}_{\mathrm{it}}=\mathit{Number\ of\ interventions}_{it}+\mathit{Semester}_{t}+\varepsilon_{it}$$

where $\varepsilon_{it}=f_i+u_t+e_{it}$

The composite error term ε_{it} comprises country-specific effects (f_i), time effects (u_t) and idiosyncratic error (e_{it}). The Hausman test was used to determine whether a fixed-effect or random-effect was more appropriate. The test could not reject the hypothesis of correlation between individual errors and the regressor neither for VAS coverage ($p=0{\cdot}661$) nor for measles coverage ($p=0{\cdot}765$), hence a random effects model was used as a base specification in both cases. On the basis of the existing literature, we expected that coverage for VAS and measles interventions would decrease with the number of interventions, hence a negative coefficient for 'Number of interventions'.

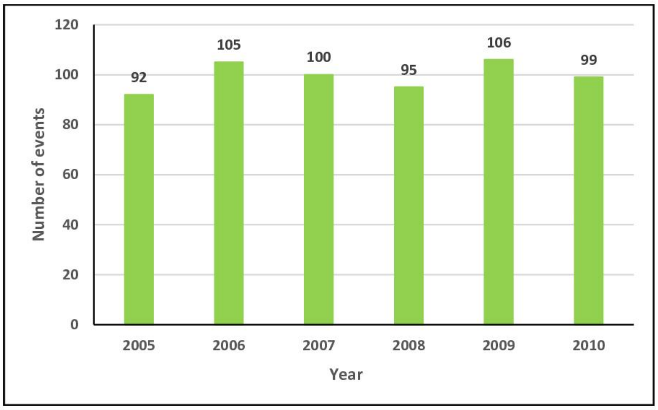

Figure 1 Number of ICHEs by year, globally (2005–2010). ICHEs, integrated child health events.

A range of robustness checks was conducted. Eight alternative regression specifications were tested, some of them with additional explanatory variables accounting for domestic and external health system spending, size of the under-5 population and density of human resources for health, in addition to sensitivity analyses with outliers removed. First, the following regression specifications were tested as alternatives to the base model (model 1): pooled ordinary least squares (OLS) regression (naive OLS ignoring the panel structure of the data set) (model 2); panel regression with country fixed effects and no time effects (model 3); panel regression with country fixed effects and time effects (model 4); model 4 with additional predictors—total population aged 0–4 years, log government health expenditure per capita (IntUS$), log external health expenditure per capita (IntUS$) and average density of nurses and midwives (per 10 000 population) in the interval 2004–2010 (model 5); panel regression with country random effects and no time effects (model 6); the base model with additional predictors, as per model 4 (model 7); panel regression using the within-between estimator[21] (model 8) and model 8 with additional predictors (model 9). The technical details are in appendix 1. Second, a sensitivity analysis with multiple cut-offs was performed with a restricted sample of observations, where outliers with intervention coverage of less than 40%, 60% and 80% were eliminated.

The number of interventions per event was categorised as either low (two to four interventions) or high (at least five interventions); the cut-off was informed empirically by an examination of the distribution of number of interventions per event, exhibiting a right skew commencing at five interventions per event. Analyses were conducted using Excel V.2010, Stata V.10 and R V.3·3·2 statistical packages.

Patient and public involvement

Patients were not involved in this study.

RESULTS

Distribution and frequencies of ICHEs

The highest numbers of ICHEs occurred in sub-Saharan Africa (62%), and then followed by East and Southern Asia and Pacific (26%). The number of ICHEs conducted each year among observations since 2005, where data was available, has been relatively stable, averaging approximately 100 events globally per year in the period 2005–2010 (figure 1). This demonstrates a significant reliance on delivering multiple interventions through ICHEs in LMICs.

Types and packages of intervention delivered

Among the 597 ICHEs, the most common interventions delivered were VAS (99%), deworming (70%) and oral polio vaccine (OPV) (46%) (box 3). In terms of the combinations of antigens delivered together, out of the 597 events, 78 co-delivered OPV and measles; 55 co-delivered OPV and tetanus toxoid (TT); 35 delivered measles and TT; and 30 co-delivered OPV, measles and TT. Due to the differing skills, resources and time required to deliver the different types of vaccines, it was important to consider each vaccine delivered as separate interventions.

Number of interventions co-delivered during ICHEs

Overall, the range of the number of child survival interventions delivered through a single ICHE was between 2 and 11. The proportion of countries delivering a high number of interventions increased year by year (appendix 2), with 82% of the total events delivering three or more interventions by 2007. In 2010, 40 events out of 66 (60%) across 24 countries delivered five or more interventions during one campaign (box 4), and where five countries delivered as much as 10–11 simultaneous interventions, exemplifying the shift to delivering a high volume of interventions through these campaigns. The increasing shift towards co-delivered services was particularly marked in West and Central Africa, in addition to Eastern and Southern Africa. The proportion of ICHEs including five or more interventions was predominantly in sub-Saharan Africa, representing 71% of all events (box 5).

Countries which delivered five or more interventions between 2005 and 2010 are listed in table 2. The largest number of interventions during ICHE were in Nigeria and the Philippines, where 11 interventions were delivered in 2010, followed by 10 interventions in the same countries along with Zambia. Nicaragua, Somalia, South Sudan, Nigeria, Madagascar, Ghana and Uganda have delivered nine interventions at once in varying years, all delivering a variety of packages of maternal and child health interventions.

The question of whether the same countries tend to deliver five or more interventions at one event was also explored. Zambia ranked the highest in this respect (12 occurrences), with a delivery of five or more interventions in 2005–2010 (box 6). In Zambia's case, between five and seven interventions were delivered between 2005 and 2009, and the number of interventions increased later on (in 2010 and 2012), especially with the adoption of the SIA strategy to achieve nationwide measles coverage (verified with project managers, Zambia, May 2014). Other

Table 2 Countries which delivered five or more interventions during ICHEs (2005–2010)

Country	Year	No. of interventions
Nigeria and the Philippines	2010	11
Nigeria, the Philippines and Zambia (×2)	2010	10
Nicaragua and South Sudan	2010	9
Nicaragua, Nigeria and Somalia (×2)	2009	9
Madagascar	2008	9
Ghana and Uganda	2006	9
Burundi (×2), Mozambique (×2), Rwanda (×2), Sudan and Uganda (×2)	2010	8
Sierra Leone	2009	8
Madagascar, Nigeria and Rwanda	2008	8
Cameroon (×2), DR Congo, Sierra Leone (×2) and Vietnam (×2)	2010	7
Angola, Burkina Faso (×2), Ethiopia, Sierra Leone, South Sudan, Togo, Uganda (×2) and Zimbabwe	2009	7
The Philippines, Sierra Leone, Sudan and Zambia	2008	7
Indonesia, Nigeria and Zambia	2007	7
Uganda	2006	7
Cambodia	2005	7
Haiti, India (×2), Lao PDR (×2), Madagascar and Somalia (×2)	2010	6
Burundi, Central African Republic, Eritrea, Ethiopia, Nigeria, Swaziland, Vietnam (×2) and Zambia (×2)	2009	6
Djibouti, Ghana, Kenya (×2), Mozambique, Nigeria, the Philippines and Zambia	2008	6
Central African Republic (×2), Djibouti, Ghana, Indonesia, Malawi, Nigeria, the Philippines (×2) and Timor Leste (×2)	2007	6
Ethiopia (×2), Ghana, Indonesia, Madagascar, Nicaragua and Zambia (×2)	2006	6
Zambia (×2)	2005	6
Burkina Faso (×2), Cote d'Ivoire, Ethiopia, Liberia, Madagascar, Niger and Senegal	2010	5
Burundi, Chad (×2), Ecuador, Guinea, Lao DPR, Korea DPR (×2), Rwanda (×2), Senegal and Zimbabwe	2009	5
Burkina Faso (×2), DR Congo, Ghana, India (×2), Korea DPR, Togo, Tanzania, Uganda (×2) and South Africa	2008	5
Eritrea (×2), Ethiopia (×2), Gabon, Cambodia, Marshall Island (×2), Mali, Nicaragua, Korea DPR, Swaziland, Uganda, Zambia and Zimbabwe	2007	5
Angola, Belize (×2), Kenya, Maldives (×2) and Sierra Leone	2006	5
Burundi, Ethiopia (×2), Ghana, Maldives (×2), the Philippines (×2), Senegal and Uganda	2005	5

DPR, Democratic People's Republic; DR, Democratic Republic; ICHEs, integrated child health events; PDR, People's DR.

countries, such as Uganda, Ethiopia, Nigeria and the Philippines, have sought to deliver very high numbers of services in one event, relying on campaign-style delivery mechanisms.

Number of interventions and VAS coverage

In 75% of events (n=429), vitamin A coverage ranged between 80% and 100%; and for 56% of events (n=322), vitamin A coverage was equal to or above 90% (appendix 3). Regression results in the base model (table 3, model 1) suggest a slightly negative association between VAS coverage and the number of co-delivered interventions (beta=–0·76), which is not statistically significant (p=0.185). Alternative regression specifications (table 3, models 2–8) confirm this result.

However, the within-between model with additional predictors (model 9) suggests that one additional intervention in between-country variation (variable *Average # interventions (country)*) is associated with a statistically significant 3.38% decrease in vitamin A coverage. Within-country variation of the number of interventions, for example, varying number of interventions from one year to another, has no effect (variable *Difference from average # interventions (country)*). Results of the sensitivity analyses that restrict the sample only to observations with VAS coverage over 40%, 60% and 80% show that the association between vitamin A coverage and number of interventions is no longer significant when the low coverage outliers are excluded (appendix 1).

Number of interventions and association with measles coverage

There has also been a steady and high coverage of measles vaccines when co-delivered in ICHEs during 2005–2010. Out of 142 events that co-delivered the measles vaccine, 55% had measles coverage data reported in the ICHE database. Coverage data for measles derived from measles SIAs showed that the majority (79%) of coverage outcomes were greater than 90%. The overall median (mean) coverage for measles was 96% (91%). Regression results in the base model indicate a negative association, which is borderline statistically significant at 5% levels (p=0·057): on average, for every additional co-intervention, measles vaccine coverage decreases by 1·81% (table 4, model 1). The effect is significant at 5% levels in the fixed effects specifications (models 4 and 5) and at 10% levels in the within-between model (p=0·070); in the latter, one additional intervention in between-country variation is associated with an average decrease of 3·89% in measles coverage. However, there is no association between coverage and the within-country variation of number of interventions. The statistical significance of any link between coverage and number of interventions disappears when excluding observations with measles coverage below 40%, 60% and 80% in the sensitivity analyses (appendix 1).

The distribution of measles vaccine coverage by number of interventions (appendix 4) shows that eight or nine

Table 3 Regression results for vitamin A coverage

	Dependent variable								
	Vitamin A coverage (%)								
	Base	OLS	FE	FE2w	FE2w+	RE	RE2w+	WB	WB+
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Number of interventions	−0.76 (0.55)	−0.77* (0.45)	−0.38 (0.49)	−0.95* (0.50)	−0.84* (0.44)	−0.42 (0.57)	−0.79 (0.61)		
Log government health expenditure per capita (IntUS$)					−1.34		−2.34* (1.35)		
Log external health expenditure per capita (IntUS$)					4.61		3.58** (1.79)		
Log total population<5 years					−32.23		1.26 (1.09)		
Average nurse and midwife density							−0.01 (0.06)		−0.003 (0.07)
Average number of interventions (country)								−1.17 (1.18)	−3.38*** (1.31)
Difference from average number of interventions (country)								−0.73 (0.48)	−0.56 (0.55)
Average log government health expenditure per capita									−3.46** (1.53)
Difference from average log government health expenditure per capita									1.45 (3.74)
Average log external health expenditure per capita									2.20 (1.95)
Difference from average log external health expenditure per capita									6.32*** (2.00)
Average log total population<5 years									1.18 (1.01)
Difference from average log total population<5 years									−5.47 (17.45)
Constant	85.97*** (2.70)	88.16				84.62*** (2.80)	69.79*** (19.08)	87.54*** (5.12)	88.47*** (17.44)
Observations	574	574	574	574	539	574	431	574	430
R^2	0.01	0.01	0.002	0.01	0.03	0.11	0.05	0.01	0.11
Adjusted R^2	0.004	0.004	−0.14	−0.16	−0.15	0.11	0.04	0.004	0.09
F statistic	−5.25	3.53* (df=1; 572)	1.12 (df=1; 500)	6.00** (df=1; 489)	3.03** (df=4; 455)	61.68***	21.86***	−4.64	48.14***

Standard errors are robust to heteroscedasticity and computed using the HC3 estimator.
*P<0.1; **p<0.05; ***p<0.01.
Base, panel random effects model with country and time effects; FE, fixed effects model with country effects; FE2w, fixed effects model with country and time effects; FE2w+, FE2w model with additional predictors; OLS, pooled ordinary least squares model; RE, random effects model with country effects; RE2w+, Base model with additional predictors;WB, random effects model using the within-between estimator; WB+, WB model with additional predictors.

Table 4 Regression results for measles vaccine coverage

	Dependent variable							
	Measles vaccine coverage (%)							
	Base	OLS	FE	FE2w	FE2w+	RE	RE2w+	WB
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
number of interventions	−1.81* (0.95)	−1.69 (1.08)	−1.97 (2.08)	−5.59** (2.62)	−4.27*** (0.91)	−1.81* (0.94)	−1.15 (1.07)	
Log government health expenditure per capita (IntUS$)					−3.87		−2.94 (2.27)	
Log external health expenditure per capita (IntUS$)					4.97		3.46 (3.70)	
Log total population<5 years					2.35		0.77 (1.49)	
Average number of interventions (country)								−3.89* (2.12)
Difference from average number of interventions (country)								−1.41 (1.21)
Constant	98.91*** (4.26)	98.68				98.91*** (4.21)	86.23*** (24.21)	106.65*** (7.26)
Observations	79	79	79	79	74	79	74	79
R^2	0.04	0.04	0.13	0.36	0.31	0.40	0.09	0.06
Adjusted R^2	0.03	0.03	−1.60	−1.95	−3.55	0.39	0.04	0.03
F statistic	3.44*	3.50* (df=1; 77)	3.98* (df=1; 26)	9.44*** (df=1; 17)	1.26 (df=4; 11)	50.44***	6.59	3.94

Standard errors are robust to heteroscedasticity and computed using the HC3 estimator.
*P<0.1; **p<0.05; ***p<0.01.
Base, panel random effects model with country and time effects; FE, fixed effects model with country effects; FE2w, fixed effects model with country and time effects; FE2w+, FE2w model with additional predictors; OLS, pooled ordinary least squares model; RE, random effects model with country effects; RE2w+, Base model with additional predictors;WB, random effects model using the within-between estimator.

interventions appear to show a slight decrease in coverage. However, explaining the lower coverage in these events requires more detailed studies in particular countries, taking into account the make-up of their health systems and the broader context.

Packages of interventions and association with VAS coverage

The relationship of the various packages of co-delivered interventions and VAS coverage was also examined. The top 10 most common package combinations delivered during ICHEs between 2005 and 2010 and the median coverage of VAS was calculated per package type (box 7). A non-parametric Kruskal-Wallis test was used to compare the median coverages of VAS across the different packages of interventions. The test showed no association at 5% significance level in VAS coverage across the different packages of interventions (p=0·07) (box 8). The specific packages of interventions were not associated with VAS coverage. The package of VAS—other antigens—growth monitoring (‘vag’) appears to result in low VAS coverages (between 6% and 49%), which pulled down the median of that package group. This lower coverage can only be explained by examining each country context as to why the coverage was lower in those particular events.

DISCUSSION

Summary of findings

The findings of our base model do not support the hypothesis of an association between the number of interventions delivered during ICHEs and coverage for VAS or measles vaccination as a result of ICHEs. The results generally hold across a range of alternative regression specifications, several of which also control for health expenditure per capita, health workforce density and size of the population under 5 years. However, there are also several specifications those suggest the presence of a statistically significant association. In these cases, the effect is not robust to sensitivity analyses, which exclude outliers with extremely low coverage. Overall, we find insufficient support for an association between the intervention coverage and number of ICHE interventions.

Interpretation of findings

The study showed that ICHEs represent a frequently used platform with the capacity to incorporate a high number of interventions without compromising the effectiveness of ICHEs or hamper the ability to sustain or increase campaign coverage of some interventions, such as VAS or measles vaccination. They remain particularly important in countries with poor child health outcomes and overstretched primary healthcare systems. This relationship was indicated across the different intervention packages. The study also demonstrated the breadth of ICHEs, which exemplified the significant reliance on campaign-mode of essential health and nutrition services delivery in LMICs. While not intuitive, these findings are consistent with other studies that demonstrate that SIAs and CHDs contribute to improved coverage of interventions.[22] This study advanced the literature by providing a comprehensive overview of integrated campaigns by looking at both the CHD and measles immunisation campaigns compared with Palmer who looked at CHDs[20]; by statistically analysing whether the number of interventions has any association on the coverage outcomes of key interventions and further developing the findings of the systematic review of integration of immunisation services with other interventions by Wallace *et al*.[2 16] The study also extends the analysis of Oliphant *et al* that explored the effects of CHDs on the coverage of child survival interventions[9] but not the effect of the number of interventions delivered through integrated campaigns.

However, these findings should be interpreted with caution, and it cannot be assumed that further expanding the intervention packages of ICHEs will continue to achieve positive outcomes.

There are also negative effects of ICHEs those should be taken into account. It has been shown that ICHEs could undermine the routine provision of basic child health services within the national health system,[23] as seen in Cameroon, Uganda, and Tajikistan, where the health staff were less motivated to perform routine activities and other primary care tasks due to immunisation campaigns because of the lack of incentives for routine activities.[22 24]

Limitations

We could not control for operational characteristics of ICHEs due to the lack of available data, for example, number of staff, size of geographical areas covered, costs of planning and implementation. The explanatory power of the regression models was low, and most country-level variables were not statistically significant predictors of intervention coverage. As such, there is substantial potential for future analyses to attempt to cover this gap by collecting and analysing ICHE operational data in order to better understand the determinants of their effectiveness.

As the coverage records were matched by the month that campaigns occurred, this may possibly have led to incorrect linkages of some interventions, or certain delivered interventions may have not been properly recorded. The routine data (and to a lesser extent the survey data) are likely to have non-negligible non-sampling error as well. Some variation in coverage data may be due to reporting or data collection and aggregation errors. For example, VAS coverage appears to be lower when six and nine interventions were delivered compared with ICHEs delivering different numbers of interventions (box 9). There is no apparent reason to expect a systematically lower coverage only in ICHEs with six or nine interventions, as this may well be an artefact. There are countries that showed VAS coverages in the low 20s and 30s during several events while delivering six interventions, which may have decreased the median VAS coverages for events that delivered six interventions. Yet, the same countries reached over 90% when delivering less or more than six interventions.

The aggregate analysis does not provide information on the conducive factors and implementation practices that are required to support countries in carrying out their own campaigns. The focus solely on coverage outcomes of VAS and measles—for which data was available in the CHD database—may not reflect the ability to successfully deliver multiple interventions within ICHEs that may include other interventions. Appropriate consideration of contextual factors is essential as they may confound the association between delivery of the intervention and coverage outcomes during the campaigns.

The study suggests, however, that adding interventions to established ICHEs may be a viable strategy in LMICs to deliver multiple essential health services and can potentially be delivered without a decrease in campaign coverage for VAS and measles. In addition, there may be positive spillover effects, with ICHEs often being a pragmatic vehicle to deliver an extensive variety of essential child health services beyond immunisation and VAS on a wide scale. Further research on the impact of different service configurations within multicomponent campaigns is critical, as well as obtaining and combining data sets that can support such research.

CONCLUSION

ICHEs were found to be a popular strategy to deliver essential child health interventions on a wide-scale across LMICs in many regions. ICHEs appear to represent a frequently used platform with the capacity to incorporate multiple interventions without compromising coverage of key interventions. More research is needed to better understand the contextual and operational factors that determine ICHEs' effectiveness in delivering multiple interventions. Furthermore, the role of ICHEs in the context of efforts to strengthen health systems in LMICs needs to be re-thought.

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