Parental Mental Health and Child Vaccination in India: A SEHAT Data Study

Henry Cust[1], Jennifer Lansford[1], Arnab Mukherji[2], Marcos Vera-Hernández[3], Joanna Maselko[4], and Manoj Mohanan[1]

[1]Duke University, Sanford School of Public Policy
[2]Indian Institute of Management Bangalore
[3]Department of Economics, University College London
[4]University of North Carolina at Chapel Hill

September 9, 2025

Abstract

Abstract: This paper examines whether parental mental health problems reduce timely childhood vaccination in India. Previous literature does not link mental health and childhood vaccination yet theory suggests poor mental health will exacerbate barriers to vaccination and prevent or delay childhood vaccination. Using five waves of the nationally representative SEHAT–CPHS panel (2022–2023), we track around 4,000 children aged 0–5 alongside repeated measures of caregiver depression and anxiety using validated PHQ-9 and GAD-7 screening tools. Child fixed-effects models identify whether within-child changes in their parental mental health lead to changes in the child's vaccination outcomes. We control for all plausible time-varying confounding to isolate the link between mother's mental health and childhood vacciantion.

We find that mothers with non-chronic moderate or severe depression are associated with a 1.7–1.8 percentage point reduction in the proportion of recommended doses received by age of the child at the time of interview, from a mean dosage coverage of 59.8% with less precise effects for anxiety. A maximum of a 6.8 percentage point reduction is found for mothers with severe depression which equates to around an 11% drop in vaccination doses. Cumulative dose delays in vaccination amount to almost a year when mothers are depressed although results suggest missed doses are not always caught up with. The strongest findings are for early-life vaccines such as BCG and polio implying post-natal depression might be playing a significant role. We find some weak evidence that boys are more affected by mothers depression but no evidence grandparents or higher-baseline states (those with fewer barriers to vaccination) are protective against the negative impacts of poor mental health.

These findings point to a "capacity and bandwidth" channel: depressive symptoms constrain the planning and follow-through needed to complete low-cost preventive care. Although modest in size,

these effects are clinically significant in a country where vaccine-preventable diseases remain leading causes of child morbidity and mortality.

Integrating simple screening and referral for parental mental health into maternal and child health platforms could improve timely vaccine uptake. Leveraging India's ASHA network to provide follow-up support for caregivers may represent a cost-effective way to strengthen demand-side determinants of universal immunisation.

1 Introduction

Despite substantial progress in childhood vaccination across low- and middle-income countries, millions of children remain un- or under-vaccinated (WHO & UNICEF 2025). Globally, financial and other access barriers such that routine immunisations are typically freely provided and highly available at the point of care, yet coverage and *timeliness* remain unequally distributed within and across countries. These missed and delayed vaccinations lead to increased susceptibility for a wide range of diseases resulting in increased child mortality (Prentice et al. 2021, Aaby et al. 2011, Higgins et al. 2016). In India and other countries where vaccine preventable deaths are rising, reduced timely vaccination also undermines herd immunity placing the wider community at increased risk (Fadel et al. 2017, Raut & Huy 2023).

Supply and logistic constraints remain a challenge in low-resource settings and is well-documented with billions of dollars annually contributed to addressing these supply issues, however, comparatively, demand-side barriers appear to be of greater importance with the rise of misinformation, pseudoscience and safety concerns increasingly recognised as a significant barriers to vaccination around the world (Agrawal et al. 2020, Singh et al. 2019, Bangura et al. 2020, Paul et al. 2024). Within these demand-side factors, however, less attention is paid to psychological factors that might exacerbate existing barriers. Common mental health disorders, such as moderate and severe anxiety and depression, are known to reduce investments in one's own health and has been linked to reduction in their child's health (Angelucci & Bennett 2024, de Quidt & Haushofer 2016, Palatucci 2024); but there is little examination of the impact of poor parental mental health on uptake of timely vaccination.

Our paper examines whether parental mental health problems act as a barrier to timely childhood vaccination in India. Using a unique dataset of approximately 32,000 households observed over five waves from a survey designed to be representative of the Indian population, we match 4,000 0–5 year-old child-parent pairs and ask whether within-child *changes* in mothers' mental health lead to within-child *changes* in vaccination status as they age. This large and rich dataset allows us to plausibly control for confounders that might influence vaccination and parental mental health. We find that moderate or severe depression among parents reduces the fraction of recommended vaccination doses received in the period by their children by 1.8 percentage points (ppt) equating to around a 3% reduction in the proportion of age-appropriate vaccination doses received by children. This rises to around 11% for mothers with severe depression. Evidence for anxiety alone is more suggestive and imprecisely estimated. We find evidence that depression in mothers with delay vaccinations due at birth by around 6 weeks with clinically significant health impacts for neonates.

2 Background and conceptual framing

The demand for child vaccination is derived entirely from caregiver preferences, capabilities, and constraints, because infants cannot choose or demand their own healthcare. Health capital models (**?**) imply that preventive investments depend on perceived returns and opportunity costs. Taking an economic perspective on depression, de Quidt & Haushofer (2016) model core symptoms of depression as including anhedonia (the inability to feel pleasure), pessimism, and physical health issues such as reduced sleep and nutrition. The result is pessimistic beliefs about the returns to effort, including for health. Downward belief shocks reduce labour and household effort, discourage follow-through on investments in education or health, and can generate "frictions" in performing everyday tasks.

Applied to immunisation, depression may: (i) lower expected returns to preventive health uptake; (ii) increase present-bias, i.e. putting off investments in human and physical capital for oneself and dependents; and (iii) reduce mental bandwidth for planning and reduce the desire for social engagement needed to schedule and attend clinics. Anxiety, often comorbid with depression, is more nuanced and theoretically could act in both directions due to "worry". Health-focused worry could increase vigilance, extreme risk-aversion and lead to over consumption of preventative healthcare, but indecision/avoidance and health-system fears may delay action, with an unknown net effect.

2.1 Literature

There is little evidence directly linking parental mental health and childhood vaccination. A review of the impacts of parental mental illness on childhood physical health does not mention vaccination as a source of ill health (Pierce et al. 2020). Similarly studies in India specifically fail to mention mental health in a study about delayed vaccination (Choudhary et al. 2019). Similarly, a literature review investigating parent-level barriers to vaccination does not list mental illness as a potential cause for delayed or missed vaccination (Kaufman et al. 2021). Despite not appearing in systematic reviews, some studies provide suggestive evidence from high-income countries, though with mixed conclusions. From the UK, using 200,000 child–parent pairs, no association between mental health (or antidepressant prescription) and vaccination status was found (Smith et al. 2022). Zaikin et al. (2022) and MacDonald et al. (2024) also found no associations in similar studies from Israel and Canada, settings with broadly functioning mental healthcare and vaccination services. On the other hand, a study from Australia published in 2003, focusing on parents followed over the first 7 months of a child's life found mental health a strong determinant of children being up to date with vaccination implying the post partum period a significant period (Turner et al. 2003). Recent Indian evidence on depression treatment informs the mechanisms through which our hypotheses act. Angelucci & Bennett

(2024) show community-based pharmacotherapy combined with light livelihoods support reduces depression severity persistently but does not raise short-run earnings/consumption, with suggestive improvement in older children's human capital investment. This pattern is consistent with depression acting primarily through motivational/executive channels rather than via income. If so, even small mental health shocks could alter timely, low-monetary-cost behaviours such as taking a child to clinic.

In LMICs, we find only two studies (from the same project) that indirectly investigate this problem. Rahman et al. (2008, 2004) found that childhood vaccination was lower in children born to depressed parents, and that CBT as a treatment for depression increased a child's vaccination status. Our study fills two important gaps in the literature. First, it is the first large-scale observational study using panel analysis in an LMIC country where mental healthcare is not readily available. Second, it is the first study to link parental mental health to preventive healthcare for children aged up to 5, whereas previous studies examined only children under two. These findings have important implications for the design and targeting of both mental health services in India and in countries seeking to improve both mental health outcomes and persistent childhood vaccination gaps.

3 Data

Our observational dataset comes from a five wave period of the Consumer Pyramids Household Survey (CPHS) that included a specifically designed SEHAT mental health module between 2022 and 2023. CPHS is a longitudinal survey by Centre for Monitoring Indian Economy[1] (CMIE) of ∼175,000 households (∼675,000 members) three times per year, collecting economic and social statistics, designed to represent 98.5% of India's population via stratified geographic sampling. The dataset is unique for answering our research question given the vast sample size, vaccination data on children up to 5 years old, and depth covering a range of social and economic household variables that can be used to isolate the effect of mental health on vaccination.

From 2022 through June 2023 the SEHAT module was administered alongside the primary survey to a random selection of around 32,000 households. SEHAT augments CPHS with mental health (PHQ-9, GAD-7), COVID stressors, and selected health outcomes for households interviewed in the first month of each wave (Feb, Jun, Oct). Mental health questions are answered by whichever adults are at home during the survey. Our analysis uses the full five-wave SEHAT dataset to construct an unbalanced child-level panel after merges with the core CPHS dataset to construct the time-varying covariates.

Each wave spans four months; households are revisited four months later, with replacements for attrition

[1] A private company that conducts the tri-annual CPHS surveys across India

meaning survey teams are working full time throughout the year completing surveys.[2] The household replacement protocol is based first on a *front-door basis* (i.e., if a household moves away, it is replaced with the new household behind the same door) and second, at a primary sampling unit level basis (i.e., if the front door no longer exists or is abandoned, once enough are assigned as abandoned, an entire new PSU is assigned to maintain representativeness).

The study period follows the main adult COVID-19 vaccination rollout in India; most remaining state-level restrictions were phasing out by mid-2022 (wave 2), and schools were fully reopened by late (wave 3) 2022 (Chakrabarti et al. 2023). Mental healthcare access is limited and stigmatised in India, particularly outside urban areas, with weak integration into primary care (Murthy 2017).

Table 1: Summary statistics

	mean	sd	obs
Observations in Wave 1	0.25	(0.44)	9061
Observations in Wave 2	0.20	(0.40)	9061
Observations in Wave 3	0.20	(0.40)	9061
Observations in Wave 4	0.18	(0.38)	9061
Observations in Wave 5	0.17	(0.38)	9061
Vaccination doses up to date with for age	0.00	(0.00)	9061
If child has at least one dose of mandatory vaccination	0.63	(0.48)	9061
Moderate or severe anxiety score	0.19	(0.39)	9061
Moderate or severe depression score	0.25	(0.43)	9061
Someone in the household gained a job	0.05	(0.23)	9061
Someone in the household lost a job	0.05	(0.21)	9061
Household income (midpoint of income group)	308560.87	(220502.68)	9061
Someone in the household died	0.02	(0.13)	9059
Someone left the household	0.07	(0.26)	9059
Someone in the household became divorced	0.07	(0.25)	9059
Someone in the household became married	0.13	(0.34)	9061
Proportion of children that are male	0.52	(0.40)	9061
Household size - Children only	1.92	(1.03)	9061
Household size - adults only	3.18	(1.32)	9061
Household has 2 generations	0.54	(0.50)	9061
Health expense shock at 40% of consumption	0.01	(0.10)	9015
Household ran a budget deficit	0.32	(0.47)	9015
Average net income	0.29	(0.23)	9015
Household utilised mental healthcare	0.15	(0.36)	9061
TBC COVID EXPOSURE	1.46	(1.70)	9009
If an enumerator had high chance of data duplication	0.09	(0.28)	9061
Someone in the household was sick, other than the child	0.18	(0.38)	9061
string_extended_to0	15.04	(16.42)	9061
Parental time spent on other household members	3.45	(1.40)	9061
Parental time spent on indoor entertainment	2.20	(1.08)	9061

Table 1 summarising the characteristics of the child's household across the full 5 waves. Table 2, breaks

[2]See https://consumerpyramidsdx.cmie.com/ for detailed documentation

Table 2: Characteristics of Households with parents that have no, chronic or non-chronic anxiety or depression

	Always good mental health		HH has non-chronic members				HH has chronic members			
	Mean	SD	Mean	SD	Diff. vs. non-chronic	P-value	Mean	SD	Diff. vs. chronic	P-value
HH had a job gain	0.117	(0.321)	0.120	(0.325)	0.003	(0.826)	0.060	(0.237)	-0.057***	(0.000)
HH had a job loss	0.099	(0.298)	0.124	(0.330)	0.026**	(0.039)	0.078	(0.269)	-0.021	(0.146)
Death in the household	0.043	(0.204)	0.044	(0.206)	0.001	(0.922)	0.011	(0.105)	-0.032***	(0.000)
HH had someone leave	0.190	(0.392)	0.179	(0.384)	-0.011	(0.494)	0.095	(0.293)	-0.095***	(0.000)
A divorce in the HH	0.174	(0.379)	0.160	(0.367)	-0.013	(0.390)	0.076	(0.266)	-0.097***	(0.000)
A marriage in the HH	0.289	(0.454)	0.336	(0.473)	0.047**	(0.012)	0.238	(0.426)	-0.051**	(0.019)
Mean income	294,150	(201,006)	320,727	(225,875)	26,576***	(0.002)	307,202	(224,823)	13,052	(0.189)
Mean household size	5.036	(1.533)	4.867	(1.435)	-0.168***	(0.006)	4.872	(1.585)	-0.164**	(0.028)
Mean number of children in the HH	1.702	(0.950)	1.814	(0.975)	0.112***	(0.004)	1.764	(0.986)	0.061	(0.184)
Household has grandparents present	0.569	(0.495)	0.513	(0.500)	-0.056***	(0.005)	0.850	(0.357)	0.260***	(0.000)
Average parental time spent on indoor leisure	2.204	(0.955)	2.211	(0.844)	0.007	(0.848)	2.037	(0.889)	-0.108**	(0.018)
Average parental time spent on caring for others	3.512	(1.284)	3.405	(1.234)	-0.107**	(0.037)	3.154	(1.201)	-0.331***	(0.000)
Observations	2,147		860				537			

down a selection of these characteristics split by households where the parents have never suffered anxiety or depression, in the first two columns; households where parents suffer non-chronic anxiety or depression in columns 3 and 4, plus the difference between non-suffering parent households and non-chronic parent households in columns 5 and 6; finally, households with chronic depression or anxiety, in columns 7 and 8 with the differences to non-suffering parents in columns 9 and 10. What is interesting is non-chronic households are more likely to experience a job loss during the 5 waves of data, more likely to experience a marriage, be richer and have a greater proportion of children in the household. It makes sense that all these factors influence households moving out of, or into, poor mental states. For example, a job loss would increase depression where as a marriage would decrease it, both significant events in any household. The presence of a greater number of children possibly indicating increased childcare responsibilities and stress at the cost of leisure time is apparent in non-chronic households. Households suffering chronic mental health issues, are less likely to experience any changes in the household, whether positive or negative. It appears happier households are both larger, less wealthy, and have more activity and change occurring. Some of these descriptive differences are seemingly substantial with households suffering chronic mental health issues having less than half the likelihood of a death, someone leaving, or a divorce [3]

It is worth noting that, because mental health questions were answered only by available adults, overall prevalence of anxiety and depression and correlated variables are likely inflated. Because of this, and because we do not use weights, it is important to not interpret Table 1 as representative of the Indian population. In addition, Wave 1 contained some proxy measures of mental health (i.e. enumerators asked respondents to answer PHQ-9 and GAD-7 for non-present members) against protocols. Enumerators were retrained before Wave 2 and impacts are controlled using wave and individual fixed effects.

Because of the way the household panels are recorded, only the direct relationship between household head and each household member is known. Therefore in larger, three-generation households where there

[3]Whilst these findings are interesting descriptively, there are a number of reasons why we treat them with caution beyond their descriptive nature, primarily because the way chronic and non-chronic are calculated, chronic are those where the status doesn't change so households taking part in fewer waves of data collection are more likely to be chronic compared to those that took part in more.

are aunts and uncles present, it is impossible to truly know who is the biological parents, or the primary caregiver of a child. As a consequence where ambiguity exists, we average the mental health statistics for all adults of the generation above the child that adds noise since sometime both their parents and aunts/uncles may be included. We believe it is a sound assumption that there exists a shared responsibility by adults in the household for the care of children and this quirk adds only noise to our findings. Given that mental health data is only available for those present at the time of the interview we believe the primary caregiver is also the most likely to be at home with the child to answer these questions.

4 Methods

4.1 Analytical framework

We view caregiver depression/anxiety as time-varying capacity constraints that reduce the probability of undertaking and completing time-sensitive preventative health actions. In a child fixed-effects framework, we expect frictions caused by episodic (changing) anxiety and depression of parents to reduce the dose and delay of for-age vaccinations of their children.

We investigate if, and the extent to which, anxiety and depression prevents timely vaccination and by how long vaccination doses are delayed for. We measure anxiety and depression as if someone suffers moderate or severe anxiety or depression measured using the validated PHQ-9 and GAD-7 measures (Kroenke et al. 2001, Spitzer et al. 2006). For vaccination outcomes we measure them as:

1. Proportion of recommended for age vaccination dose received,

2. Cumulative weeks delayed in receiving recommended for age vaccination doses.

We have data of four of the Government of India's recommended vaccinations, namely: BCG, Polio, DPT, Measles (of Health and Family Welfare of India 2017). Table 3 summarises the age and doses recommended. The proportion of recommended vaccination doses is measured as the number of doses received (individual over-vaccination capped) divided by the total number of doses required by age. Cumulative weeks delayed is the sum of the dose-by-dose number of weeks since a vaccination was due. For example a child of 9 weeks old who has received no vaccinations (when 2 were due at birth) would have a value of 18 cumulative weeks delayed.

Table 3: Vaccine Schedule

Sl. No.	Age	Vaccines (with route)	Cumulative Doses
1	Birth	BCG (injection) OPV-0 (oral)	BCG: 1 Polio: 1
2	6 Weeks	OPV-1 (oral) DPT-1 (injection, via Pentavalent-1)	BCG: 1 Polio: 2 DPT: 1
3	10 Weeks	OPV-2 (oral) DPT-2 (injection, via Pentavalent-2)	BCG: 1 Polio: 3 DPT: 2
4	14 Weeks	OPV-3 (oral) DPT-3 (injection, via Pentavalent-3) IPV-2 (injection)	BCG: 1 Polio: 4 DPT: 3
5	9–12 Months	MR-1 (injection)	BCG: 1 Polio: 4 DPT: 3 Measles: 1
6	16–24 Months	MR-2 (injection) DPT Booster-1 (injection) OPV Booster (oral)	BCG: 1 Polio: 5 DPT: 4 Measles: 2
7	5–6 Years	DPT Booster-2 (injection)	BCG: 1 Polio: 5 DPT: 5 Measles: 2

Diseases Prevented: BCG – Tuberculosis; OPV/IPV – Poliomyelitis; DPT – Diphtheria, Pertussis (Whooping Cough), Tetanus; MR – Measles, Rubella.

4.2 Empirical strategy

We estimate child fixed-effects models:

$$Y_{it} = \beta_0 + \beta_1 MH_{it} + \sum_{j=1}^{k} \beta_j Z_{j,it} + \delta_i + \lambda_t + (\lambda_t \times \psi_g) + \varepsilon_{it}, \tag{1}$$

Where:

- Y_{it}: Represents the outcome variable for individual i, at time wave t. Our outcome is defined in two ways as described previously.
- MH_{it}: The key treatment variables of PHQ and GAD defined as moderate or severe, for for individual i, at time wave t. We also use categoric measures, namely individuals in bins of: mild, moderate, moderately severe and severe depression and anxiety, compared to no depression or anxiety.
- β_1 is the coefficient of primary interest, representing the estimated effect of a one-unit change in MH_{igt} on Y_{igt}, holding all other variables constant.
- $\beta_j Z_{j,it}$ is a vector of coefficients of time-varying control variables for individual i that vary across time t. This vector includes other relevant covariates that might influence Y_{igt} and are not captured by the fixed effects and are detailed in the next section.
- β_0 represents the intercept of the model.
- δ_i represents the individual-specific fixed effects for individual i. These capture unobserved, time-invariant characteristics of each individual that might affect the outcome.
- λ_t represents the wave (time period) fixed effects for wave t. These account for common nationwide shocks or trends affecting all individuals in a given time period.
- ψ_g represents the state-specific fixed effects g. Whilst states are fixed for all individuals, when interacted with time, these capture unobserved, time-variant changes within states that might affect outcomes and treatment. This includes seasonal and state-level shocks or policy changes that might affect both mental health and vaccination provision.
- ϵ_{igt} is the idiosyncratic error term for individual i, in state g, at time wave t. It captures all unobserved factors not accounted for by the other terms in the model.

Time-varying confounding. The individual fixed-effects design means all time-varying confounding that might explain both changes in mental health and changes in vaccination status are controlled for which includes, education, long-term economic conditions, geography (our data does not track people moving house, genetic predisposition, and long held beliefs about vaccination among others. What remains to be controlled for is time-varying confounding and since the decision to receive a vaccination flows directly and entirely through the primary care-giver of children the list of confounders is not extensive. We highlight four main channels that we need to control for to isolate an unbiased estimate below and summarise in a DAG found in appendix Figure 1:

1. **Household composition/support:** support networks in the household will both support mental health and affect decisions to vaccinate children in a timely manner. We control for births/deaths/migration/marriage/di number of children. We also use robust standard errors clustered at the primary sampling unit to account for wider neighbourhood effects too.

2. **Work and income:** despite vaccinations being provided for free in the public sector, there remain financial barrier to accessing vaccines. Income and employment has clear impacts on mental health. We control for change in employment, income, net spending, health income shocks.

3. **Healthcare contact:** routine care visits may prompt catch-up doses. Because mental healthcare should influence symptoms of depression and anxiety and also impact the likelihood that vaccinations are sought, we control for mental health contacts. However, since general health contacts should not affect mental health symptoms (these are differentiated in the survey), if there is an impact lies on the causal pathway, we do not control for these contacts.

4. **Time use:** A common symptom or cause of anxiety and depression is changes in time-use that could also impact the seeking of care. For example, losing a job may increase the time available to make preventative health investments. We control for the parents time spent on "tasks for others in the household" that include care for children, and on "indoor entertainment" to capture changes in the amount of leisure time they have.

5. **Policy and epidemic context:** Individual COVID shocks that affect households and communities could affect mental health and decisions to vaccinate and so are controlled for. We control for lingering COVID restrictions using the COVID-19 stringency index[4]. Any other state level confounding are controlled for using state and wave fixed effects such as policy differences.[5]

[4]available at: https://github.com/OxCGRT/covid-policy-dataset

[5]We control for stringency index at the day the interview was conducted hence can vary within a wave meaning it is not fully absorbed in the state wave fixed effects.

6. **Enumerator effects:** We also include a control for enumerator quality, measured through an index of the likelihood of replicated data. This is modelled through a binary indicator of if the enumerator lies above or below a set level on the index of quality. With 729 different enumerators across our sample of 4,000 child-parent pairs, we chose not to include enumerator fixed effects since the number of estimated parameters reaches close to 900 that significantly reduces the quality of model estimates.

7.

Add DAG in appendix; table defining all $Z_{j,it}$.

5 Results

Table 4: Effect of mother's mental health on their child's completed vaccination doses

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Prop. doses	Prop. doses	Prop. doses	Prop. doses	Prop. doses
Moderate or severe anxiety or depression score	-0.018**				
	(0.007)				
Moderate or severe depression score		-0.017**			
		(0.007)			
Category of depression = 1, 1. Mild			0.002		
			(0.007)		
Category of depression = 2, 2. Moderate			-0.013*		
			(0.008)		
Category of depression = 3, 3. Moderately severe			-0.020		
			(0.013)		
Category of depression = 4, 4. Severe			-0.064***		
			(0.024)		
Moderate or severe anxiety score				-0.018**	
				(0.007)	
Category of axiety = 1, 1. Mild					0.035
					(0.022)
Category of axiety = 2, 2. Moderate					-0.018
					(0.021)
Category of axiety = 3, 3. Severe					0.055
					(0.048)
Constant	0.702***	0.703***	0.700***	0.701***	0.940***
	(0.042)	(0.042)	(0.042)	(0.042)	(0.122)
Observations	7,909	7,909	7,891	7,909	8,527
R^2	0.390	0.390	0.390	0.390	0.450
Number of uid2	3,938	3,938	3,933	3,938	4,185
Mean Y	0.598	0.598	0.598	0.598	0.598
Time varying controls	Yes	Yes	Yes	Yes	Yes
State#wave FE	Yes	Yes	Yes	Yes	Yes
Weights	No	No	No	No	No

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5: Effect of mother's mental health on the cumulative weeks of delay to a child's full vaccination

VARIABLES	(1) Cumulative Weeks Delayed	(2) Cumulative Weeks Delayed	(3) Cumulative Weeks Delayed	(4) Cumulative Weeks Delayed	(5) Cumulative Weeks Delayed
Moderate or severe anxiety or depression score	27.693				
	(21.002)				
Moderate or severe depression score		43.394**			
		(21.635)			
Category of depression = 1, 1. Mild			-37.426		
			(27.352)		
Category of depression = 2, 2. Moderate			23.135		
			(22.861)		
Category of depression = 3, 3. Moderately severe			37.683		
			(34.257)		
Category of depression = 4, 4. Severe			-0.272		
			(80.149)		
Moderate or severe anxiety score				-6.808	
				(20.251)	
Category of axiety = 1, 1. Mild					-9.970
					(25.196)
Category of axiety = 2, 2. Moderate					-18.078
					(24.997)
Category of axiety = 3, 3. Severe					34.477
					(48.362)
Constant	596.593***	590.915***	583.590***	606.075***	600.282***
	(135.898)	(135.144)	(129.618)	(135.901)	(128.288)
Observations	8,736	8,736	8,714	8,736	8,721
R^2	0.142	0.143	0.145	0.141	0.143
Number of uid2	4,340	4,340	4,336	4,340	4,335
Mean Y	625.709	625.709	625.709	625.709	625.709
Time varying controls	Yes	Yes	Yes	Yes	Yes
State#wave FE	Yes	Yes	Yes	Yes	Yes
Weights	No	No	No	No	No

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 4 present the findings for mothers on the proportion of doses children have received and Table 5, the cumulative weeks a child has been without their recommended doses, proxying delays in vaccination. Suffering moderate or severe anxiety and depression leads to a consistent 1.7 to 1.8 percentage point (ppt) drop, or a 3% drop, in the proportion of the recommended doses a child has received at the time of the SEHAT interview, columns, 1, 2 and 4. When investigating the gradient of effect by severity category, we see a strong association with impacts rising as severity rises to a maximum of 6.4 ppt or an 11% drop, in the proportion of recommended doses a child has received, column 3. However, as suspected, for anxiety, whilst there is an overall effect, we do not see the same severity gradient. When considering the impacts on delays to vaccination. There is no significant impact for combined mental health issues, column 1, but those children who's mothers are suffering moderate or severe depression have a cumulative delay of around 44 weeks, equating to just under a year. The impact across different categories for depression and anxiety have point estimates rising as severity increases, except the most severe depression, columns 3 and 5, however, whilst neither are statistically significant, it is supportive evidence for our hypotheses. The fact we find a strong and significant results for the proportion of doses received but less precise evidence for delays in vaccination implies delays are not the primary mechanism explaining lower vaccination coverage. We interpret this as depression will lead to missed doses, and while there is some recovery, it does not look like recovery of vaccinations is as strong when mothers regain mental health.

We also add fathers to the model making the exposure variable an average of parental mental health

outcomes. Whilst only around 20% of mental health questions were answered by fathers, the results lose precision when they are added. When we conduct the analysis using only fathers, we find no impacts. In theory, if the impact of fathers was the same as mothers it would strengthen our findings, the loss of precision implies their marginal impact is reduces the negative association of anxiety and depression with childhood vaccination. This follows our typical gendered care responsibilities in India, but a lack of effect in fathers alone is probably due to lower sample size resulting in a more unbalanced panel.

5.1 Individual antigens and zero-dose

Table 6: Zero-dose and antigen-specific effects

VARIABLES	(1) Zero dose	(2) BCG	(3) BCG_delay	(4) Polio	(5) Polio_delay	(6) DPT	(7) DPT_delay	(8) Measles	(9) Measles_delay
Moderate or severe anxiety or depression score		-0.036**	7.195**	-0.023***	10.822	-0.008	4.643	-0.027	5.033
		(0.018)	(3.456)	(0.009)	(12.255)	(0.010)	(9.753)	(0.019)	(3.359)
Constant		1.007***	6.198	0.541***	384.704***	0.760***	191.990***	0.945***	13.701
		(0.103)	(19.663)	(0.048)	(62.441)	(0.058)	(63.977)	(0.094)	(16.651)
Observations	7,909	8,542	8,736	8,084	8,736	7,899	8,736	8,149	8,736
R^2		0.398	0.309	0.239	0.161	0.273	0.188	0.312	0.214
Number of uid2	3,938	4,190	4,340	4,010	4,340	3,930	4,340	4,011	4,340
Mean Y	0.000	0.811	36.615	0.548	311.741	0.566	234.171	0.737	43.182
Time varying controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State#wave FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Weights	No	No	No	No	No	No	No	No	No

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Different treatment courses and types of vaccination are likely to interact with mental health problems. For example, vaccinations doses due to be taken at, or soon after birth, may be affected more so because of post-natal depression, estimated to affect 22% of mothers in India (Panolan & Thomas M 2024). Conversely if a birth occurs in a health facility, one would expect vaccinations to be more readily available. Other characteristics of the vaccinations, e.g. oral (polio), injection (BCG, DPT and Measles), side-effects, misinformation (MR vaccines) could also interact with mental health. Theory suggests that if barriers are exacerbated by poor parental mental health, it means injection, greater known or perceived side-effects (measles) would be more likely to be missed by parents going through a poor mental health episode.

Table 6 shows that the effects hold for BCG (taken at birth) with a 3.7 ppt drop in proportion of children having had their single dose and on average being 7 weeks delayed in taking it. Polio, that is orally taken for the first dose is 2.3 ppt lower, where as DPT and measles are unaffected. It is worth noting for measles the point estimate is a 2.8 ppt reduction if the parents suffer anxiety or depression but is not statistically significant. This implies that post-partum depression could be a significant driver of the reduced vaccination with those doses that come after birth and in early life most affected by anxiety and depression of mothers.

BCG is shown to have significant protective effects for neonatal children. Evidence from Uganda from an RCT of children healthy enough to be discharged from hospital, showed that children vaccinated at birth, compared to those at 6 weeks old, were less likely to be diagnosed with non-TB infectious diseases (hazard ratio 0.71 [95% CI 0.53–0.95], p=0.023) but that once BCG was administered differences were not detectable (Prentice et al. 2021).

6 Heterogeneity

6.1 Gender

Table 7: Heterogeneity by child's gender

VARIABLES	(1) Prop. doses	(2) Weeks Delayed	(3) Prop. doses	(4) Weeks Delayed	(5) Prop. doses	(6) Weeks Delayed
Moderate or severe anxiety or depression score	-0.024***	34.086*	-0.015	51.965*	-0.023***	38.265
	(0.007)	(20.639)	(0.012)	(31.494)	(0.009)	(26.125)
Female*Moderate/High Anx. or Dep.	0.014	-15.557				
	(0.009)	(18.600)				
Low vaccination state*Moderate/High Anx. or Dep.			-0.004	-45.478		
			(0.014)	(43.046)		
Three generation*Moderate/High Anx. or Dep.					0.013	-26.563
					(0.012)	(27.835)
Constant	0.760***	323.105**	0.757***	324.430**	0.758***	327.336**
	(0.105)	(151.283)	(0.105)	(151.223)	(0.105)	(151.709)
Observations	7,909	8,736	7,909	8,736	7,909	8,736
R^2	0.390	0.144	0.390	0.144	0.390	0.144
Number of uid2	3,938	4,340	3,938	4,340	3,938	4,340
Mean Y	0.598	625.709	0.598	625.709	0.598	625.709
Time varying controls	Yes	Yes	Yes	Yes	Yes	Yes
State#wave FE	Yes	Yes	Yes	Yes	Yes	Yes
Weights	No	No	No	No	No	No

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

In India, boys typically receive greater investment in their human capital than girls (Jayachandran & Kuziemko 2011, Barcellos et al. 2014). Changes in Indian health system that resulted in free hospital care for many more Indians showed gender inequities in seeking care, particularly as barriers such as indirect out of pocket expenses and distance increased which affected girls more than boys (Dupas & Jain 2024). If mother's are typically putting more effort into investing into sons over daughters, we would expect poor mental health episodes to therefore reflect a large impact on boys than girls. Columns 1 and 2 of Table 7 show girls are 1.3 ppt more vaccination doses vs. boys when parents are suffering either depression or anxiety and be less delayed. However, these estimates are not statistically significant.

Table 2 predict smaller households but more children are more likely to have chronic and non-chronic anxiety and depression we hypothesise that households with grandparents present, those with experience of the challenges of raising children may be sheltered somewhat from the effects of mothers difficulties keeping children up to date. However, we do not find any protective effect of grandparents being in the household, Table 7, columns 3 and 4. Interesting according to Table 2 non-chronic households are less likely to have grandparents, whereas parents that suffer chronic anxiety or depression are more likely to have grandparents present.

Finally, we hypothesise that states with lower baseline vaccination rates, potentially reflecting geographic differences, supply constraints, or weaker health system performance, may be more responsive to parental

mental health shocks as poor mental health will exacerbate the barriers already present in these states. However, splitting the sample this way yields no detectable effects, Table 7, columns 5 and 6.

7 Threats to causal interpretations and robustness checks

As discussed in the analytical framework, for the relationship's estimated in this paper to be considered causal, all time-varying confounding that might explain both changes in mental health and changes in vaccination status of under-5's must be accounted for. We believe our controls account for the vast majority of this confounding since there are only a few plausible pathways that link the two sides of our equation. However, outside of theoretical confounding factors, bias could be introduced through data generation concerns.

One concern is that, mental health and doses of vaccination are both self-reported and there could be a correlation between parents who report poor mental health, perhaps under-reporting vaccination doses because they are distracted, less engaged with the survey or more forgetful. However, part of the training for enumerators was to collect vaccination information directly from vaccination cards which most parents have and would eliminate this source of bias. There will be some cases where parents cannot find their child's vaccination cards, they do not have them, or that enumerators forget to ask for them, so we cannot eliminate this as a source of bias entirely.

Reverse causality is another concern where it is ill health of unvaccinated children that could be driving the relationships. For vaccination status to affect parental mental health, children would need to be contracting vaccine-preventable diseases, unlikely to be highly prevalent. Even partial vaccination would have to be driving ill-health to the extent that parents mental health suffers despite the fact it provides some protection in reducing transmission and the severity of illness. However, we test explicitly whether the child required medical care is associated with parental mental health, finding no empirical relationship when using the same set of controls and fixed effects (Table 8) [update table].

As a robustness check we include enumerator fixed effects. The results are in Table 10 in the appendix showing little relationship, likely do to overfitting of model with around 900 parameters.

Table 8: Child illness and caregiver mental health (reverse pathway)

VARIABLES	(1) Mother suffered anx. or dep.	(2) Mother suffered anx. or dep.
If child under 5 accessed healthcare since the last wave	0.026	-0.037
	(0.042)	(0.040)
Constant	0.393***	0.392***
	(0.139)	(0.110)
Observations	8,736	8,736
R^2	0.038	0.210
Number of uid2	4,340	4,340
Mean Y	0.276	0.276
Time varying controls	Yes	Yes
State#wave FE	No	Yes
Weights		No

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

7.1 Lagged exposure

In our dataset, our main outcome of proportion of vaccination doses received, is calculated through dividing doses received at the time of the survey compared to the recommended doses that should have been received. A dose exists for the lifetime of the child, meaning additions to this dosage count can occur in the entire 4-month period between survey waves (or longer if a household missed a wave). Mental health questions refer only to the previous two weeks presenting a potential variable reference period issue because mental health is only measured a the end of the 4 month vaccination window. However, we do not believe this is a large issue because PHQ-9 and GAD-7 are shown to capture persistent symptoms and show consistency over time, implying they reflect longer-term parental well-being beyond the two-week window. All we do know is that at some point in the last 4 months, or since the last wave, the mental health state of the mother changed and persisted to today. Mathematically, if we assume onset of poor mental health is random we can therefore assume that on average the latter half of the time period was affected, equating to 2.5 months (midpoint + two-week reference period), which remains the majority, and most important period, of the vaccination window. In the other direction, moving from worse to better mental health, parents could catch-up after an episode of anxiety and depression.

If we used lagged exposure, it's tempting to think that this will eliminate the problem. However, shifting forward vaccination status, we are now suggesting that last wave's poor mental health, will affect vaccination today. Since we are estimated the impact of episodic anxiety and depression, it implies that many will have received in this wave giving them the opportunity to 'catch up' watering down the impacts of anxiety and depression on vaccination. We find that there is in fact, no measurable effect using lagged exposure variables,

Table 9.

Table 9: Lagged mental health predicting current vaccination

VARIABLES	(1) Prop. doses	(2) Weeks Delayed
Lagged moderate or severe depression or anxiety	-0.001	-1.356
	(0.009)	(19.539)
Constant	0.734***	548.193***
	(0.066)	(161.776)
Observations	5,276	5,320
R^2	0.260	0.150
Number of uid2	2,807	2,831
Mean Y	0.598	0.598
Time varying controls	Yes	Yes
State#wave FE	Yes	Yes
Weights	No	No

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

8 Discussion

Our findings support a "capacity/bandwidth" channel linking caregiver mental health to timely child preventive care in a context where financial barriers are low, non-financial barriers to vaccination remain, and access to mental healthcare is poor. They are consistent with previous literature and with the results of (Angelucci & Bennett 2024), which suggest that motivational frictions drive delays in uptake of preventative healthcare of oneself and dependents. In our setting, depression more consistently reduced vaccination coverage and delays timely vaccination, whereas the findings for anxiety are mixed and less precise. The impacts are observed more strongly on the intensive margin, the proportion of doses received, than on the timeliness margin of initiating all age-appropriate vaccination regimes. Furthermore, depression appears to have a larger impact on earlier doses in life. However, according to our DAG in Appendix Figure 1, the causal pathway also acts through interactions with the health system. Mothers that are more depressed are going to reduce contacts with health services for other reasons besides for vaccinations. At these contacts they could be reminded of vaccinations or receive advice from medical practitioners that updates their demand for preventative health services. We are unable to establish the proportion of effect that runs through this

health system contact pathway, but it does not change our policy recommendations.

Although the overall magnitudes of our estimates are modest, they are clinically meaningful for children who become more vulnerable to vaccine-preventable diseases and harm herd immunity in places where coverage is lower. In the pursuit of universal immunisation, our findings suggest that embedding mental health screening, referral and treatment, particularly targetted at new mothers, into health worker visits to households could increase vaccination coverage and reduce delays. In addition, mental health screening when mothers attend for late vaccinations may help to target treatment and referrals to those mothers that are struggling most. The Indian ASHA health worker programme is already testing and scaling-up psychological treatment through the Sangath initiative for depression in rural areas (Agrawal et al. 2025). Our findings support this initiative and imply that the benefits may bring additional benefits to vaccination.

9 Conclusion

Parental depression and anxiety appear to delay children's routine immunisations in India. Depression in parents leads to a modest 1.8 ppt drop, or a 3% reduction, in the proportion of age-appropriate doses a child receives. The impact seems relatively consistent across the country, with few heterogeneous effects across different subgroups. Mothers depression, worryingly appears to delay vaccinations for newborns by around 7 weeks, a delay shown to be clinically linked to increase non-TB infectious disease and mortality (Prentice et al. 2021, Higgins et al. 2016). Integrating basic mental health support into routine child health visits may complement supply-side efforts to close the remaining gaps in vaccination coverage, improve child health as well as improving detection and treatment of anxiety and depression of mothers.

References

Aaby, P., Roth, A., Ravn, H., Napirna, B. M., Rodrigues, A., Lisse, I. M., Stensballe, L., Diness, B. R., Lausch, K. R., Lund, N., Biering-Sørensen, S., Whittle, H. & Benn, C. S. (2011), 'Randomized Trial of BCG Vaccination at Birth to Low-Birth-Weight Children: Beneficial Nonspecific Effects in the Neonatal Period?', *The Journal of Infectious Diseases* **204**(2), 245–252.
URL: *https://doi.org/10.1093/infdis/jir240*

Agrawal, A., Kolhapure, S., Di Pasquale, A., Rai, J. & Mathur, A. (2020), 'Vaccine Hesitancy as a Challenge or Vaccine Confidence as an Opportunity for Childhood Immunisation in India', *Infectious Diseases and Therapy* **9**(3), 421–432.
URL: *https://doi.org/10.1007/s40121-020-00302-9*

Agrawal, R. N., Sood, M., Patel, A., Sharma, T., Yadav, H., Kaur, J., Kumari, S., Sharma, P., Shukla, V., Tripathi, B., Dongare, N., Narasimhamurti, N. S., Bhan, A., Tiwari, S., Sakalle, S. & Patel, V. (2025), 'Scaling up the task-sharing of an evidence-based psychological treatment for depression in rural India: an implementation study', *BMC Primary Care* **26**(1), 267.
URL: *https://doi.org/10.1186/s12875-025-02943-6*

Angelucci, M. & Bennett, D. (2024), 'The Economic Impact of Depression Treatment in India: Evidence from Community-Based Provision of Pharmacotherapy', *American Economic Review* **114**(1), 169–198.
URL: *https://pubs.aeaweb.org/doi/10.1257/aer.20210687*

Bangura, J. B., Xiao, S., Qiu, D., Ouyang, F. & Chen, L. (2020), 'Barriers to childhood immunization in sub-Saharan Africa: A systematic review', *BMC Public Health* **20**(1), 1108.
URL: *https://doi.org/10.1186/s12889-020-09169-4*

Barcellos, S. H., Carvalho, L. S. & Lleras-Muney, A. (2014), 'Child Gender and Parental Investments in India: Are Boys and Girls Treated Differently?', *American Economic Journal: Applied Economics* **6**(1), 157–189.
URL: *https://www.aeaweb.org/articles?id=10.1257/app.6.1.157*

Chakrabarti, A., Bair, E. F. & Thirumurthy, H. (2023), 'Routine child immunizations in India during the COVID-19 pandemic', *SSM - Population Health* **22**, 101383.
URL: *https://www.sciencedirect.com/science/article/pii/S2352827323000484*

Choudhary, T. S., Reddy, N. S., Apte, A., Sinha, B., Roy, S., Nair, N. P., Sindhu, K. N., Patil, R., Upadhyay, R. P. & Chowdhury, R. (2019), 'Delayed vaccination and its predictors among children under 2 years in

India: Insights from the national family health survey–4', *Vaccine* **37**(17), 2331–2339.
URL: *https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6996155/*

de Quidt, J. & Haushofer, J. (2016), 'Depression for Economists'.
URL: *https://www.nber.org/papers/w22973*

Dupas, P. & Jain, R. (2024), 'Women Left Behind: Gender Disparities in Utilization of Government Health Insurance in India', *American Economic Review* **114**(10), 3345–3385.
URL: *https://www.aeaweb.org/articles?id=10.1257/aer.20230521*

Fadel, S. A., Rasaily, R., Awasthi, S., Begum, R., Black, R. E., Gelband, H., Gerland, P., Kumar, R., Liu, L., Mathers, C., Morris, S. K., Nair, S., Newcombe, L., Pandey, A., Ram, F., Ram, U., Rodriguez, P. S., Sahu, D., Sati, P., Shah, P. J., Shet, A., Sheth, J., Singh, J. K., Singh, L., Sinha, A., Suraweera, W. & Jha, P. (2017), 'Changes in cause-specific neonatal and 1–59-month child mortality in India from 2000 to 2015: a nationally representative survey', *The Lancet* **390**(10106), 1972–1980. Publisher: Elsevier.
URL: *https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(17)32162-1/abstract*

Higgins, J. P. T., Soares-Weiser, K., López-López, J. A., Kakourou, A., Chaplin, K., Christensen, H., Martin, N. K., Sterne, J. A. C. & Reingold, A. L. (2016), 'Association of BCG, DTP, and measles containing vaccines with childhood mortality: systematic review'. Publisher: British Medical Journal Publishing Group Section: Research.
URL: *https://www.bmj.com/content/355/bmj.i5170.short*

Jayachandran, S. & Kuziemko, I. (2011), 'Why Do Mothers Breastfeed Girls Less than Boys? Evidence and Implications for Child Health in India*', *The Quarterly Journal of Economics* **126**(3), 1485–1538.
URL: *https://doi.org/10.1093/qje/qjr029*

Kaufman, J., Tuckerman, J., Bonner, C., Durrheim, D. N., Costa, D., Trevena, L., Thomas, S. & Danchin, M. (2021), 'Parent-level barriers to uptake of childhood vaccination: a global overview of systematic reviews', *BMJ Global Health* **6**(9), e006860. Publisher: BMJ Specialist Journals Section: Original research.
URL: *https://gh.bmj.com/content/6/9/e006860*

Kroenke, K., Spitzer, R. L. & Williams, J. B. W. (2001), 'The PHQ-9', *Journal of General Internal Medicine* **16**(9), 606–613.
URL: *https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1495268/*

MacDonald, S. E., Dhungana, M., Stagg, V., McDonald, S., McNeil, D., Kellner, J. D., Tough, S. & Saini, V. (2024), 'Impact of maternal depression and anxiety on immunization status of children: a prospective

cohort study', *Archives of Public Health* **82**(1), 89.
URL: *https://doi.org/10.1186/s13690-024-01323-3*

Murthy, R. S. (2017), 'National Mental Health Survey of India 2015–2016', *Indian Journal of Psychiatry* **59**(1), 21–26.
URL: *https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5419008/*

of Health and Family Welfare of India, M. (2017), 'National Immunization Schedule'.

Palatucci, J. S. (2024), 'Child Health, Parental Mental Health, and the Role of Living Arrangements'.
URL: *https://papers.ssrn.com/abstract=4783566*

Panolan, S. & Thomas M, B. (2024), 'Prevalence and associated risk factors of postpartum depression in India: A comprehensive review', *Journal of Neurosciences in Rural Practice* **15**(1), 1–7.
URL: *https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10927066/*

Paul, S., Salunkhe, S., Mane, S. V. & Bahal, M. (2024), 'Confronting Vaccine Hesitancy in India: A Vital Call for Unified Action', *Cureus* **16**(11), e73459.

Pierce, M., Hope, H. F., Kolade, A., Gellatly, J., Osam, C. S., Perchard, R., Kosidou, K., Dalman, C., Morgan, V., Di Prinzio, P. & Abel, K. M. (2020), 'Effects of parental mental illness on children's physical health: systematic review and meta-analysis', *The British Journal of Psychiatry: The Journal of Mental Science* **217**(1), 354–363.

Prentice, S., Nassanga, B., Webb, E. L., Akello, F., Kiwudhu, F., Akurut, H., Elliott, A. M., Arts, R. J. W., Netea, M. G., Dockrell, H. M., Cose, S., Prentice, S., Nassanga, B., Akurut, H., Akello, F., Kiwudhu, F., Cose, S., Dockrell, H., Webb, E., Elliott, A., Nabaweesi, I., Zziwa, C., Namutebi, M., Namarra, B., Akello, F., Nakazibwe, E., Amongi, S., Kamukama, G., Iwala, S., Ninsiima, C., Tumusiime, J., Kiwanuka, F., Nsubuga, S., Akello, J., Owilla, S., Levin, J., Nash, S., Nakawungu, P. K., Abayo, E., Nabakooza, G., Kaushaaga, Z. & Akello, M. (2021), 'BCG-induced non-specific effects on heterologous infectious disease in Ugandan neonates: an investigator-blind randomised controlled trial', *The Lancet Infectious Diseases* **21**(7), 993–1003. Publisher: Elsevier.
URL: *https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(20)30653-8/fulltext*

Rahman, A., Iqbal, Z., Bunn, J., Lovel, H. & Harrington, R. (2004), 'Impact of Maternal Depression on Infant Nutritional Status and Illness: A Cohort Study', *Archives of General Psychiatry* **61**(9), 946–952.
URL: *https://doi.org/10.1001/archpsyc.61.9.946*

Rahman, A., Malik, A., Sikander, S., Roberts, C. & Creed, F. (2008), 'Cognitive behaviour therapy-based intervention by community health workers for mothers with depression and their infants in rural Pakistan: a cluster-randomised controlled trial', *The Lancet* **372**(9642), 902–909. Publisher: Elsevier.
URL: *https://www.thelancet.com/journals/lancet/article/PIIS0140673608614002/fulltext*

Raut, A. & Huy, N. T. (2023), 'Recrudescence of measles in India: an emerging threat', *Pathogens and Global Health* **117**(4), 326–327.
URL: *https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10177746/*

Singh, S., Sahu, D., Agrawal, A. & Vashi, M. D. (2019), 'Barriers and opportunities for improving childhood immunization coverage in slums: A qualitative study', *Preventive Medicine Reports* **14**, 100858.
URL: *https://www.sciencedirect.com/science/article/pii/S2211335519300439*

Smith, H. C., Saxena, S. & Petersen, I. (2022), 'Maternal postnatal depression and completion of infant immunizations: a UK cohort study of 196,329 mother-infant pairs, 2006–2015', *The Journal of Clinical Psychiatry* **83**(4), 41416. Publisher: Physicians Postgraduate Press, Inc.
URL: *https://legacy.psychiatrist.com/jcp/maternal-postnatal-depression-completion-infant-immunizations-uk-cohort-study-196329-mother-infant-pairs-2006-2015/*

Spitzer, R. L., Kroenke, K., Williams, J. B. W. & Löwe, B. (2006), 'A brief measure for assessing generalized anxiety disorder: the GAD-7', *Archives of Internal Medicine* **166**(10), 1092–1097.

Turner, C., Boyle, F. & O'Rourke, P. (2003), 'Mothers' health post-partum and their patterns of seeking vaccination for their infants', *International Journal of Nursing Practice* **9**(2), 120–126. Publisher: John Wiley & Sons, Ltd.
URL: *https://onlinelibrary.wiley.com/doi/full/10.1046/j.1322-7114.2003.00410.x*

WHO & UNICEF (2025), 'Global childhood vaccination coverage holds steady, yet over 14 million infants remain unvaccinated – WHO, UNICEF'.
URL: *https://www.who.int/news/item/15-07-2025-global-childhood-vaccination-coverage-holds-steady-yet-over-14-million-infants-remain-unvaccinated-who-unicef*

Zaikin, A., Koren, G., Chodick, G. & Grossman, Z. (2022), 'No Association Between Maternal Post-partum Depression and Vaccination Uptake of Infants: A Matched Cohort Study in a Large Health Maintenance Organization Database in Israel', *Frontiers in Pediatrics* **9**. Publisher: Frontiers.
URL: *https://www.frontiersin.org/journals/pediatrics/articles/10.3389/fped.2021.771089/full*

A Additional Tables and Figure

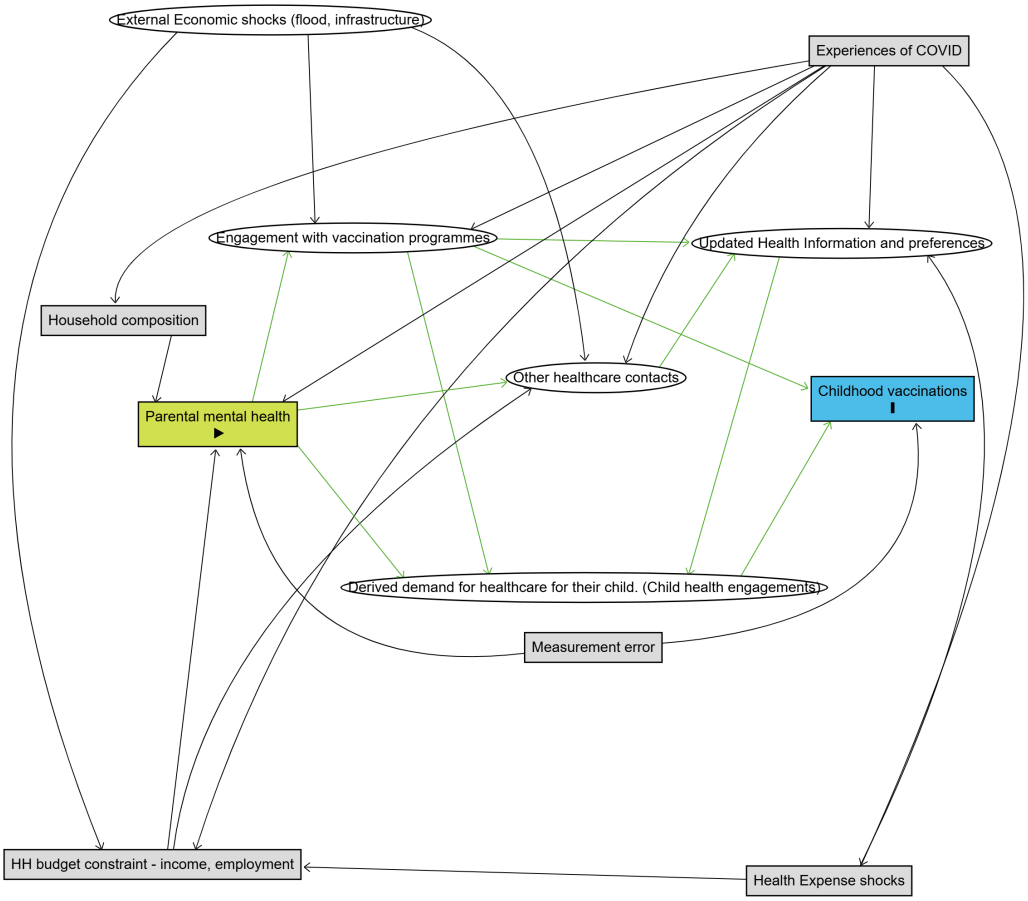
Table 10: Main specification results with enumerator fixed effects

VARIABLES	(1) Prop. doses	(2) Prop. doses	(3) Prop. doses	(4) Prop. doses	(5) Prop. doses
Moderate or severe anxiety or depression score	-0.009				
	(0.007)				
Moderate or severe depression score		-0.004			
		(0.007)			
Category of depression = 1, 1. Mild			-0.003		
			(0.008)		
Category of depression = 2, 2. Moderate			-0.005		
			(0.009)		
Category of depression = 3, 3. Moderately severe			-0.001		
			(0.013)		
Category of depression = 4, 4. Severe			-0.012		
			(0.020)		
Moderate or severe anxiety score				-0.011	
				(0.009)	
Category of axiety = 1, 1. Mild					0.024
					(0.020)
Category of axiety = 2, 2. Moderate					0.005
					(0.024)
Category of axiety = 3, 3. Severe					0.053
					(0.036)
Constant	0.710***	0.717***	0.745***	0.706***	0.839***
	(0.040)	(0.041)	(0.042)	(0.043)	(0.103)
Observations	7,909	7,909	7,891	7,909	8,527
R^2	0.603	0.603	0.603	0.603	0.662
Number of uid2	3,938	3,938	3,933	3,938	4,185
Mean Y	0.598	0.598	0.598	0.598	0.598
Time varying controls	Yes	Yes	Yes	Yes	Yes
State#wave FE	Yes	Yes	Yes	Yes	Yes
Enumerator FE	Yes	Yes	Yes	Yes	Yes

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Figure 1: DAG



- Green box = Exposure variable
- Blue box = Outcome variable
- White oval = Variables **not** controlled for
- Grey box = Variables **controlled** for
- Black lines and arrows = direction of theoretical causal influence
- Green lines and arrows = direction of estimated causal effects. i.e isolated causal pathway between exposure and treatment