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Social capital and utilization of immunization service: A multilevel analysis in rural Uttar Pradesh, India

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ARTICLE INFO

ABSTRACT

The National Health Policy (2017) of India advocates Universal Health Coverage through inclusive growth, decentralization, and rebuilding a cohesive community through a participatory process. To achieve this goal, understanding social organization, and community relationships – defined as social capital – is critical. This study aimed to explore the influence of individual and community-level social capital on a critical health system performance indicator, three-doses of diphtheria–pertussis–tetanus (DPT3) immunization among 12–59 month children, in rural Uttar Pradesh (UP), India. The analysis is based on a cross-sectional survey from two districts of UP, which included 2239 children 12–59 months of age (level 1) from 1749 households (level 2) nested within 346 communities (level 3). We used multilevel confirmatory factor analysis to generate standardized factor scores of social capital constructs (*Organizational Participation, Social* Support*, Trust* and *Social Cohesion*) of the household heads and mothers both at individual and community level, which were then used in the multilevel logistic regressions to explore the independent and contextual effect of social capital on a child's DPT3 immunization status. The result showed only community-level *Social Cohesion* of the mothers was associated with a child's DPT3 immunization status (Adjusted odds ratio = 1.25, 95% confidence interval = 1.12–1.54; p = 0.04). Beyond its independent effect on utilization of immunization service, the collective *Social Cohesion* of the mothers significantly modified the relationship of child age, mother's knowledge of immunization, community wealth, and communities' contact with frontline workers with immunization status of the child. With a strong theoretical underpinning, the result substantially contributes to understanding the individual and contextual predictors of immunization service utilization and further advancing the literature of social capital in India. This study can serve as a starting point to catalyze social capital within the health interventions for achieving wellbeing and the collective development of society.

1. Introduction

Childhood immunization is considered one of the "Best Buys," and the net return of immunization is predicted to be 44 times the cost of the program in low and middle-income countries (Ozawa et al., 2016). For the last decade, globally, the coverage of three doses of diphtheria, tetanus, and pertussis (DTP3)[1] vaccine is stagnant around 86%, and around 20 million children remained unvaccinated (World Health Organization, 2019). While the coverage of DPT3 vaccine in South Asia and India is almost similar to the Global scale – 87% and 89%

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accordingly – due to the sheer size of the population, more than 2.6 million children remain unvaccinated in India today (UNICEF, 2019).

However, if we take a more in-depth look, it appears there is still a significant inequality in immunization coverage across states of India. According to the latest National Family and Health Survey (NFHS), only 62% of the children aged 12–23 months receive all immunization – ranging from 91% in Puducherry to 35% in Nagaland. Among the northern states of India, Uttar Pradesh (UP) has seen a 28% increase in immunization coverage since 2005, yet it is one of the low performing states of India with only 51% of full immunization coverage (International Institute for Population Sciences & ICF, 2017).

Immunizing children not only depends on parental preference or the efficiency of the health system but also social context and the everyday interaction among individuals and communities. The contextual characteristics associated with the missing opportunity of immunization include – but not limited to – lack of social interaction (Rainey et al., 2011; Sridhar, Maleq, Guillermet, Colombini, & Gessner, 2014), mistrust towards vaccine, healthcare provider or institutions (Benin, Wisler-Scher, Colson, Shapiro, & Holmboe, 2006; MacDonald, Schopflocher, & Vaudry, 2014; Smith, Marcuse, Seward, Zhao, & Orenstein, 2015), peer influence and conformity with norms (Bults, Beaujean, Richardus, Steenbergen, & Voeten, 2011). Cumulatively all these contextual factors can be linked with social capital.

Social capital is the aggregated resources embedded within the social network and relationships of individuals and groups (Bourdieu, 1986). These resources can be exclusively available for the people within that social network. Beyond its utility as a private good, social capital is also conceptualized as the characteristics of social organization such as cohesiveness, norms, and trust, which can be used for coordinated actions for mutual benefits (Putnam, 1995). Social capital can be classified into structural and cognitive components. Structural social capital indicates the associational network among individuals and the community (Bourdieu, 1986). It is measured by civic engagement, community participation, collective action, and transaction of social support. In the time of need, structural social capital can be used to gain information, acquire financial assistance or access health services, etc. (Lindström, 2008). On the other hand, cognitive social capital is defined by the perception of trust, social cohesion, or solidarity among individuals and groups. Trust is necessary to facilitate the sharing of information and resources and to incentivize societal cooperation (Buchan, Croson, & Solnick, 2008). Social cohesion implies the depth of connections and perception of belongingness of individuals or groups to their community (Kawachi & Subramanian, 2007).

1.1. Social capital and immunization service utilization

Literature indicates five different pathways through which social capital can influence health-seeking. First, civic engagement and community participation (structural social capital) – allow the dissemination of information and initiate coordinated actions within the social network. As an example, the women's self-help group in India was able to significantly improve maternal and child health by formalizing a network of impoverished women (Saha, Annear, & Pathak, 2013). Secondly, structural social capital can influence health-related behavior when a person tried to access the "*actual and potential*" resources embedded within his/her social network. These resources (cash, in-kind support, transportation, etc.) can be instrumental in accessing and utilizing healthcare. As the third pathway, people can also invest in their social network to build reciprocity. In the time of need – such as taking the child to the health facility for immunization – this "credit slip" can help to acquire social support and buffer any stress.

Being a part of the community or a group often offers power and exclusivity, which can provide greater access to healthcare. As an example, health insurance only allows its contributing members to access the pooled fund while paying for care (Donfouet & Mahieu, 2012). Lastly, trust and cohesiveness among community members can foster

collective action or impose informal social control to regulate health-related behaviors. If immunization is considered as a social norm, a cohesive community will work together to remove any barrier to the immunization service (Seid, Hesse, & Bloomfield, 2015). In reverse, members of the anti-vaccine campaigns also demonstrate a higher level of cohesiveness and refrain from vaccination (Mitra, Counts, & Pennebaker, 2016).

1.2. Immunization program in UP, India

The Expanded Program of Immunization (EPI) was started in India in 1978, followed by the Universal Immunization Program (UIP) in 1985 (Lahariya, 2014). Later in 2005, to re-strengthen the primary care service – including the immunization program – a systemwide reform was initiated through the National Health Mission (NHM) (Ministry of Health and Family Welfare, 2005). NHM introduced a new cadre of frontline workers (FLWs) called *Accredited Social Health Activist* (ASHA), *Village Health, Sanitation and Nutrition Committee* (VHSNC), and, most importantly, *Mission Indradhanush* – an intensified immunization campaign targeting 90% coverage of full immunization by 2020.

Since the inception of NHM, at the community level, the immunization campaign is led by ASHA, *Anganwadi Workers* (AWW, an FLW tenured by Ministry of Women and Child Development), and *Auxiliary Nurse Midwife* (ANM) – a government health worker assigned at the village-level health facilities. Every month the triad of FLWs organized *Village Health Nutrition Day* (VHND) to provide routine immunization to the children in the community. The organization and functioning of VHND are supported by VHSNC, which includes FLWs, local leaders, and other community-based organizations (Ministry of Health and Family Welfare, 2005). VHSNC assists FLWs by ensuring community participation, raising awareness, and tracking children who dropped out of the immunization schedule (Government of India, 2013).

Despite having a well-structured immunization program in paper, contextual factors such as trust, social norms, functioning of community organization, power dynamics in the community were shown to be associated with the immunization of children in India (Sahu, Pradhan, Jayachandran, & Khan, 2010; Scott, George, Harvey, Mondal, Patel, Ved, et al., 2017; Story, 2014). Moreover, recognized demand-side barriers for immunization care – such as age and gender of the child, mother's education, place of residence, social caste, religion, and socioeconomic status – are still relevant in the context of UP (Gupta, Prakash, & Srivastava, 2015; Shrivastwa, Gillespie, Kolenic, Lepkowski, & Boulton, 2015).
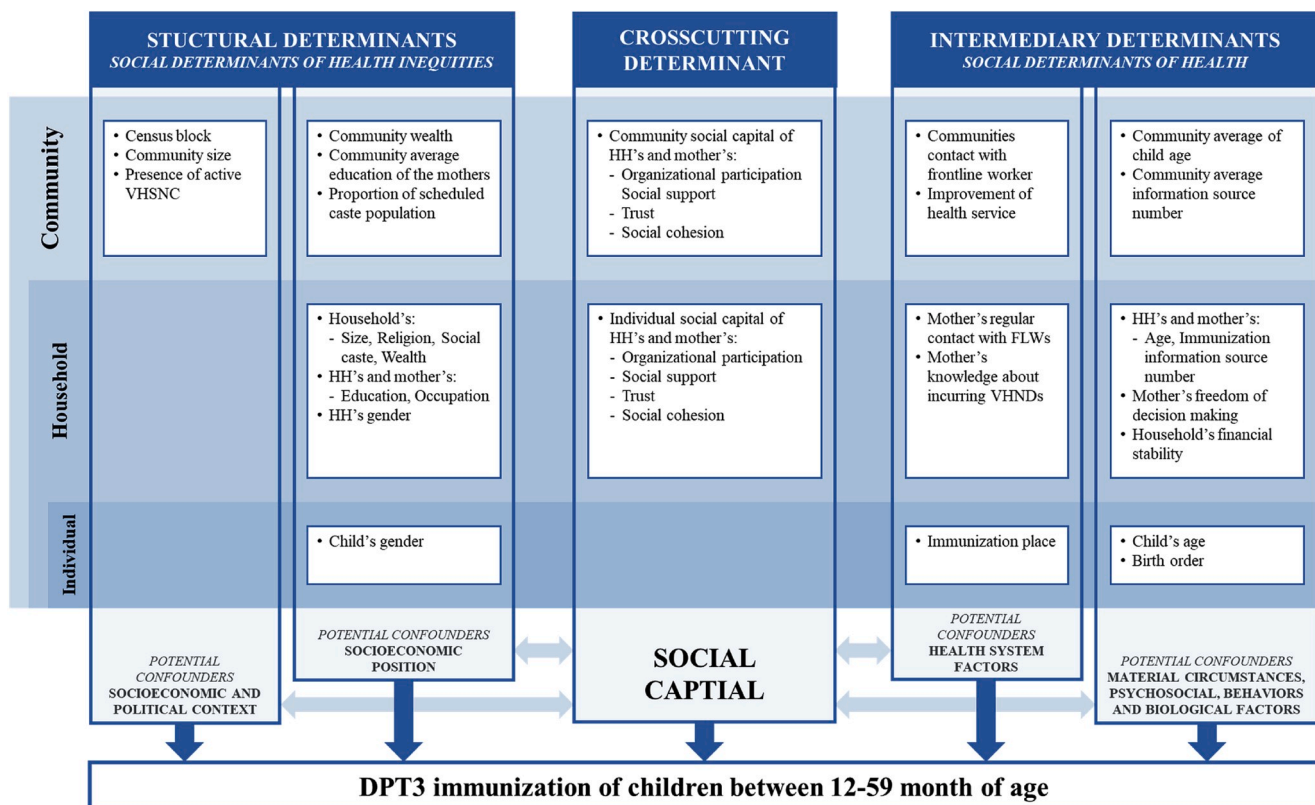
In a unique caste-based social structure of rural UP, where social norms, trust, and community support influence health-seeking behavior, considering social capital as a determinant for immunization is imperative. This study aimed to examine the association of individual and community-level social capital on DPT3 immunization among 12–59 month children using a multilevel analytical framework.

2. Method

2.1. Conceptualizing social capital within the framework of social determinant of health

Social capital can not influence care-seeking practice in a void. It interacts with other social determinants (Marmot, 2005). Thus, we considered the World Health Organization's (WHO) Commission on Social Determinants of Health (CSDH) framework to understand social capital's influence on the utilization of immunization service (Fig. 1). This framework was initially drafted in 2005 (Commission on Social Determinants of Health, 2005), however, to develop our conceptual framework (Fig. 1), we adopted the final version of the framework by WHO (2010).

Our conceptual framework stratified social determinants into three broad categories. First – as the structural determinant – socioeconomic

Fig. 1. Conceptual framework to explore the role of social capital as a determinant of DPT3 immunization among 12-59-month-old children in UP, India.

position and socio-political context have to be included. Socioeconomic position includes – gender, household wealth, race/ethnicity, education, etc., and socio-political context includes governance, social policy, and cultural values of the community. These determinants collectively represent the social context, which grants differential levels of power and social position to individuals and groups (Graham, 2004). The second category of predictors is the intermediary social determinants. They are broadly divided into two groups. The first group includes – psychosocial, behavioral, and biological factors of individual or group, which represents life's material circumstances. Socially disadvantaged groups living with unfavorable material circumstances often engage in health-damaging behavior leading to poor health outcomes (World Health Organization, 2010). The health system's characteristics were considered as the second group of the intermediary determinants. If we consider India's community-based vaccination program, a robust health system can reduce inequality and financial burden among the poor and also generate social capital through building social support networks, solidarity, and social cohesion.

In between structural and intermediary social determinants of health, social capital is situated as the cross-cutting determinant (World Health Organization, 2010). The constructs of social capital (e.g., trust, cohesiveness, social support, social participation) can independently influence healthcare utilization and also indirectly influence other structural and intermediary determinants (Kawachi, Ichiro, Subramanian, , & Kim, 2008).

2.2. Study design and population

The analysis of this study was based on a multi-topic cross-sectional household survey conducted in two rural districts of UP. The multi-topic survey was a part of the baseline evaluation of a rural development

initiative called "Project Samuday" led by the HCL Foundation (2018). The survey was implemented in randomly selected 6218 households from 346 rural communities – also know as Gram Panchayats (GPs) – from June to August 2017. The study design and sampling process of the survey were mentioned elsewhere (Hasan et al., 2019). Trained data collectors interviewed 6218 household heads (≥18years) and all women between 15-49 years of age (n = 6826) after receiving verbal informed consent.

During the survey, ever-married women responded to the maternal and child care utilization module where they reported the immunization status of under 59-month children. As it is possible that a child did not receive all vaccinations before 12 months of age (Wagner, Shenton, Gillespie, Mathew, & Boulton, 2019), to avoid partially immunized children, we considered 12–59 month children as the unit of analysis (n = 2239). With a 96.52% response rate, the final analytical sample for the regression analysis was 2161 children from 1705 households in 346 communities. Ethical approval of the study was received from the Institutional Review Board Office of Johns Hopkins Bloomberg School of Public Health, Maryland, USA, and locally from the Center for Media Studies, New Delhi, India.

2.3. Response variable

This study considered the DPT3 immunization status of a child as the dependent variable. DPT3 coverage is internationally used to monitor health system performance (World Health Organization, 2018) and indicates individual and community level immunization service utilization (Acharya, Kismul, Mapatano, & Hatløy, 2018; Fatiregun & Etukiren, 2014). During the survey, immunization information was extracted using both immunization records and mothers' reporting following the current standardized method (International Institute for Population

Sciences & ICF, 2017). DPT3 immunization status was defined as a binary indicator by assigning the value "1" for those children who received all three DPT vaccines before 12 months and "0" otherwise.

2.4. Explanatory variables

The primary explanatory variable of the analysis was social capital, which was considered as the cross-cutting social determinant of health. Other individuals, household and community level covariates, were classified according to the social determinant of health framework into structural or intermediary determinants. Table 1 maps out the explanatory variables included in the analysis (See supplemental materials for the detail list and definition of the covariates).

2.4.1. Social capital: the cross-cutting determinant

Social capital was measured by a contextually modified Shortened and adapted Social Capital Assessment Tool in India (SASCAT-I). The development and validation of the SASCAT-I were detailed elsewhere (Hasan et al., 2019). During the survey, participants responded to 13 SASCAT-I questions related to their participation in community groups, collective action with community, acquired social support, perception of trust, and cohesiveness. The SASCAT-I responses were converted into 12 categorical indicators, and multilevel confirmatory factor analytical (MCFA) models were implemented separately for the household heads and the mothers. MCFA generated four theoretically unique latent social capital constructs – *Organizational participation*, *Social* Support, *Trust,* and *Social Cohesion*. In total, 16 standardized factor scores were extracted as composite indicators of social capital – four indicators for each household head and mother both at individual and community-level. (See supplemental materials for the complete SASCAT-I and the methodological details of conducting MCFA).

2.4.2. Level 1 covariates: individual child's characteristics

Covariates related to individual children were classified into structural and intermediary determinants. A child's gender was considered as the only individual-level structural determinant. Biological factors such as the reported age of the child and birth order were considered as intermediary determinants. Also, we included the type of health facility where the child received most of his/her immunizations as health system-related intermediary determinants.

2.4.2. Level 2 covariates: mother, household head and household characteristics

From each household, mother's education and occupation were included as structural determinants. Her self-reported age, perceived ability of decision making (*How much freedom do you have in making personal decisions?*) (Babalola, 2009; Glatman-Freedman & Nichols, 2012) and knowledge about immunization (*the number of sources from where the mother received information about immunization*) are included as intermediary determinants. The individual mother's interaction with the health system was accounted for by including her regular contact with the FLWs and her knowledge of incurring VHNDs. Three household head's characteristics (gender, education and occupation) were included as structural determinants. In addition, household head's age, and knowledge about immunization were considered as intermediary determinants.

At the household-level, household size, religion, social caste, and wealth were included as structural determinants. We considered the number of people living in the household for the last 6 months as the indicator of the household size. Religion was categorized into "Hindu" and "Muslim and Others". Caste was categorized into "General", "Scheduled Castes or Scheduled Tribes" and "Other backward caste and others". As a measure of household wealth, each household was assigned a wealth quintile of a linear index created by principal components analysis (PCA) of household assets (Filmer & Pritchett, 2001). As an

Table 1
Covariates included in the analysis classified according to the social determinant of health framework and across the level of analysis.

Levels of Analysis		Variables included in the analysis classified according to the social determinant of health framework		
		Structural determinants	Intermediary determinants	Social capital
Level 1: Individual child		- Child's gender	- Child's Age - Child's birth order - Facility where the child received most of the vaccinations	
Level 2: Household	**Mother**	- Mother's education - Mother's occupation	- Mother's age - Mother's freedom of decision making - Mother's knowledge of immunization - Mother's regular communication with FLWs - Mother knew about incurring VHND	- Individual organizational participation of the mother - Individual social support of the mother - Individual trust of the mother - Individual social cohesion of the mother
	Household head	- Household head's gender - Household head's education - Household head's occupation	- Household head's age - Household head's knowledge of immunization	- Individual organizational participation of the household head - Individual social support of the household head - Individual trust of the household head - Individual social cohesion of the household head
	Household	- Household size - Household religion - Household caste - Household wealth quintile	- Household's financial stability	
Level 3: Community		- Census Block - Community (GP) size - Community scheduled caste population - Community wealth - Community average education of mothers - Presence of active VHSNC in the community	- Community average age of children - Community average knowledge of immunization - Communities contact with the FLWs - Improvement of the health service of the community	- Community-level organizational participation of mother - Community-level social support of mother - Community-level trust of mother - Community-level social cohesion of mother - Community-level organizational participation of household heads - Community-level social support of household heads - Community-level trust of household heads - Community-level social cohesion of household heads

Note: FLWs = Front line health workers; GP = Gram Panchayat; VHSNC = Village Health Sanitation and Nutrition Committee; VHND = Village Health and Nutrition Day.

intermediary determinant of the household's everyday material circumstances, household head's reported financial stability was included and categorized into "Worsen" or "Stable or Improved".

2.4.3. Level 3 covariates: community characteristics

Other than individual and community levels social capital measure, child characteristics, and household-level compositional covariates, the analysis included several contextual covariates. Community-level structural determinants were further divided into two types. The first group was the sociopolitical context of the community – including administrative boundary (census blocks), community (GP) size, and the presence of active VHSNC in the community. The second set reflected the socioeconomic context of the community – including community wealth (average asset index of all households from a community included in the survey), average educational attainment of the mothers, and proportion of Scheduled Caste population in the community.

Other contextual variables incorporated in the analysis as intermediary determinants included – average age of the children living in the community, average of total number of immunization information sources reported by household heads and mothers, communities contact with FLWs (percentage of mothers in the community with regular contact with FLWs) and improvement of the health service (average response of household heads to the question about any improvement of the functioning of government health services in the village since last year).

2.4. Statistical analysis

As the descriptive analysis, the distribution of DPT3 immunization across covariates were explored as number and percentages. Next, the study implemented multilevel mixed-effect logistic regressions to assess the association of social capital measure with DPT3 immunization considering individual children as level 1, households as level 2, and GPs or communities as level 3. First, the effect of each individual, household, and community-level covariates on DPT3 immunization status was independently estimated. Covariates that presented a p-value ≤ 0.2 in the bivariate regression models were included in the multivariate regressions (Maldonado & Greenland, 1993). Next, to estimate the adjusted fixed-effect of social capital measure, seven multilevel mixed-effect logistic models were sequentially fitted to the data considering household and community as random intercepts. Model 1 (*M1*) was a null model without any covariate, which decomposed the total variance of DPT3 immunization between households and the community level. Model 2 (*M2*) only included child-related covariates. Model 3 (*M3*) extended *M2* by including the characteristics of mothers and household heads. Model 4 (*M4*) further extended *M3* by including standardized factor scores of individual mothers and household heads social capital. Model 5 (*M5*) and Model 6 (*M6*) were expanded by sequentially adding the household and community-level covariates. The last model (*M7*) incorporated all covariates from *M6* and included community-level standardized factor scores of mothers' and household heads' social capital. We have also examined several interactions between significant social capital measures with other covariates, which presented a statistically significant association with DPT3 immunization. MCFA models were implemented using Mplus 8.1 (Muthén & Muthén, 2017), and data management, descriptive and regression analysis were performed using Stata 15.1 (StataCorp, 2017).

3. Result

Table 2 presents the descriptive statistics of 12–59 months old children disaggregated by their DPT3 immunization status. Within the study sample, 57% (n = 1282) of children have been immunized by the DPT3 vaccine before 12 months of age. Fig. 2 presents the distribution of the 12 social capital indicators among household heads (n = 1749) and mothers (n = 1779). Among the 12 indicators, *group membership,*

emotional, and financial support did not present any statistically significant difference between the household heads and mothers (χ^2 p-value > 0.05).

Table 3 presents the crude odds ratios (COR) and adjusted odds ratios (AOR) between DPT3 immunization and covariates. After adjusting for individual, household, and community-level covariates, only community-level *Social Cohesion* of the mothers presented a significant association with a child's DPT3 immunization status in the final model (*M7*). Between two communities that differ by one standard deviation (SD) of mothers' collective *Social Cohesion*, a child living in the community with higher *Social Cohesion* of the mothers had 25% higher odds (AOR = 1.25, 95% Confidence Intervals [CI] = 1.12–1.54; p = 0.04) compared to a child from a community with lower *Social Cohesion* of the mothers.

Among other covariates, mother's education and the child's age category presented robust and significant association. After adjusting for all covariates and random effects, a child whose mother attained primary educations had 66% higher odds (AOR = 1.66, 95%CI = 1.12–2.46; p < 0.001) and a child whose mother attained above primary education had 159% higher odds (AOR = 2.59, 95%CI = 1.66–4.02; p < 0.001) of being immunized by DPT3, compared to a child of an illiterate mother. Additionally, adjusting for all confounders, mother's knowledge of immunization, community wealth, presence of active VHSNC in the community, and community's contact with FLWs were significantly associated with DPT3 immunization (p < 0.05).

We identified four significant interactions between community-level *Social Cohesion* of the mothers and other covariates – child age, mother's knowledge of immunization, community wealth, and communities' contact with FLWs (Fig. 3). Among the age categories, 24–35 months presented the highest interaction effect of 1.69 (95%CI = 1.11–2.57; p < 0.05). This indicated that the synergistic effect of mothers' *Social Cohesion* is 69% higher among 24–35 month children compared to the oldest age category (48–59 months). The interaction between community-level *Social Cohesion* of the mothers and community wealth presented a positive effect (Exponentiated coefficient = 1.24, 95%CI = 1.03–1.50; p < 0.05).

The cross level-interaction effect with individual mother's knowledge of immunization presented a negative correlation with DPT3 immunization (Exponentiated coefficient = 0.72, 95%CI = 0.60–0.86; p < 0.001). If a child lived in a community with lower collective *Social Cohesion* among mothers, his/her probability of receiving DPT3 vaccine increased proportionately with his/her mother's knowledge of immunization (Fig. 3b), and living in a community with higher *Social Cohesion* among mothers had the opposite effect. A negative interaction was also observed between the community's contact with FLWs and *Social Cohesion* among mothers (Exponentiated coefficient = 0.38, 95%CI = 0.19–0.76; p < 0.001). Regardless of the negative interaction effect, we observed an increase in the direct effect of both collective *Social Cohesion* of mothers (AOR = 2.16, 95%CI = 1.37–3.40; p < 0.001) and community's contact with FLWs (AOR = 5.06, 95%CI = 2.26–11.31; p < 0.001) in the interaction model. (See supplemental materials for the result of the interaction analysis)

4. Discussion

4.1. Discussion of the result

Just more than half of the children in the sample received all three doses of DPT vaccine before the age of 12 months. The coverage among 12–35 month children was 67%, which is very similar to the latest estimates of UP (66.5%), reported by the NHFS of 2015 (International Institute for Population Sciences & ICF, 2017). Social capital – especially *Social Cohesion* of the mothers – appears to be a contextual characteristic of the community, which positively correlates with the utilization of immunization care for children. This finding was also reported by William T. Story (2014) and other studies exploring self-rated health

Table 2

Demography of children between 12-59 months in two districts of UP, India (N = 2239).

	DPT vaccination status					Total (n = 2239)	
	Yes (n = 1282)		No (n = 957)		P-Value		
	n	%	n	%		n	%
Child's age category [a]							
12–23 month	358	67.17	175	32.83	0.00	533	100.00
24–35 months	345	63.42	199	36.58		544	100.00
36–47 months	330	55.56	264	44.44		594	100.00
48–59 months	235	46.91	266	53.09		501	100.00
Child's birth order [a]							
Firstborn	1016	57.05	765	42.95	0.00	1781	100.00
Not firstborn (Second/third/fourth born)	252	64.45	139	35.55		391	100.00
Child's gender [a]							
Boy	661	57.83	482	42.17	0.44	1143	100.00
Girl	621	56.71	474	43.29		1095	100.00
Facility where most vaccinations received [a]							
AWC or VHND	758	62.59	453	37.41	0.00	1211	100.00
Sub-Centers	326	60.93	209	39.07		535	100.00
PHC, CHC or Hospital	177	60.41	116	39.59		293	100.00
Mother's age category [a]							
15–19 years	25	65.79	13	34.21		38	100.00
20–29 years	856	60.54	558	39.46		1414	100.00
30–39 years	358	52.65	322	47.35		680	100.00
40–49 years	38	39.58	58	60.42		96	100.00
Mother's education [a]							
Illiterate	572	50.57	559	49.43	0.00	1131	100.00
Up to Primary	318	60.00	212	40.00		530	100.00
Above Primary	387	68.25	180	31.75		567	100.00
Mother's occupation [a]							
Unemployed/Housewife	1215	57.34	904	42.66	0.73	2119	100.00
Employed	62	56.88	47	43.12		109	100.00
Mother's regular communication with FLWs							
Yes	795	61.58	496	38.42	0.00	1291	100.00
No	487	51.37	461	48.63		948	100.00
Mother knew about incurring VHNDs							
Yes	658	60.81	424	39.19	0.00	1157	100.00
No	624	53.93	533	46.07		1082	100.00
Mother's Freedom of decision-making [a]							
No freedom at all	193	51.60	181	48.40	0.00	374	100.00
Freedom in very few decisions	304	62.42	183	37.58		487	100.00
Freedom in some decisions	377	60.32	248	39.68		625	100.00
Freedom in most decisions	226	52.56	204	47.44		430	100.00
Freedom in all decisions	181	56.92	137	43.08		318	100.00
Head's age category [a]							
18–29 years	160	54.98	131	45.02	0.00	291	100.00
30–39 years	291	54.91	239	45.09		530	100.00
40–49 years	323	60.60	210	39.40		533	100.00
50–59 years	243	58.84	170	41.16		413	100.00
60–69 years	184	55.93	145	44.07		329	100.00
More than 70 years	78	56.52	60	43.48		138	100.00
Head's education							
Illiterate	516	57.14	387	42.86	0.38	903	100.00
Up to Primary	307	55.12	250	44.88		557	100.00
Above Primary	459	58.92	320	41.08		779	100.00
Head's occupation							
Cultivator	693	58.83	485	41.17	0.13	1178	100.00
Wage laborer	250	52.63	225	47.37		475	100.00
Salaried Worker	170	59.03	118	40.97		288	100.00
Unemployed	169	56.71	129	43.29		298	100.00
Religion							
Hindu	1102	57.10	828	42.90	0.70	1930	100.00
Muslim and Others	180	58.25	129	41.75		309	100.00
Caste							
General	205	58.91	143	41.09	0.40	348	100.00
Scheduled Caste and Schedule Tribe	598	58.17	430	41.83		1028	100.00
Other Backward Caste and others	479	55.50	384	44.50		863	100.00
Wealth Quintile							
Quintile 1	168	52.50	152	47.50	0.08	320	100.00
Quintile 2	196	58.51	139	41.49		335	100.00
Quintile 3	266	58.72	187	41.28		453	100.00
Quintile 4	287	54.25	242	45.75		529	100.00
Quintile 5	365	60.63	237	39.37		602	100.00
Census Block							
Behadar	257	58.54	182	41.46	0.92	439	100.00
Kachhauna	158	60.77	102	39.23		260	100.00

Table 2 (*continued*)

	DPT vaccination status						Total (n = 2239)	
	Yes (n = 1282)		No (n = 957)		P-Value			
	n	%	n	%			n	%
Kothwan	232	53.58	201	46.42			433	100.00
Kasmanda	203	54.57	169	45.43			372	100.00
Machhrehta	202	62.15	123	37.85			325	100.00
Sidhauli	230	56.10	180	43.90			410	100.00
District								
Hardoi	647	57.16	485	42.84	0.92		1132	100.00
Sitapur	635	57.36	472	42.64			1107	100.00
Total	**1282**	**57.26**	**957**	**42.74**			**2239**	**100.00**
	Mean	SD	Mean	SD			Mean	SD
Mother's information source for immunization	1.49	1.17	1.20	1.03	0.00		1.37	1.12
Head's information source for immunization	1.30	1.52	1.16	1.48	0.03		1.24	1.50
Individual standardized social capital score								
Mother's Organizational Participation	0.02	0.96	0.00	1.05	0.58		0.01	1.00
Mother's Social Support	-0.01	0.96	0.00	1.05	0.82		-0.01	1.00
Mother's Trust	0.07	0.99	-0.04	0.99	0.01		0.03	0.99
Mother's Social Cohesion	0.06	1.00	-0.04	0.97	0.03		0.02	0.99
Head's Organizational Participation	0.01	0.98	-0.03	1.03	0.34		0.00	1.00
Head's Social Support	0.02	0.99	-0.03	1.02	0.22		0.00	1.00
Head's Trust	-0.03	1.00	0.04	1.00	0.08		0.00	1.00
Head's Social Cohesion	-0.03	1.00	0.04	1.02	0.09		0.00	1.01

Note: Table presents row percentage, a = Variable present missing values,
AWC = Anganwadi Center, CHC = Community Healthcare Center, FLW = Front Line Health Workers, VHND = Village Health and Nutrition Day, PHC = Primary Healthcare Center.
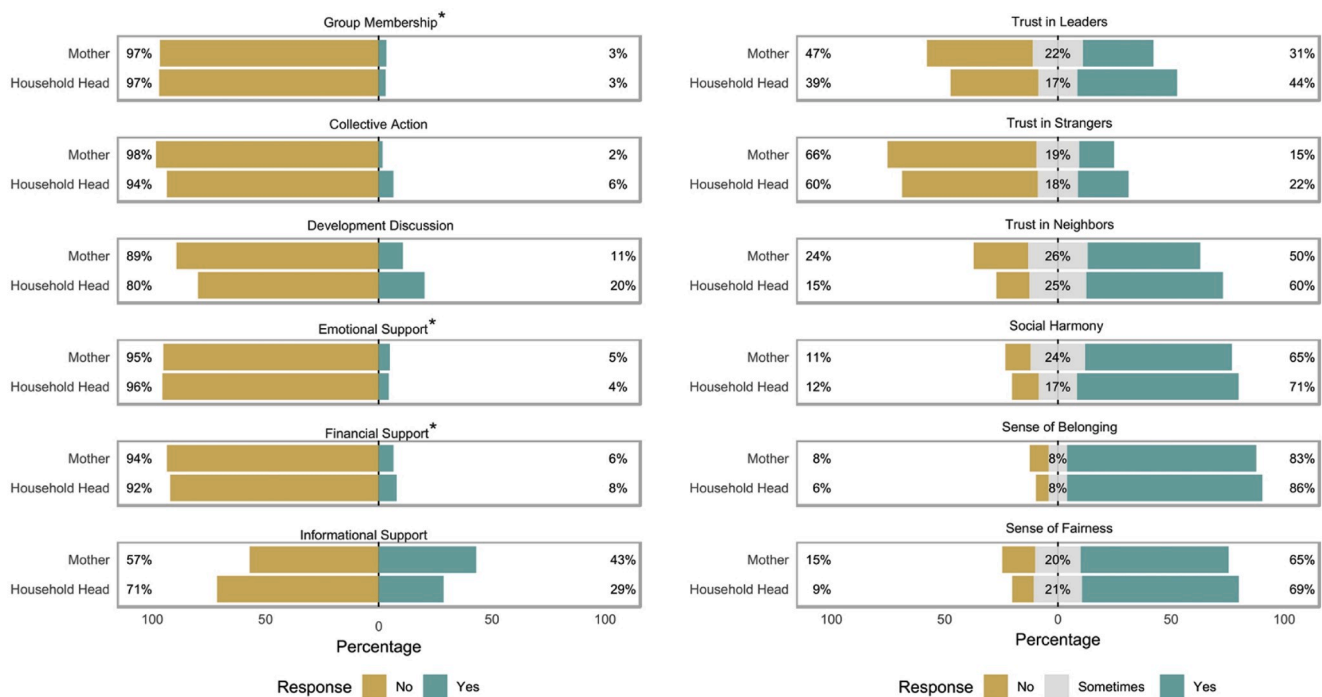
Note: * = Indicators which did not present any significant different between household head and mothers of 12-59 month of child in Chi-square difference tests at the significance level 0.05

Fig. 2. Distribution of social capital indicators of household heads (n = 1749) and mothers (n = 1779) of 12-59-month-old children in UP, India.

(Mohnen, Groenewegen, Völker, & Flap, 2011), mental health (De Silva, Huttly, Harpham, & Kenward, 2007) and other health behaviors (Chuang & Chuang, 2008). Emerged from the collective human relations, a community's *Social Cohesion* can positively influence the community's behavior by performing coordinated action for the common good (Kim & Kawachi, 2017; Putnam, 1995) – here, utilization of immunization service. In UP, where vaccination service is embedded

within the community and largely depends on the coordination between the health providers and community organizations (VHND), the role of *Social Cohesion* becomes particularly important. The collective cohesiveness of the mother would empower the community, foster entitlement, and create an enabling environment to access health services (Kim & Kawachi, 2017). However, Story (2014) did not observe any association with the *Social Cohesion* of mothers with complete childhood

Table 3

Comparison of three-level mixed-effect models for fixed and random-effect estimates for DPT3 immunization among children between 12-59 months in two districts of Uttar Pradesh, India.

Fixed effects	COR	M1	M2	M3	M4	M5	M6	M7	95% CI
		AOR	AOR	AOR	AOR	AOR	AOR	AOR	
Child's characteristics									
Age categories (Ref- 48 to 59 months)									
12–23 months	5.05***		4.87***	3.94***	3.97***	4.00***	4.61***	4.50***	[2.65, 7.64]
24–35 months	3.73***		3.66***	3.26***	3.25***	3.26***	3.77***	3.79***	[2.36, 6.08]
36–47 months	1.90**		1.87**	1.78**	1.79**	1.80**	1.96**	1.99**	[1.32, 3.00]
Birth order (Ref- Firstborn)									
Not firstborn (second or third)	2.26***		1.04	1.13	1.13	1.13	1.07	1.08	[0.72, 1.63]
Gender (Ref- Boy)									
Girl	0.95								
Facility for vaccination (Ref- AWC/VHND)									
Sub-centers	0.92								
PHC, CHC or Hospital	0.71								
Mother's characteristics									
Age categories (40–49 years)									
15–19 year	6.12**			2.62	2.72	2.40	2.49	2.57	[0.64, 10.32]
20–29 years	4.22***			2.27*	2.36*	2.18*	2.32*	2.35*	[1.10, 5.01]
30-30 years	2.42*			1.76	1.78	1.69	1.72	1.77	[0.83, 3.78]
Education (Ref-Illiterate)									
Up to primary	1.86***			1.65*	1.66*	1.64*	1.69**	1.66*	[1.12, 2.46]
Above primary	3.32***			2.60***	2.57***	2.53***	2.58***	2.59***	[1.66, 4.02]
Occupation (Ref-Unemployed)									
Employed	0.86								
Knowledge of immunization	1.51***			1.47***	1.47***	1.46***	1.43***	1.42***	[1.19, 1.69]
Regular communication with FLWs (Ref- No)									
Yes	1.74***			1.41*	1.35	1.33	0.99	1.00	[0.69, 1.45]
Knew about incurring VHNDs (Ref- No)									
Yes	1.44*			1.18	1.18	1.17	1.20	1.23	[0.89, 1.70]
Freedom of decision making (Ref- No freedom at all)									
Freedom in very few decisions	1.66*			1.56	1.53	1.47	1.37	1.29	[0.78, 2.14]
Freedom in some decisions	1.63*			1.61	1.62*	1.58	1.42	1.35	[0.84, 2.18]
Freedom in most decisions	1.04			1.09	1.06	1.00	0.89	0.84	[0.50, 1.42]
Freedom in all decisions	1.26			1.06	1.02	0.97	0.93	0.87	[0.49, 1.55]
Mother's Individual social capital									
Organizational participation	1.02								
Social support	0.99								
Trust	1.13[a]			1.27	1.26	1.24	1.09		[0.77, 1.54]
Social cohesion	1.11[a]			0.90	0.91	0.93	1.02		[0.74, 1.40]
Household Head's characteristics									
Gender (Ref: Male)									
Female	0.86								
Age categories (18–29 years)									
30–39 years	0.89								
40–49 years	1.38								
50–59 years	1.23								
60–69 years	0.93								
More than 70 years	1.07								
Occupation (Ref- Cultivator)									
Wage laborer	0.80								
Salaried worker	1.16								
Unemployed/Student/Housewife	0.94								
Education (Ref- Illiterate)									
Up to primary	0.99								
Above primary	1.16								
Knowledge of immunization	1.09[a]			1.03	1.03	1.03	1.02	1.02	[0.9, 1.16]
Household Head's Individual social capital									
Organizational participation	1.02								
Social support	1.04								
Trust	0.87[a]			0.91	0.92	0.94	1.01		[0.70, 1.47]
Social cohesion	0.88[a]			0.95	0.93	0.94	0.90		[0.63, 1.29]
Household's characteristics									
Household Size (Member Number)	0.95[a]					0.96	0.95	0.95	[0.88, 1.02]
Religion (Ref- Hindu)									
Muslim and Others	1.15								
Caste (Ref- General)									
Scheduled Caste/Scheduled Tribe	0.92								
Other backward caste and others	0.83								
Household wealth (Ref- Quintile 1)									
Quintile 2	1.71*					1.51	1.49	1.50	[0.85, 2.65]
Quintile 3	1.46[a]					1.51	1.45	1.44	[0.84, 2.44]
Quintile 4	1.15					1.09	1.08	1.07	[0.64, 1.78]
Quintile 5	1.66*					1.70*	1.69*	1.67*	[1.00, 2.77]
Household financial stability (Ref- Worsen)									

(*continued on next page*)

Table 3 (*continued*)

Fixed effects	COR	M1 AOR	M2 AOR	M3 AOR	M4 AOR	M5 AOR	M6 AOR	M7 AOR	95% CI
Stable or Improved	1.19								
Community characteristics									
Census Block (Ref- Behadar)									
Kachhauna	1.10								
Kothwan	0.70								
Kasmanda	0.75								
Machhrehta	1.29								
Sidhauli	0.86								
Community size (Ref- Small)									
Medium	0.71						0.69	0.67	[0.43, 1.06]
Large	0.67[a]						0.58*	0.56*	[0.35, 0.89]
Community-level scheduled caste population (Ref: Low)									
Medium	1.18								
High	1.20								
Community wealth	1.37***						1.39**	1.34**	[1.09, 1.64]
Community average age of children (Months)	1.03[a]						1.06**	1.05**	[1.02, 1.09]
Community average mothers' education	1.69*						0.76	0.77	[0.46, 1.29]
Community average knowledge of immunization	1.25**						1.10	1.11	[0.93, 1.34]
Communities contact with the FLWs	4.05***						4.80***	4.74***	[2.12, 10.58]
Improvement of the health service (Ref- No)									
Yes	1.02								
Presence of active VHSNC (Ref- No)									
Yes	1.66**						1.58*	1.58*	[1.08, 2.32]
Mothers' community-level social capital									
Organizational participation	1.03								
Social support	0.86[a]							0.84	[0.67, 1.05]
Trust	0.85[a]							0.89	[0.71, 1.11]
Social cohesion	1.18[a]							1.25*	[1.12, 1.54]
Household Head's community-level social capital									
Organizational participation	1.02								
Social support	0.96								
Trust	0.88[a]							0.86	[0.7, 1.05]
Social cohesion	0.98								
Random effects									
Level 3: Community level variation (variance)		1.16***	1.58***	1.39***	1.31***	1.34***	0.93***	0.88***	[0.49, 1.59]
ICC		0.17	0.19	0.18	0.17	0.18	0.13	0.13	[0.08, 0.20]
Level 2: Household level variation (Variance)		2.20***	3.42***	3.03***	2.97***	2.79***	2.94***	2.89***	[1.62, 5.17]
ICC		0.51	0.60	0.57	0.57	0.56	0.54	0.53	[0.41, 0.66]
Observations		2161	2161	2161	2161	2161	2161	2161	
Log-likelihood (LL)		-1407.59	-1370.16	-1323.65	-1320.41	-1316.25	-1292.51	-1288.06	
Akaike information criterion (AIC)		2821.2	2754.3	2687.3	2688.8	2690.5	2659.0	2658.1	

Note: *** = $p < 0.001$, ** = $p < 0.01$, * = $p < 0.05$, [a] = $p < 0.2$.

Regressions include data from 2161 children of 12–59 months from 1705 households within 346 Gram Panchayats (PSU).

AOR = Adjusted odds ratio, AWC = Anganwadi Center, CHC = Community Healthcare Center, COR = Crud odds ratio, FLW = Front Line Health Workers, ICC = intra-class correlation, PHC = Primary Healthcare Center, VHND = Village Health and Nutrition Day, VHSNC = Village Health Sanitation and Nutrition Committee.

immunization. The study was conducted with a national level representative sample and did not report a state-level disaggregated result. The socioeconomic and cultural diversity of northern India – especially in UP – may explain the dissimilarity of the result.

The result also showed community-level *Social Cohesion* of the mothers acted as an effect modifier by differentially influencing both structural and intermediary determinants of health. Knowledge about immunization is an established social determinant of immunization, and our finding corroborates this (Glatman-Freedman & Nichols, 2012). However, moving from lower to a higher degree of community-level mother's *Social Cohesion*, the association between mother's knowledge of immunization and DPT3 immunization gradually attenuated and then moved towards negative (Fig. 3b). This may indicate the influence of informal social control of a highly cohesive community. The existing social norm and values of a tightly bonded community often discourage its members from adopting behaviors even the members have adequate knowledge to perform that activity (Vikram, Vanneman, & Desai, 2012).

The direct effect of the community's contact with FLWs – both in the adjusted model (Table 3) and in the interaction model (see supplemental materials) – had a strong positive relationship with the child's DPT3

immunization status. Provider-parent engagement is critical for building trust in immunization (Ames, Glenton, & Lewin, 2017; Connors, Slot-winski, & Hodges, 2017). However, we also found that community-level mother's *Social Cohesion* could modify the relationship between community-FLW's interconnection and child's immunization status. When the collective *Social Cohesion* of mothers were low, higher engagement with FLWs and the community had a positive relationship with DPT3 immunization of a child. With an increasing level of cohesiveness among mothers, this effect gradually attenuated and leading to a null level when the cohesiveness among mothers was highest (Fig. 3d). While we have identified literature independently supporting the positive association of social cohesion (Kim & Kawachi, 2017) and provider-parent interaction (Ames et al., 2017; Connors et al., 2017) with immunization, this study was first to report this type of heterogeneous effect modification of social capital. It might be the case that health workers had to proactively engage with those communities where the mothers' *Social Cohesion* is low to ensure immunization of the children. On the other hand, communities with higher *Social Cohesion* among mothers were able to organize themselves, ensuring child immunization irrespective of the level of FLW's interaction with them.
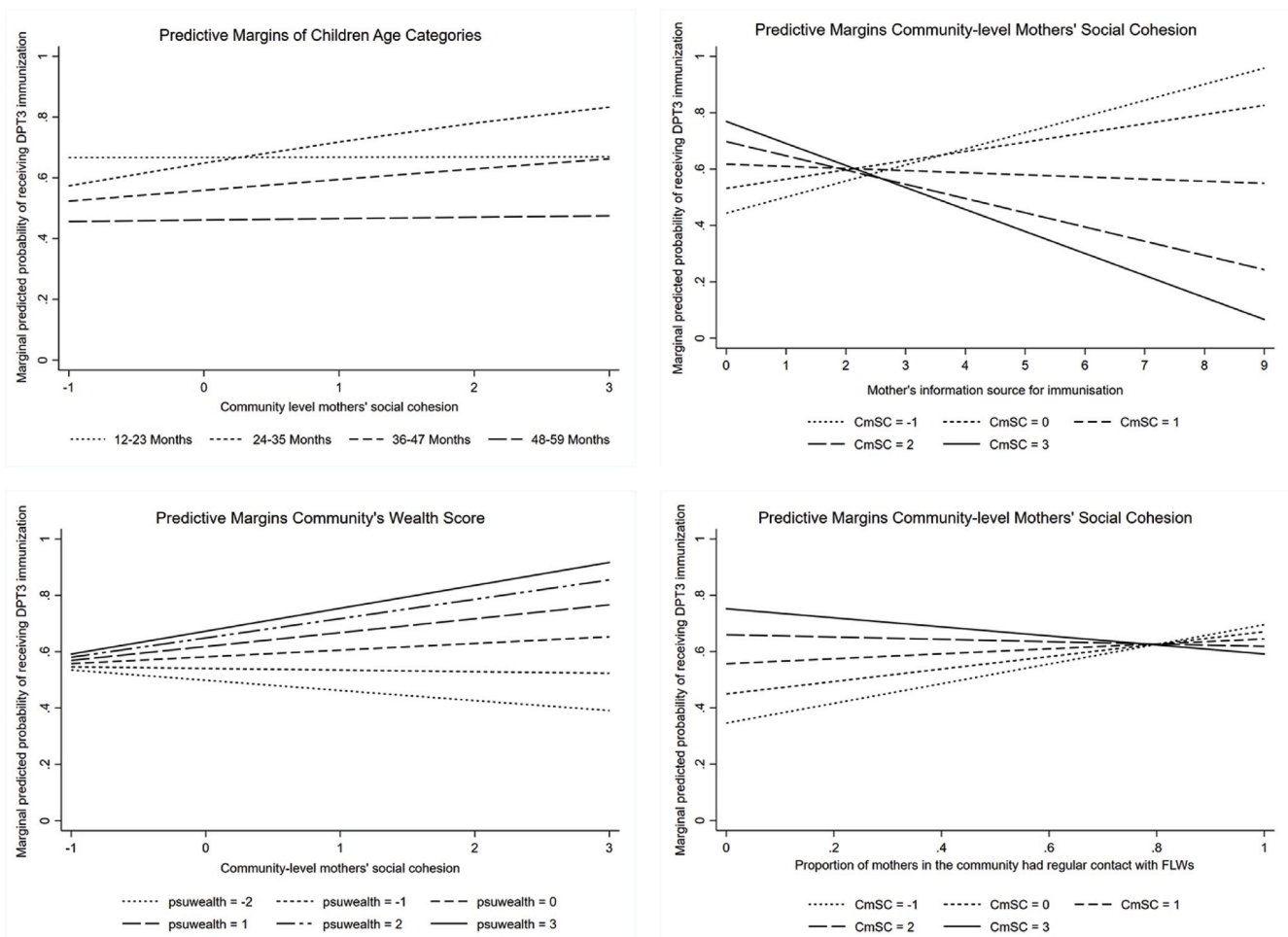
Note: psuwealth = Community wealth score, CmSC = Community level mothers' social cohesion
(a) Predictive margins of child's age across the level of community-level mothers' social cohesion
(b) Predictive margins of community-level mothers' social cohesion across the level of mother's knowledge of immunization
(c) Predictive margins of community's wealth across the level of community-level mothers' social cohesion
(d) Predictive margins of community-level mothers' social cohesion across the level of community's regular contact with FLWs

Fig. 3. Modification effect of community-level social cohesion of mothers on the association between covariates and predicted the probability of a child receiving DPT3 immunization.

Historically, in rural India, gender-based discrimination, caste, and class hierarchies restricted people to avail benefits of the health services (Scott, George, Harvey, Mondal, Patel, & Sheikh, 2017; Singh, 2016). Thus, the strategy of health sector reforms in India primarily focused on developing a community-centered primary care system to reduce the barriers for access, utilization, and healthcare cost (Ministry of Health & Family Welfare, 2017; Rao, Arora, & Ghaffar, 2014). Some progress is evident as gender, religion, social caste, or class did not appear to influence the utilization of immunization service in our study.

Among household heads (who were mostly men), no covariates – including measures of social capital – presented any significant associations with DPT3 immunization. Previous studies in India and Uttar Pradesh also reported no male involvement in childhood immunization, whereas they generally participated in family planning, institutional delivery, antenatal, and postnatal care (Caleb-Varkey et al., 2004; Sahu et al., 2016). As immunization service is delivered within the community through VHNDs, the involvement of the household head may not be necessary to access or utilize the care.

4.2. Strengths and limitations of the study

This is the first study that included the social capital measure of both

mother and household head to explore the contextual effect of social capital on child immunization. Applying multilevel analysis, we were able to distinguish the influence of individual and community level social capital. The use of a validated measurement scale and application of MCFA were significant steps forward to reduce measurement bias in the analysis. Moreover, having a strong theoretical underpinning with a holistic conceptual framework is the major strength of our study.

However, the result must be interpreted, considering some limitations. We only explored the correlation between social capital and DPT3 immunization. Any causal inference cannot be made due to the cross-sectional nature of the data. As the information source of immunization status, we considered mother's report for those children who did not have an available immunization card - which is the current standard of analysis (International Institute for Population Sciences & ICF, 2017). While we acknowledge the mother's reporting may have recall bias, excluding the self-reported data would lead to sample attrition and overestimation of the immunization coverage (Babalola, 2009). The study measured the current social capital of the respondents. However, the recall period for self-reported immunization status of the child was up to five years preceding the survey.

5. Conclusion

This study will significantly contribute to understanding the influence of social capital as a determinant of immunization in rural UP and further advancing the literature of social capital in India. The primary finding of the study indicated social capital – specifically mothers collective *Social Cohesion* – operates mainly at the community-level. It was also able to modify – both positively and negatively – the relationship of other social determinants of immunization.

As India is striving towards Universal Health Coverage, building cohesiveness and solidarity to promote health and equality became a core tenant of the central and the state government of UP (Ministry of Health & Family Welfare, 2017; National Informatics Centre (NIC), Ministry of Electronics & Information Technology, Government of India, 2018). Social capital or cohesiveness does not emerge in a vacuum. They are generated through social interaction among people, and reciprocally influence their everyday life. There is no cookie-cutter solution to build social capital in any context. So, more in-depth exploration is warranted to understand how social capital is generated within the complex social structure of rural UP. Building social cohesion may lead to significant positive externalities on the overall wellbeing and healthcare utilization. We recommend further research to explore the causal pathways between social capital and healthcare utilization, and the implications of synergistic and antagonistic effects of improving social capital as a health policy tool.

Funding

Ethical approval

Ethical approval of the study was received from the Institutional Review Board Office of Johns Hopkins Bloomberg School of Public Health, Maryland, USA (IRB No: 00007469) and locally from the Center for Media Studies, New Delhi, India (IRB No: IRB00006230).

Declaration of competing interest

None.

CRediT authorship contribution statement

Md Zabir Hasan: Conceptualization, Methodology, Formal analysis, Visualization, Writing - original draft. **Lorraine T. Dean:** Conceptualization, Methodology, Writing - review & editing. **Caitlin E. Kennedy:** Conceptualization, Writing - review & editing. **Akshay Ahuja:** Project administration, Writing - review & editing. **Krishna D. Rao:** Conceptualization, Methodology, Writing - review & editing. **Shivam Gupta:** Conceptualization, Supervision, Project administration, Funding acquisition, Writing - review & editing.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ssmph.2020.100545.

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