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RESEARCH ARTICLE

MATERNAL MORTALITY IN INDIA: PREVENTION AND ITS STRATEGIES

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Abstract

Introduction: Maternal health is an important aspect of any country's development in terms of equity and poverty reduction. The health of women before and during pregnancy, during childbirth, and after childbirth is referred to as "Maternal Health." The Maternal Mortality Ratio (MMR) is an important indicator of the quality of the country's health-care system. India has made remarkable progress in reducing maternal mortality over the last two decades.

Methods: Relevant articles were searched using both electronically and print sources. Electronically from search engines such as PubMed and Google Scholar, as well as the WHO, CDC, and MoHFW websites. Print sources for the database included newspapers, the central library, and the departmental library of the Community Medicine, which included a variety of journals and standard textbooks. The following keywords were used in the literature search: maternal health, maternal death, maternal mortality and vaccination for pregnant women. Articles that did not contain these keywords were excluded from consideration. The search was not limited by publication year, and original articles, review articles, systematic reviews, and meta-analyses were all considered.

Recommendation: Early detection and timely management of High-Risk Pregnancy (HRP) are critical factors in reducing maternal mortality.

Introduction:-

The majority of maternal deaths are preventable. About three quarters of all maternal deaths are caused by postpartum haemorrhage, hypertensive disorders during pregnancy such as pre-eclampsia/eclampsia, infections, unsafe abortions, and other delivery-related complications. Theoretically, all of the major causes of maternal death can be treated with effective and timely clinical interventions. Practically, however, even if a woman manages to access prenatal care and deliver in a health facility with a skilled birth attendant, poor quality of care can be life-threatening. The World Health Organization (WHO) defines Maternal Death as "the death of a woman while pregnant or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy, from

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any cause related to or aggravated by the pregnancy or its management but not from accidental or incidental causes." [1]. One of the key indicators of maternal mortality is the Maternal Mortality Ratio (MMR),which is defined as "the number of maternal deaths during a given time period per lakh live births during the same time period" [2].

Institutional factors such as national resource allocation, health system infrastructure, and political accountability for evidence-based programming, as well as social determinants such as place of residence, socioeconomic status, and race/ethnicity, all influence a woman's likelihood of dying from childbirth-related complications. Family planning is one of the four pillars of the Safe Motherhood Initiative, which aims to reduce maternal mortality in developing countries. Given that met need for contraception could prevent approximately 29% of maternal deaths and access to safe abortion could prevent another 13%, special attention should be paid to family planning [3].

The Sustainable Development Goals (SDGs) and Maternal Mortality Ratio

The global Maternal Mortality Ratio (MMR) dropped by 44% between 1990 and 2015, from 385 to 216 maternal deaths per 100,000 live births [4]. Despite this progress, the world is still falling far short of the Millennium Development Goals (MDGs) target of reducing global MMR by 75% by 2015. Furthermore, large geographic disparities persist. Sub-Saharan Africa, for example, has by far the highest MMR in the region, at 546 maternal deaths per 100,000 live births, because many women who experience maternal death in Sub-Saharan Africa live in poverty and do not receive adequate care in time to address complications, whereas the average MMR in developed regions is only 12 maternal deaths per 100,000 live births [5, 6]. Figure-1.

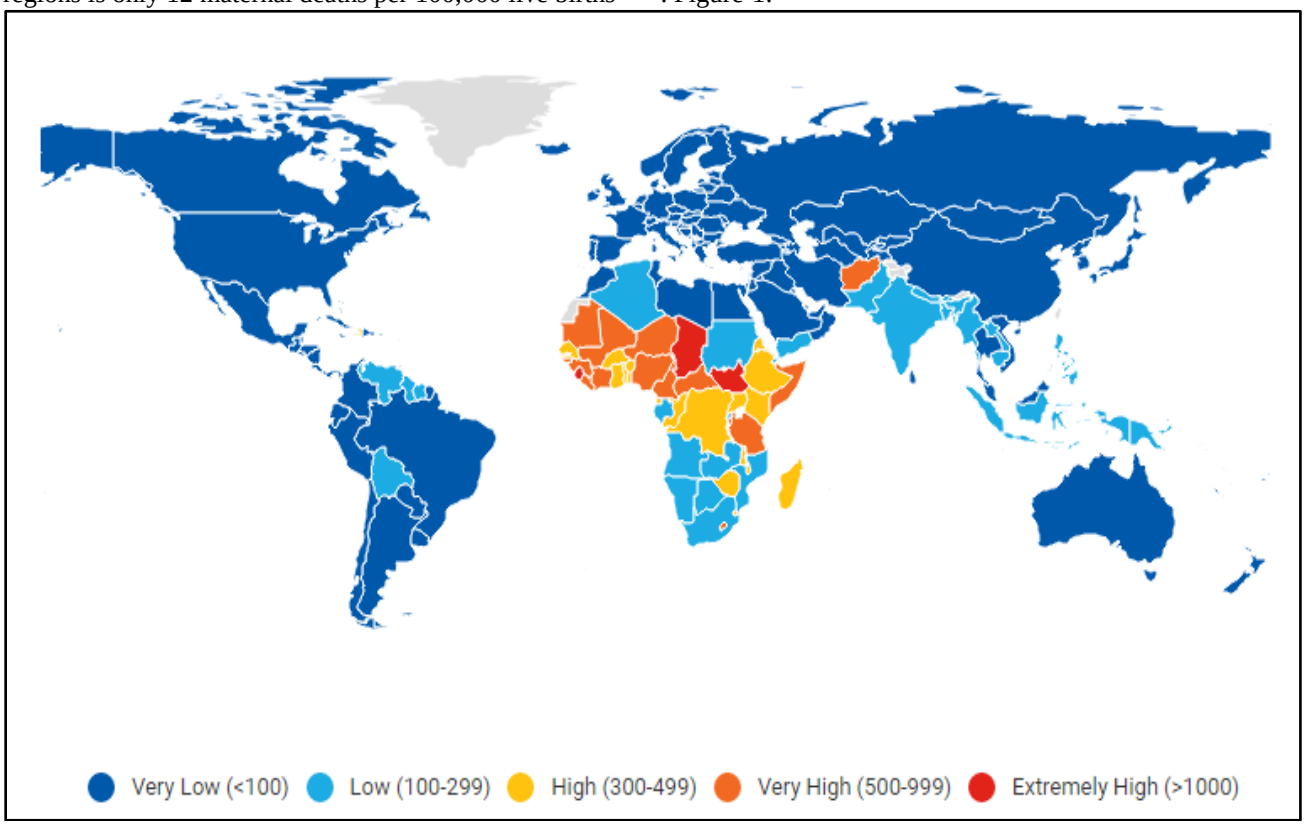

Figure 1:- Maternal Mortality Ratio (MMR) in 2017,
Source: World Health Organization, UNICEF, United Nations Population Fund and The World Bank, Trends in Maternal Mortality: 2000 to 2017 WHO, Geneva, 2019.

Maternal mortality reduction remains a priority in the new Sustainable Development Goals (SDGs) agenda through 2030 [7]. SDG Target 3.1 calls for the global maternal mortality ratio (MMR) to be reduced to less than 70 per 100,000 by 2030, with no country having an MMR greater than 140 per 100,000 [8]. The World Health Organization (WHO) published "Strategies for Ending Preventable Maternal Mortality (EPMM)" (EPMM Strategies) in February 2015, a vision-setting report outlining global targets and strategies for reducing maternal mortality under the SDGs [9]. Table-1.

Table 1:- EPMM Targets[10].

Global Target	• By 2030, reduce the global maternal mortality ratio (MMR) to less than 70 maternal deaths per 100,000 live births.
Supplementary National Target	• By 2030, no country should have MMR greater than 140 maternal deaths per 100,000 live births, a number twice the global target.
Country Targets	• For countries with MMR less than 420 per 100,000 live births in 2010: Reduce the national MMR by at least two-thirds from the 2010 baseline by 2030 • For countries with MMR greater than 420 per 100,000 live births in 2010: The rate of decline should be steeper so that in 2030, no country has an MMR greater than 140 • For all countries with low MMR in 2010: Achieve equity in MMR for vulnerable populations at the subnational level.

Trend of maternal mortality in the country

The Sample Registration System (SRS) is one of the country's largest demographic sample surveys, providing direct estimates of maternal mortality through a nationally representative sample, among other indicators. As shown in Figure-2, the Maternal Mortality Ratio in India has decreased over time, falling to 97 in 2018-20 from 103 in 2017-19 and 130 in 2014-2016.To better understand the country's maternal mortality situation and map the changes that have occurred, states have been divided into three groups: "Empowered Action Group" (EAG) States (Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh, Odisha, Rajasthan, Uttar Pradesh & Uttarakhand, and Assam); "Southern" States (Andhra Pradesh, Telangana, Karnataka, Kerala, and Tamil Nadu); and "Other" States covering the remaining States/UTs; as was done in the previous reports [Table-2].

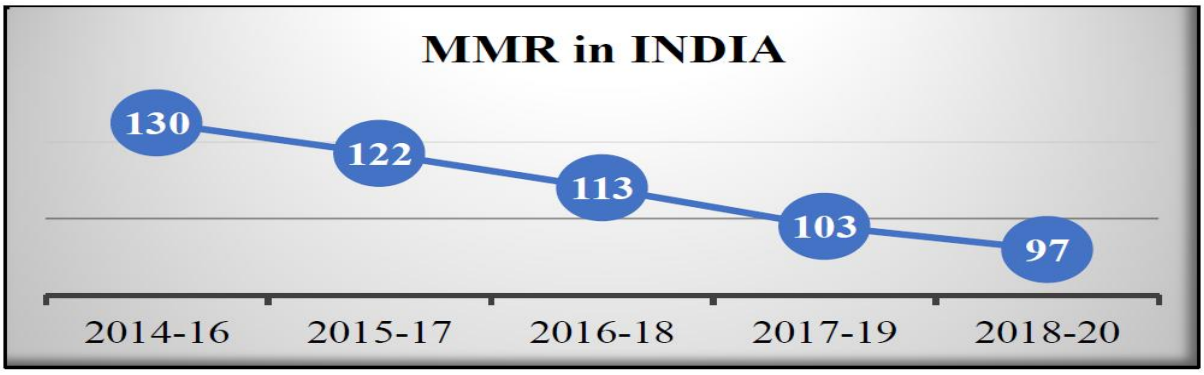

Figure 2:- Accelerated pace of decline in MMR for India.
[Source: Sample Registration System (SRS)-special bulletin on maternal mortality in India; 2018-20]

Table 2:- Maternal Mortality Ratio (MMR), Maternal Mortality Rate and Life Time Risk; India, EAG & Assam, South and Other states, 2018-20.

Serial No.	India & Major States	MMR*	95% CI	Maternal Mortality Rate#	Lifetime risk$
	INDIA	**97**	**(88 - 106)**	**6.0**	**0.21%**
1	Assam	195	(117 - 272)	12.1	0.42%
2	Bihar	118	(78 - 157)	11.2	0.39%
3	Jharkhand	56	(10 - 101)	4.2	0.15%
4	Madhya Pradesh	173	(126 - 220)	15.3	0.53%
5	Chhattisgarh	137	(54 - 219)	9.9	0.35%
6	Odisha	119	(71 - 167)	7.3	0.25%
7	Rajasthan	113	(71 - 155)	9.6	0.33%

8	Uttar Pradesh	167	(126 - 207)	14.3	0.50%
9	Uttarakhand	103	(52 - 154)	6.3	0.22%
	EAG AND ASSAM SUBTOTAL	**137**	**(121 - 154)**	**11**	**0.38%**
1	Andhra Pradesh	45	(13 - 78)	2.4	0.08%
2	Telangana	43	(4 - 83)	2.3	0.08%
3	Karnataka	69	(35 - 103)	3.5	0.12%
4	Kerala	19	(0 - 42)	0.9	0.03%
5	Tamil Nadu	54	(24 - 85)	2.7	0.09%
	SOUTH SUBTOTAL	**49**	**(35 - 64)**	**2**	**0.09%**
1	Gujarat	57	(28 - 86)	3.9	0.14%
2	Haryana	110	(58 - 162)	8.0	0.28%
3	Maharashtra	33	(10 - 56)	1.8	0.06%
4	Punjab	105	(40 - 170)	5.4	0.19%
5	West Bengal	103	(64 - 143)	5.0	0.18%
6	Other states	77	(55 - 98)	3.9	0.14%
	OTHER SUBTOTAL	**76**	**(63 - 89)**	**4**	**0.15%**

Table 3:- Age Distribution of Maternal and Non-Maternal deaths, India, 2018-20.

Sr. No.	Age Group	Maternal Deaths		Non-maternal Deaths	
		Proportion	95% CI	Proportion	95% CI
1	15-19	6%	(4 - 8)	9%	(8 - 9)
2	20-24	32%	(27 - 36)	11%	(11 - 12)
3	25-29	30%	(25 - 34)	12%	(12 - 13)
4	30-34	20%	(16 - 24)	13%	(12 - 14)
5	35-39	8%	(6 - 11)	14%	(13 - 15)
6	40-44	3%	(1 - 4)	18%	(17 - 19)
7	45-49	2%	(1 - 3)	22%	(21 - 23)
	15-49	**100%**		**100%**	

Table-3 depict, majority of maternal deaths occurred at the age of 20-24yrs i.e., 32% at 95% CI during pregnancy followed by 25-29yrs (30%), and 30-34yrs (20%) respectively.

Table 4:- State wise distribution of Maternal Mortality Mate (MMR) in India, 2017-20.

MMR in States	Sample Registration System(SRS) Report		Decline in Points
	2018-20 (Released in March, 2022)	2017-19 (Released in November 29, 2022)	
Rajasthan	**113**	**141**	**28**
Chhattisgarh	137	160	23
Odisha	119	136	17
Karnataka	69	83	14
Andhra Pradesh	45	58	13
Telangana	43	56	13
Gujarat	57	70	13
Bihar	118	130	12
Kerala	19	30	11
Assam	195	205	10

(Source: Times of India; Dated: Nov 30, 2022)

According to the Sample Registration Report-2022 (SRS), Rajasthan had the greatest decrease in maternal mortality ratio in the country, by 28 points [11] [Table-4]. Rajasthan has played an important role in saving maternal lives bydeveloping better government health care infrastructure, and raising awareness among pregnant women and their families about the importance of institutional deliveries.

The benefits of vaccination during pregnancy:

During pregnancy, vaccination protects both the mother and her unborn child from infectious diseases and the risk of intra-uterine infections. Furthermore, maternal vaccination protects the baby in the first few months of life by transferring neutralising antibodies such as Immunoglobulin-G (IgG) and/or Immunoglobulin-A (IgA) antibodies through breast milk, conferring passive immunity in the form of vaccine-induced IgA, IgG, and IgM secreted into colostrum and breast milk during breastfeeding [12]. Furthermore, due to the immature immune system, many vaccines are not administered to infants during the first six weeks of life, and if given, two doses of the vaccine may be required before full protection is achieved. Maternal vaccination has the advantage of increasing maternal antibody transmission and thus overcoming infant vulnerability during the first six weeks of life [13].

Vaccine safety in pregnancy:

Vaccines considered safe during pregnancy include virus vaccines that have been killed or inactivated, protein subunit vaccines, toxoid-containing vaccines, and conjugated vaccines [14]. Vaccinating pregnant or breastfeeding women with inactivated viral or bacterial vaccines or toxoids poses no risk to the foetus or infant [15]. Live vaccines, on the other hand, increase the risk of miscarriage and congenital infections and are thus prohibited during pregnancy [16]. The American College of Obstetrics and Gynaecology (ACOG), on the other hand, is in favour of vaccinating women during pregnancy and has recommended that all pregnant women receive the tetanus toxoid, reduced diphtheria toxoid, and acellular pertussis (Tdap) vaccine between 27 and 36 weeks [17]. Pregnant women should be advised that administering the 'Tdap' vaccine during each pregnancy is safe and necessary to ensure that each new-born is protected against pertussis at birth [18]. Unvaccinated pregnant women have a higher risk of maternal and foetal morbidity and mortality, while vaccinated women have a lower risk.

The COVID-19 pandemic has highlighted the world's low rates of pregnancy vaccination. Many studies have found that pregnant women have a higher rate of vaccination hesitancy, owing to concerns about the safety and effectiveness of vaccines for both mothers and infants [19]. Many studies showed that the main determinants that influenced vaccine uptake in pregnant women were vaccine awareness, disease severity and susceptibility, vaccine benefits, side effects, and risk of harm during pregnancy, as well as previous vaccination history [20].

Routinely recommended vaccines in pregnancy:

Influenza vaccination

Several studies have found that pregnant women are more likely than non-pregnant women to develop severe disease and die from seasonal influenza [21]. According to a study conducted by Dawood FS et al., (2018) [22], seasonal influenza during pregnancy resulted in miscarriages and low birth weight babies. The World Health Organization (WHO) recommends using seasonal vaccination all year due to the increased risk of seasonal influenza in pregnant women [23]. There is currently no consensus on the gestational age at which the vaccine should be administered because the vaccine's primary goal is maternal benefit rather than foetal benefit, and it should therefore be administered as soon as possible during flu season. According to Dawood FS et al., (2018) [22], the incidence and severity of influenza were highest in the first trimester of pregnancy, supporting the recommendation to vaccinate in early pregnancy. However, receiving the vaccination during the third trimester is more beneficial to the foetus because more antibodies are vertically transmitted through the placenta, providing protection for the baby for up to six months after birth [24]. Breast-feeding also aids in the passage of antibodies to the infant. The WHO currently recommends that all pregnant women be vaccinated against seasonal influenza, and that the vaccine can be given during any trimester of pregnancy [25].

Diphtheria, Tetanus and Pertussis vaccine:

Whooping cough, also known as pertussis, is a highly contagious respiratory illness caused by the bacteria Bordetella pertussis. Prior to the discovery of a vaccine in the 1940s, pertussis had a high mortality rate [26]. Vaccination in childhood, adolescence, and adulthood, excluding pregnant women, resulted in a significant decrease in childhood deaths, but infant mortality remained high [27]. The pertussis vaccine is given along with the diphtheria and tetanus vaccines. The current diphtheria, tetanus, and pertussis (DTaP) vaccine includes an acellular pertussis vaccine made up of highly purified individual B pertussis components. Tdap and Td are given to pregnant women, non-pregnant women, adults, adolescents, and children over the age of seven, while DTap is given to children under the age of seven [28] (Figure-3). Tdap should be administered between the 27th and 36th weeks of pregnancy in all cases, according to the Centers for Disease Control and Prevention (CDC); even if a pregnant woman has had a Tdap vaccine within the last 10 years, the vaccine should be administered again [29]. [Table-5]

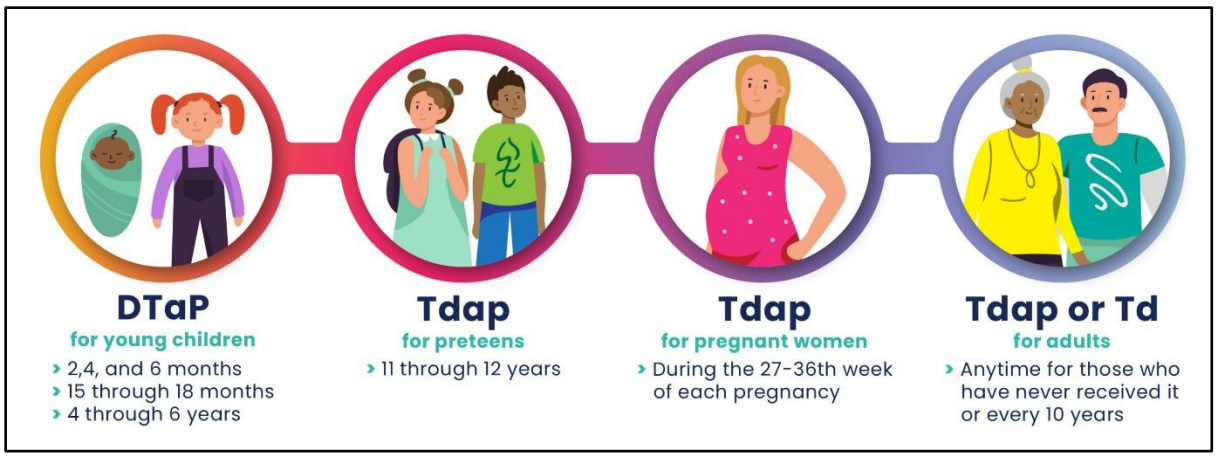

Figure 3:- Vaccination of against Diphtheria, Tetanus and Pertussis at different age group.

Table 5:- National Immunization Schedule (NIS) for pregnant women.

Vaccine	When to given	Dose	Route	Site
Tetanus Toxoid (TT) /Tetanus & adult Diphtheria (Td)-1	Early in pregnancy	0.5ml	Intra-muscular	Upper Arm
TT/Td-2	4 weeks after TT-1	0.5ml	Intra-muscular	Upper Arm
TT/Td-Booster	If received 2 TT/Td doses in a pregnancy within the last 3 year*	0.5ml	Intra-muscular	Upper Arm

*One dose if previously vaccinated within 3 years
[Source:National Immunization Schedule (NIS) 2018][30]

COVID-19 vaccination

The severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) was discovered in late December 2019 in Wuhan, China, and triggered the global coronavirus disease 2019 (COVID-19) pandemic [31]. Pregnant women are at a higher risk of severe illness from COVID-19 than non-pregnant women of the same age [32]. Pregnant women are also more likely to have stillbirths and preterm labour, as well as thrombotic events and pre-eclampsia [33]. The high rates of maternal and perinatal complications associated with COVID-19 infections highlight the importance of risk-mitigation strategies. COVID-19 maternal vaccination is one such strategy. Vaccinated pregnant women have active SARS-CoV-2 antibodies in their breast milk for up to six weeks after vaccination, and the antibodies have been shown to have neutralising properties and may be effective in protecting neonates [34].

The National Technical Advisory Group on Immunization (NTAGI) has recommended that pregnant women be vaccinated against COVID-19. If no contraindications exist, experts believe the COVID-19 vaccine could be given to pregnant women. In India, three vaccines have been approved for limited use in emergency situations. One is an inactivated vaccine called Covaxin, and the other two are non-replicating viral vector platforms called Covishield and Sputnik V [35].

Effective strategies for reducing maternal mortality in India:

1) Better government health care infrastructure, even in remote areas, as well as many government health schemes promoting good health care services and increasing awareness among pregnant women and their families for hospital-based deliveries and prompt referrals to higher centres are all playing important roles in saving maternal lives[36].
2) The majority of maternal deaths are avoidable. If care is provided during the intrapartum period, which is the time period spanning childbirth from the onset of labour to the delivery of the placenta, maternal deaths could be reduced by 50%.
3) Increased referrals for high-risk pregnancies have also contributed to a decrease in maternal deaths. The main causes of high MMR were late arrivals to health care facilities and home deliveries.

4) Another critical recommendation is that the healthcare professional (professional nurse and/or medical doctor) monitor the patients on a regular basis during their antenatal visits to ensure they receive all vaccines.
5) Another system for increasing vaccine uptake is the development of community-based platforms where people can learn not only about the benefits of pregnancy vaccination but also about its safety profile.
6) Kilich et al. discovered in their study that a pregnant woman's decision to accept vaccination is strongly influenced by the recommendation of her healthcare professional [20]. As a result, healthcare providers should not only offer but also actively recommend vaccination during pregnancy, as well as provide ample time and opportunity for the woman to express her concerns and make an informed decision.
7) A regular training programme for health care workers to improve communication skills and care quality.
8) If every pregnant woman in India is examined by a MedicalOfficer/Specialist and Investigated appropriately at least once duringthe PMSMA, the Abhiyan can play a crucial role in reducing the numberof maternal deaths & High-Risk Pregnancy (HRP) in our country[37].
9) Early detection and treatment via regular antenatal check-ups are critical in avoiding high-risk pregnancy and its complications. As a result, accurate screening and comprehensive strategies are required to identify high-risk pregnancy cases and prevent maternal and childhood complications.
10) More media exposure, particularly on television and radio, as well as street plays about maternal health services and how to overcome socio-cultural barriers to effective health care utilisation, are required in rural areas.

Data availability:
Data are available from PubMed (https://pubmed.ncbi.nlm. nih.gov/), Google Scholar (https://scholar.google.com/), CDC (https://www.cdc.gov/), MoHFW (https://www.mohfw.gov.in/), and WHO (https://www.who.int/)

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Conflicts of interest
There are no conflicts of interest.

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