Vegueta. Anuario de la Facultad de Geografía e Historia
26 (1) 2026
eISSN: 2341-1112

GEOGRAPHICAL ANALYSIS OF CAESAREAN DELIVERY IN INDIA BY INTUITIONISTIC FUZZY SETS

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Abstract. In this study we analyze the caesarean delivery in India. We first divide the total states into six region central, east, north east, north, south and west. By comparing the state wise NFHS data we observe that percentage of education differ in all this region, region with higher education attain maximum caesarean rate. By comparing delivery in public and private hospital through out six region, region where people opt for public health care shows minimum c-section delivery rate. So by observing this we take women education, family condition, health care facility and maternal choice has factors. In this study we use intuitionistic fuzzy set theory to find some meaningful result to minimize c-section rate. Atanassov's intuitionistic fuzzy set is more adept or representing and managing uncertainty. Within intuitionistic fuzzy set theory, intuitionistic fuzzy measure is a significant field of study. First, based on the minimum and maximum level of similarity, we suggest a new similarity metric between intuitionistic fuzzy value. It is possible to show some aspects of the suggested similarity measure between intuitionistic fuzzy set by taking into account the modal operators and their different extensions. In this method we choose the best alternative among four options to minimize c-section rate.
Keywords: Intuitionistic fuzzy sets, Modal operators, measure of similarity, six regions, alternatives.

INTRODUCTION:

Caesarean section, also termed as c section or caesarean delivery refers to the surgical procedure for delivery of babies by making an incision in the mother's abdomen usually performed due to pregnancy complications. This surgical intervention is a major life saving obstetric procedure to prevent both, mother and baby, from unwanted delivery related complication. It has also been reported that C-section are highly effectual in saving lives of mother and infant, only when they are needed for medically indicated causes.

Over a decade there is a rapid increase in C-Section delivery rates across the globe and this rise in number shows a varied prevalence across different regions. The number of C-Section births recorded each year globally are more than 18 million, accounting for approx. 19% of total birth which is higher than that of WHO's recommendation. The C-Section are comparatively less in low and middle income countries(LMIC) 5% in Nepal, 23% in Bangladesh and 20% in Pakistan.

This rule in C-Section deliveries is now a matter of concern amongst the policy makers as WHO has recommended that C-Section rates higher than 10% do not show association with reduction in maternal & newborn morality rates. India has undoubtedly shown remarkable progress in institution delivery from 26% in 1992-93 to 78.9% in 2015-16 to 88.6% in 2019-21.

India has undoubtedly shown remarkable progress in institutional delivery i.e., from 26% in1992-1993 to 78.9% in 2015-2016 to 88.6% in 2019-2021.The Government of India(GOI) is continuously running various

schemes and programs to improve maternal health and access to healthcare facilities in India at a central level. To mitigate the challenges of maternal and Infant health programs i.e., Surakshit Matritva Aashwasan (SUMAN), Pradhan Mantri Surakshit Matritva Abhiyan, Janani Shishu Suraksha Karyakaram (JSSK), Pradhan Mantri Matru Vandana Yojana (PMMVY) etc. are being run to provide comprehensive financial and medical support for both pre and postnatal care along with the elimination of high out of pocket expenditure.

In the same context WHO has recommended that Caesarean sections are effective only if they are needed for obstetric complications and thus the Robson categorization system is proposed by WHO as a global standard for assessing, monitoring, and comparing caesarean section rates across time in healthcare facilities.

Despite several studies investigating factors contributing to caesarean section The socio-economic lop-sidedness of Caesarean-section deliveries in India towards urban and wealthier population is well entrenched. Another study based upon large scale national level sample surveys highlighted the skewed distribution of caesarean deliveries towards private hospitals and have reported that C-section births accounted for 13.7 % of births in public hospitals and 37.9% of births in private institutions.16 A study based on NFHS data in India claimed that from 2005–06 to 2015–16, the percentage of C-section deliveries in public hospitals decreased from 15.2 percent to 11.9 percent, wherein the prevalence has risen significantly; from roughly 25% to around 40%, among private healthcare practitioners.18 In- spite of all the findings there are still studies unavailable which provides a recent update on the geographical variability of caesarean section delivery. With this backdrop, this study is planned which attempts to explore State/ UT wise change in caesarean section delivery, to examine the factors leading to caesarean delivery .In this study we divide India into six regions such as central, east, northeast, north, south and west. By comparing the caesarean delivery in all these six region we are taking factors leading to c section delivery. The below table shows the comparison data of caesarean delivery in 2016-19 to 2021. This data is taken from National Family Health Survey(NFHS) i.e., NFHS 2016 and NFHS 2021.

TABLE 1.1 COMPARISON DATA OF CASEAREAN DELIVERY IN 2016 TO 2021

REGION	**NFHS 4**	**NFHS 5**
INDIA	17.2	21.5
CENTRAL	9.1	12.9
CHATTISGARH	9.9	15.2
MADHYA PRADESH	8.6	12.1
RAJASTHAN	8.6	10.4
UTTAR PRADESH	9.4	13.7
EAST	13.5	19.2
BIHAR	6.2	9.7
JHARKHAND	9.9	12.8
ODISSA	13.8	21.6
WEST BENGAL	23.8	32.6
NORTH EAST	13.9	17.6
ARUNACHAL PRADESH	8.9	14.8
ASSAM	13.4	18.1
MANIPIUR	21.1	25.6
MEGHALAYA	7.6	8.2
MIZORAM	12.7	10.8
NAGALAND	5.8	5.2
SIKKIM	20.9	32.8
TRIPURA	20.5	25.1

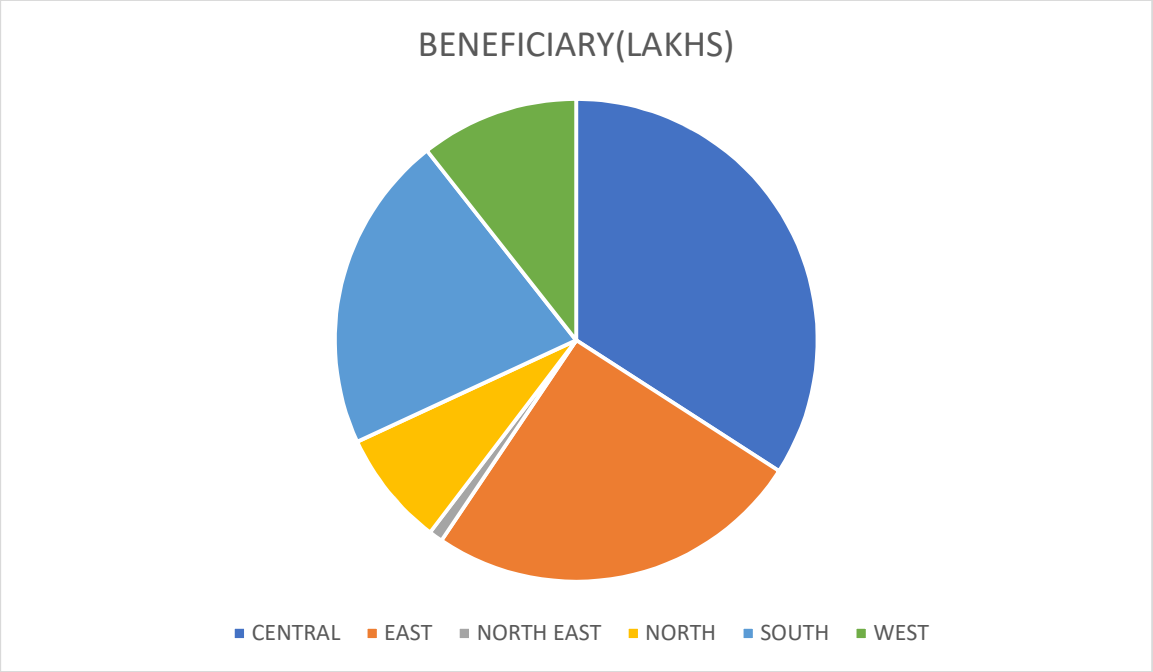
NORTH	21.3	28.0
DELHI	26.7	23.6
CHANDIGARH	22.6	31.3
HARYANA	11.7	19.5
HIMACHAL PRADESH	16.7	21.0
JAMMU&KASHMIR	33.4	41.7
PUNJAB	24.6	38.5
UTTARAKHAND	13.1	20.4
SOUTH	38.3	43.7
ANDHRA PRADESH	40.1	42.4
KARNATAKA	23.6	31.5
KERALA	35.8	38.9
TAMIL NADU	34.1	44.9
TELANGANA	57.7	60.7
WEST	23.4	28.6
GOA	31.4	39.5
GUJARAT	18.4	21.0
MAHARASHTRA	20.1	25.4

From the table it is understood that c sec delivery is very high north, south and west part of state. Caesarean delivery is very low in central, east and north east region. This variation may be due to many factors because every state has different state policy, economic development, custom and health care facility, lifestyle, age, and education of women. Maternal and child nutrition has always been an important aspect of India's policy paradigm. Though government put more efforts, India's performance on various maternal health is very poor. Only 20% of pregnant women receive full antenatal checkup. Taking this into account government of India introduced INDIRA GANDHI MATRIVA SAHYOG YOJANA(IGMSY), The scheme was introduced in oct 2010 on pilot basis, operational in 52 districts. However prime minister Narendra Modi introduced Pradhan Mantri Matriva Vandana Yojana(PMMVY) on December 31,2016. The utilization of PMMVY scheme in all states varies according to awareness of the people in that state and the state govt efforts to make all people to get benefited by scheme.

TABLE 1.2: COMPARISON OF HEALTH SCHEME BENEFICIARY IN 2020 AND 2021

Sl. No.	State	2020-21		2021-22	
		No. of Beneficiaries enrolled	Total amount Disbursed* (₹ in Lakhs)	No. of Beneficiaries enrolled	Total amount Disbursed* (₹ in Lakhs)
1	**CENTRAL**	**2125306**			
	Chhattisgarh	1,23,512	5,452.00	71,511	2,888.83
	Madhya Pradesh	5,90,450	29,058.00	3,26,880	13,830.16
	Rajasthan	2,98,756	13,773.00	1,95,186	6,151.75
	Uttar Pradesh	11,12,588	44,422.00	5,98,544	20,316.88
2	**EAST**	1577362			
	Bihar	11,15,837	48,286.00	2,16,611	7,443.95
	Jharkhand	1,64,238	5,723.00	56,535	1,674.55

	Odisha	0	0	0	0
	West Bengal	2,97,287	0.33	48,085	0
3	**NORTH EAST**	57343			
	Arunachal Pradesh	7,261	296	2,134	95.54
	ASSAM				
	Manipur	14,958	664	5,108	235.66
	Mizoram	5,515	248	3,950	177.61
	Nagaland	6,371	267	2,332	119.2
	Sikkim	2,626	84	1,749	21.07
	Tripura	20,612	730	8,723	187.09
4	**NORTH**	4,82,951			
	Delhi	85,885	2,545.00	51,170	1,818.35
	Chandigarh	5,100	230	3,437	131.59
	Haryana	1,20,811	3,376.00	78,461	3,083.33
	Himachal Pradesh	41,496	1,978.00	26,579	898.03
	Jammu And Kashmir	65,658	1,949.00	35,223	1,761.27
	Punjab	1,05,742	4,134.00	52,317	480.2
	Uttarakhand	58,249	2,707.00	35,300	1,424.61
5	**SOUTH**	1327009			
	Andhra Pradesh	2,26,803	7,917.00	1,10,157	838.96
	Karnataka	5,05,328	15,675.00	2,49,731	6,871.83
	Kerala	1,81,657	6,600.00	1,02,387	4,233.06
	Tamil Nadu	4,13,221	12,388.00	2,06,040	4,215.91
	Telangana	0	0	0	0
6	**WEST**	661427			
	Goa	4,260	188	2,246	60.21
	Gujarat	88,439	4,711.00	22,350	63.21
	Maharashtra	5,68,728	26,391.00	4,01,623	16,790.03



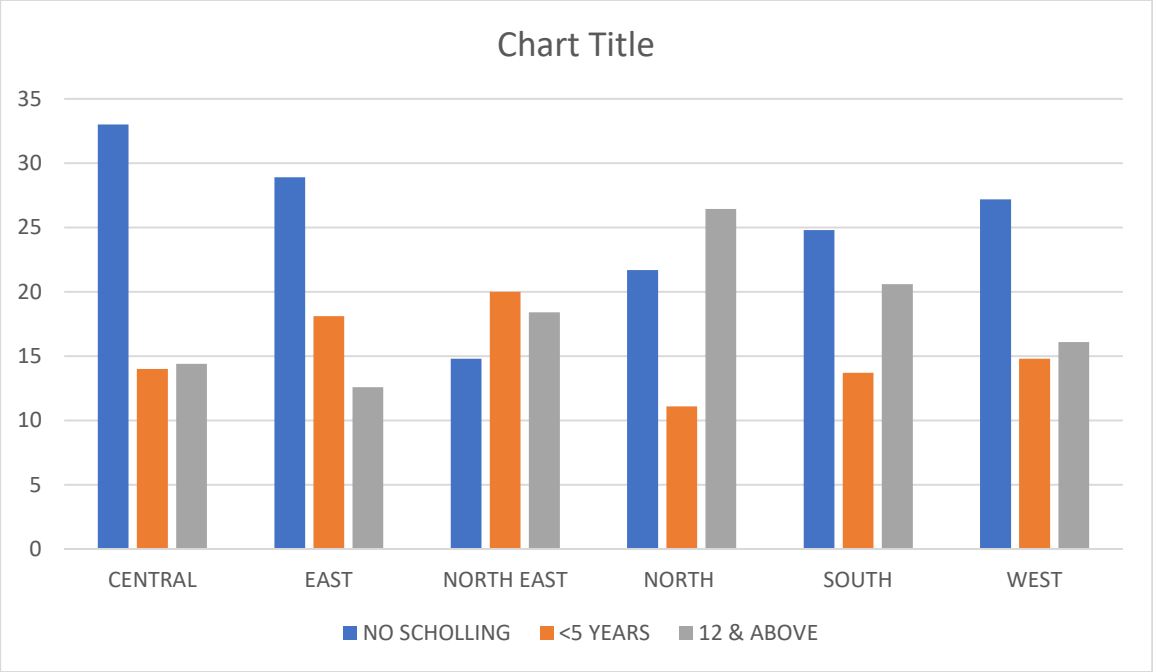
If we see the figure we can clearly understood that central states are getting enrolled in big percentage, north east states are not aware of this scheme. Though the government has introduced schemes to help women, there is no awareness among the people about this government schemes. The Maternal age also differs in all states like Tamilnadu, Kerala women are getting good education so the marriage also differs. But still in some states women are getting married early ages.

We can now analyse the education of women in all states.

TABLE 1.3: STATEWISE EDUCATION DETAILS OF WOMEN

STATE	NO SCHOOLING	<5YRS	5-7 YRS	8-9 YRS	10-12 YRS	12 YRS AND ABOVE	MISSING
INDIA	28.2	15.5	15.8	13.5	10.4	16.6	0
NORTH	**21.7**	**11.1**	**14.8**	**15.1**	**12.7**	**26.45**	**0.1**
CHANDIGARH	13.3	9.4	14.4	12.3	14.7	35.9	0.1
DELHI	16.2	12.4	14.2	12.8	12.5	31.9	0.1
HARYANA	26.2	11.8	16.1	13.3	11.3	21.2	0
HIMACHAL PRADESH	19	10.5	17.4	11.7	14.6	26.7	0
JAMMU & KASHMIR	29.9	10.8	10.6	15.2	12.3	21.2	0
UTTARAKHAND	24.7	12.4	15.1	14.3	9.3	24.1	0.1
PUNJAB	22.8	10.5	16	11.8	14.8	24.2	0
CENTRAL	**33**	**14**	**15.7**	**14.8**	**7.8**	**14.4**	**0**

RAJASTHAN	36.5	13.5	16.1	12.5	7.8	13.6	0
UTTAR PRADESH	32.5	14.4	14.6	13.1	7.6	17.5	0
CHATTISGARH	30.7	14.2	15.7	16.1	8.7	14.7	0
MADHYA PRADESH	32.5	14.2	16.5	17.8	7.2	11.8	0
EAST	**28.9**	**18.1**	**15.1**	**14.9**	**10.1**	**12.6**	**0.1**
BIHAR	35.4	16.9	13.9	12.8	9.1	11.6	0.1
JHARKHAND	28.4	18.3	14.1	15.7	9.9	10.7	0.1
ODISHA	23.1	20.9	16.9	16.8	10.4	13	0.1
WEST BENGAL	28.8	16.6	15.7	14.4	11.1	15.1	0
NORTH EAST	**14.8**	**20**	**18.3**	**18.2**	**11.8**	**18.4**	**0.063**
ARUNACHAL PRADESH	21.8	21.1	14	20.9	8.5	11.5	0
ASSAM	16	18.8	16.2	19	11.9	21.2	0
MANIPUR	14	28.4	13.1	15.6	9.8	13.4	0.1
MEHALAYA	6.6	23.7	18.7	18.6	13.3	19.1	0.2
MIZORAM	14.8	18.8	18.6	19	11.7	18.2	0
NAGALAND	16.3	16.2	17.6	15.5	11.9	23.1	0
SIKKIM	18.1	19.8	17	26.5	7.8	8.4	0.1
TRIPURA	11	13.4	19.3	11.2	19.6	32.8	0.1
WEST	**27.2**	**14.8**	**15.9**	**12.1**	**11.3**	**16.1**	**0**
GOA	27.1	15.2	11.9	14.9	9.2	14	0
GUJARAT	20.3	16.4	19.6	13.1	12.8	20.9	0
MAHARASHTRA	34.4	13	16.4	8.3	12.1	13.4	0
SOUTH	**24.8**	**13.7**	**16.5**	**10.3**	**14.4**	**20.6**	**0**
ANDHRA PRADESH	34.4	13	18.8	8.3	12.1	13.4	0
KARNATAKA	27	14.7	18.8	8.6	15.7	17.5	0
KERALA	4.4	16.2	16.4	14.6	19.5	30.4	0.1
TAMILNADU	19.6	13.8	14.8	13.8	12.1	24.3	0
TELANGANA	39	11.1	13.6	6.2	12.7	17.4	0



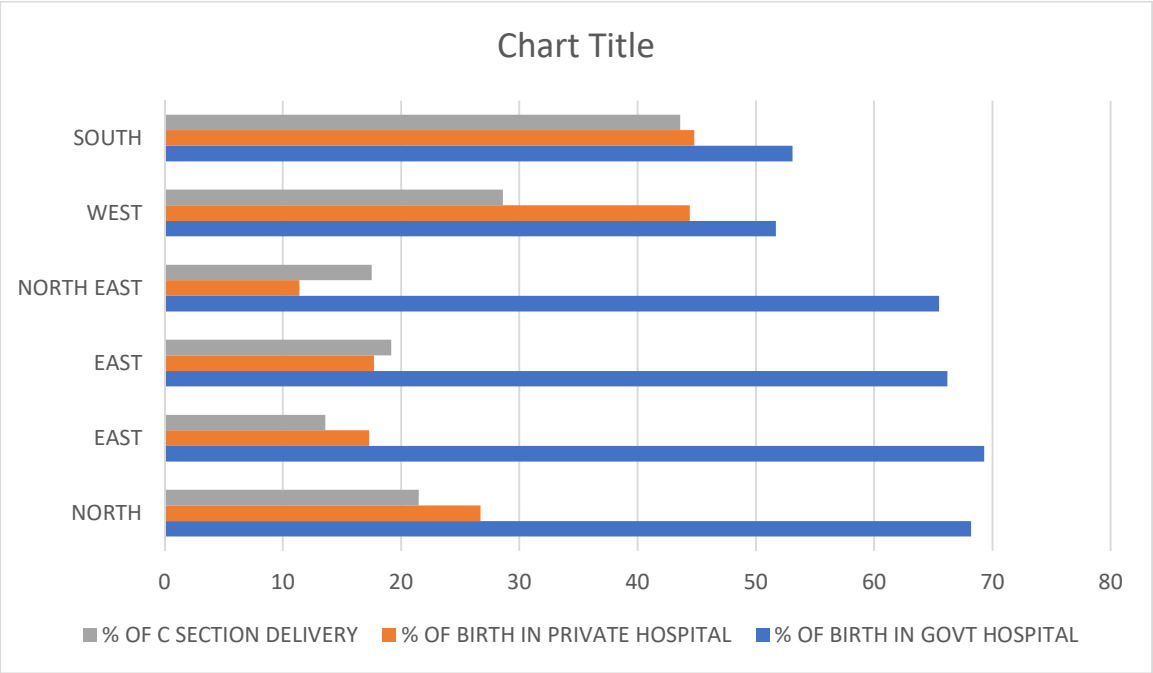
- This data reflects a profound developmental divide. The **Southern Region**, which possesses robust educational foundations, logs the highest C-section delivery footprint (**43.7% in NFHS-5**). Conversely, the **Central Region**, characterized by high "No Schooling" rates (**33%**), displays the lowest demand or access to surgical births (**12.9% in NFHS-5**). Higher schooling tiers (12 Years and Above) show a direct positive link to surgical births. States where senior-level education is prevalent (such as Kerala, Chandigarh, and Tamil Nadu) display C-section rates that far exceed the national average of **21.5%**. Educated households typically possess higher health literacy, financial capacity, and access to private hospital delivery systems.Despite Meghalaya (**6.6%**) and Nagaland (**16.3%**) recording low illiteracy rates, they feature India's lowest C-section rates (**8.2%** and **5.2%** respectively). This points to geographical barriers or a cultural preference for natural childbirth.Delhi presents a unique inverse shift. While maintaining high 12+ years schooling (**31.9%**), it is the only major urban zone to observe a **decrease** in C-sections, dropping from **26.7% to 23.6%**.
- This table demonstrates that **maternal schooling directly impacts surgical delivery access**. Higher educational attainment across India correlates with higher C-section rates due to increased urban healthcare access, while the uneducated populations in Central and Eastern India face a dual deficit of lower schooling and limited clinical birth interventions.

TABLE 1.4: STATEWISE COMPARISON OF BIRTHS IN PRIVATE AND PUBLIC HOSPITAL

	PERCENTAGE OF BIRTHS DELIVERED IN A PUBLIC HOSPITAL	PERCENTAGE OF BIRTHS DELIVERED IN A PRIVATE HOSPITAL	PERCENTAGE OF C SECTION DELIVERY
INDIA	**61.9**	**26.7**	**21.5**
NORTH	**68.2**	**23.8**	**25.7**
CHANDIGARH	83.2	13.6	31.3
DELHI	62.4	29.3	23.6

HARYANA	57.5	37.4	19.4
HIMACHAL PRADESH	71.7	16.5	21
JAMMU & KASHMIR	86.8	5.6	41.7
PUNJAB	53.9	40.4	38.5
RAJASTHAN	77	17.9	10.4
UTTARAKHAND	53.3	29.9	20.4
CENTRAL	**69.3**	**17.3**	**13.6**
CHATTISGARH	70	15.7	15.2
MADHYA PRADESH	80.2	10.5	12.1
UTTAR PRADESH	57.7	25.7	13.7
EAST	**66.2**	**17.7**	**19.17**
BIHAR	56.9	19.3	9.7
JHARKHAND	56.8	18.9	12.8
ODISHA	78.7	13.5	21.6
WEST BENGAL	72.4	19.4	32.6
NORTH EAST	**65.5**	**11.4**	**17.5**
ARUNACHAL PRADESH	74.8	4.3	14.8
ASSAM	74.4	9.7	18.1
MANIPUR	59.4	20.5	25.6
MEGHALAYA	49.1	8.9	8.2
MIZORAM	73.8	12	10.8
NAGALAND	35.8	9.9	5.2
SIKKIM	78.6	16.1	32.8
TRIPURA	78.7	10.4	25.1
WEST	**51.7**	**44.4**	**28.6**
GOA	56.2	43.5	39.5
GUJARAT	43.3	51	21
MAHARASHTRA	55.8	38.9	25.4
SOUTH	**53.1**	**44.8**	**43.6**
ANDHRA PRADESH	50.4	46.1	42.4
KARNATAKA	64.8	32.2	31.5
KERALA	34.1	65.7	38.9
TAMILNADU	66.9	32.7	44.9
TELANGANA	49.7	47.4	60.7

INDIA	**61.9**	**26.7**	**21.5**
NORTH	**68.2**	**23.8**	**25.7**
CENTRAL	**69.3**	**17.3**	**13.6**
EAST	**66.2**	**17.7**	**19.17**
NORTH EAST	**65.5**	**11.4**	**17.5**
WEST	**51.7**	**44.4**	**28.6**
SOUTH	**53.1**	**44.8**	**43.6**



- If we observe the table above,Public hospitals handle most births nationally (61.9%). Jammu & Kashmir (86.8%) and Chandigarh (83.2%) rely heaviest on public care. Kerala relies the least on public hospitals (34.1%), with a massive shift toward private healthcare (65.7%). Southern India leads the country in C-section surgeries (43.6%). Telangana has the highest rate at 60.7%. Jammu & Kashmir also shows an exceptionally high rate at 41.7%. Meghalaya (8.2%), and Bihar (9.7%) have the lowest C-section rates. This often points to limited surgical access in rural or remote areas. Southern states prefer private hospitals and experience significantly higher C-section rates. Northern and Central states rely more on public infrastructure and record much lower surgery rates. C-section rates fluctuate wildly from 5.2% to 60.7% across different states. This suggests that medical procedures are influenced heavily by local healthcare access, wealth, and hospital practices rather than health needs alone.

From the above facts, we observe that women education, family condition, health care facility and maternal choices influence c-section delivery.

FACTORS

1. **Women education**

2. **Women Family condition**
3. **Maternal choices**
4. **Health care facility**

Women education

Women's education level significantly influences the rate of caesarean delivery, with higher education generally associated with an increased likelihood of having a C-section, particularly in developed states. The specific reasons for this correlation can vary depending on regional and individual factors. More educated women are often from higher socioeconomic backgrounds and urban areas, where private health facilities and advanced medical services are more readily available and accessible. They are more likely to be attended by skilled health staff and physicians who may recommend or perform C-sections. Higher education can empower women to play a greater role in their own healthcare decisions, including the mode of delivery. This autonomy allows them to request a C-section, sometimes without a strict medical indication, based on their own perceptions or preferences. Educated women may perceive the C-section as a safer method for both the mother and baby, or as a way to avoid labour pain, a negative previous experience with vaginal delivery, or potential injury. Some studies suggest that educated women may prefer C-sections to better manage their professional workloads or for convenience, as the procedure can be scheduled in advance.

Women Family condition:

Families living in urban areas have significantly higher C-section rates compared to rural families. This is often due to better access to private healthcare facilities, which tend to have higher surgical rates than public hospitals. Advice from parents, mothers-in-law, and relatives significantly shapes a woman's decision. In some African and Asian cultures, family members may even be entrusted with the final decision-making regarding the mode of delivery. A previous C-section within the family (or a woman's own history) is one of the strongest predictors for a repeat procedure. Traumatic vaginal birth stories shared by relatives can also foster a fear of natural labour, leading families to prefer a surgical approach.A husband's preference can strongly correlate with a woman's intention to have a C-section.

Maternal choices:

Maternal choice influences the rate of caesarean delivery (CS) through a range of interconnected personal, social, and systemic factors. These reasons often stem from deeply personal experiences and perceptions of safety, rather than solely a desire for convenience. This is one of the most common reasons women request a CS. The fear often involves anticipation of intense labor pain, loss of control during the process, or fear of injury to themselves (like perineal trauma) or the baby. Women who have experienced a traumatic vaginal birth, prolonged labor, or an emergency CS in the past are significantly more likely to request a planned repeat CS to avoid a similar experience. Many women believe a planned CS is the safest option for both the mother and the baby, as it can avoid potential complications associated with a difficult vaginal delivery, such as fetal distress or birth injuries. This perception may be influenced by a lack of knowledge about the actual risks and benefits of both delivery modes. A planned CS allows women to schedule the exact date and time of birth, which offers a sense of control and predictability over their life dynamics, including work or childcare arrangements.

Health care facility:

Healthcare facilities influence caesarean delivery rates through a complex mix of infrastructure, financial incentives, provider practices, and quality of care standards. These factors often lead to high rates of unnecessary C-sections, particularly in private settings, while some public facilities may experience the opposite problem of unmet need due to resource constraints. The single most impactful factor is often whether the delivery occurs in a public or private institution. Private hospitals consistently have significantly higher C-section rates (sometimes three to four times higher) than public hospitals. This disparity is often linked to profit motives, with C-sections generating more revenue than vaginal deliveries. Fee-for-service models and health insurance coverage that easily reimburse C-section procedures can influence healthcare providers' decision-making towards surgical intervention. A lack of standardized clinical guidelines, insufficient training in difficult vaginal deliveries (such as instrumental delivery or vaginal birth after C-section - VBAC), and variations in senior obstetricians' practices contribute to higher C-section rates. Some providers may opt for C-sections due to a lack of skill or fear of potential complications and legal action from a complicated vaginal birth. C-sections offer convenience for both doctors and patients as they can be scheduled. Factors like physician workload, staff shortages, and the desire for time management can drive the preference for a scheduled surgical delivery over a potentially long and unpredictable labor process. Poor quality of care, lack of privacy, and disrespectful treatment during labor in some facilities can lead women to prefer a C-section in a private setting, believing it to be a safer and more dignified experience.

ALTERNATIVES

1. Government Strict Regulation to Healthcare System.
2. Awareness Program for Pregnant Women About Pregnancy.
3. Strenthening Public Health Care System to Reduce Caesarean Delivery
4. Enhancing The Health Schemes for the Benefit of Women.

1. Government Strict Regulation to Healthcare System.

To effectively regulate the healthcare system and reduce unnecessary C-sections in the future, the government can move from basic monitoring to strict enforcement and structural shifts. One of the strongest regulatory moves is removing the "profit motive" from surgery. Under government insurance schemes like Ayushman Bharat (PM-JAY), regulations can be set so that the payout for a normal delivery is equal to or even higher than a C-section. This encourages hospitals to invest time in natural labour rather than rushing to surgery for higher billing. Regulating the maximum price difference between normal and C-section deliveries in private hospitals to prevent "up-selling" of surgical procedures.

Scaling platforms like the Pre-conception and Pre-natal Diagnostic Techniques (PCPNDT) infrastructure to track every delivery in real-time. If a hospital exceeds a certain C-section threshold (e.g., 20%), the system automatically triggers a "show-cause" notice. Linking every birth to the mother’s ABHA (Ayushman Bharat Health Account). This allows regulators to see if a healthy, low-risk woman was given a C-section without a documented medical emergency. Future regulations could mandate that every C-section performed on a "low-risk" woman (Robson Group 1) must have a signed peer-review justification within 24 hours. Making a hospital’s annual license renewal conditional on meeting "Respectful Maternity Care" standards and maintaining C-section rates within the WHO-recommended 10-15% range.

Legally requiring hospitals to discuss and sign a "Birth Plan" with the mother during the second trimester, outlining her preference for a natural birth and the specific conditions under which she consents to surgery. Expanding the "National Health Ranking" to include maternity performance. Hospitals with high

normal-delivery rates and high patient satisfaction should receive "Star Ratings" and government incentives.

2. Awareness Program for Pregnant Women About Pregnancy

To improve an awareness program for educating pregnant women, the focus should be on community based, interactive, and culturally sensitive health education, with strong support systems and accessible quality healthcare services. Tailor educational content to the specific needs, literacy levels, and cultural beliefs of the local pregnant women, especially those in rural or underserved areas, traditional beliefs about pregnancy and birth can influence health practices, so materials must be sensitive to this (e.g., using local photos and language, avoiding off-putting imagery). move beyond traditional lectures to engaging methods that foster better learning and retention. Use counselling sessions, group discussion, and Q&A forums to encourage active participation. Incorporate visual aids, such as flip charts, posters with clear danger signs, and educational videos. Utilize storytelling and patient testimonials to make information relatable and motivate action.

Ensure women have access to support from various individuals and groups. Involve family members (husband, partners, mothers, etc.) in the education process so they can provide support and help with decision-making. Engage community health workers, such as accredited social health activists (ASFAs) or midwives, who can conduct home visits, build trust, and provide consistent, reliable information in the local setting. Promote mothers' groups or associations where women can connect with peers, share experiences, and receive mutual support.

Ensure the curriculum covers essential, evidence-base information in a clear and consistent manner. Importance of regular antenatal and postnatal care visits and check-ups (e.g., blood pressure, haemoglobin, urine tests). Nutrition and personal hygiene during pregnancy. Recognition of danger signs during pregnancy, labour, and postpartum, and knowing when to seek immediate medical attention. Information on available government schemes. Entitlements, and health services (e.g., free transport, drugs, diagnostics). Birth preparedness and planning for institutional delivery with a skilled birth attendant. Breastfeeding practices (early initiation and exclusive breastfeeding for the first six months). Family planning and the importance of birth spacing. Mental health awareness and available counselling services. Education must be linked to accessible, affordable, and respectful health care services. Ensure referral system to higher-level facilities for complicated pregnancies are clear and functional. Train healthcare providers on effective communication, respectful care, and implicit bias to ensure a positive experience for women. Provide essential equipment and supplies at health facilities and birthing centres.

Continuously assess the program's effectiveness through data collection (e.g., attendance records, pre/post-intervention questionnaires, health outcomes) and gather feedback for participants to refine the program. By implementing these steps, awareness programs can significantly improve maternal health literacy, leading to better health practices and improves outcomes for both mothers and babies

3. Strengthening Public Health Care System to Reduce Caesarean Delivery:

Strengthening the public healthcare system to reduce unnecessary caesarean deliveries involves a combination of clinical audits, infrastructural improvements, and the integration of professional midwifery. Current government strategies focus on ensuring that C-sections are medically justified while promoting natural birth through quality-driven initiatives. Rigorous monitoring of delivery data helps identify and address

trends in over-medicalisation. The WHO Robson Classification System is being institutionalized across public facilities to categorize every birth, allowing regulators to audit C-section rates within specific, comparable groups. Facilities with high C-section rates—sometimes flagged through National Health Management Information System (HMIS) data—are subjected to mandatory audits and corrective reviews during state review meetings.

Some clinical protocols now mandate a second opinion from a senior obstetrician for every non-emergency C-section to ensure surgical intervention is strictly necessary. The Midwifery Service Initiative aims to train a specialized cadre of midwives to handle physiological births, which reduces the workload on obstetricians and focuses on natural laboursupport. Establishing dedicated units within public hospitals where midwives provide primary care for low-risk pregnancies helps maintain lower C-section rates without compromising safety.

The LaQshya program regulates the quality of care in labour rooms and maternity operation theatres (OTs).LaQshya mandates "Respectful Maternity Care," which includes ensuring privacy, dignity, and a positive birthing environment, which often encourages women toward natural birth.Guidelines promote the presence of a "Birth Companion" or Doula during labour, a practice clinically proven to reduce the likelihood of surgical intervention by providing continuous emotional support.Awareness programs conducted from the early stages of pregnancy educate families on the benefits of natural birth versus the risks of unnecessary surgeries.

4. ENHANCING HEALTH SCHEMES IN INDIA:

To enhance existing health schemes for pregnant women in India, improvements should focus on ensuring uniform quality of care, strengthening infrastructure in remote areas, and addressing socioeconomic barriers. While coverage of ANC has increased, the quality of care needs improvement. This involves ensuring all recommended screenings and diagnostics (e.g., for anaemia, gestational diabetes, HIV, syphilis) are consistently provided and that healthcare providers are adequately trained in evidence-base practices.

Ensuring all FRYs are fully operational with necessary manpower (specialists like obstetricians and anaesthetists), equipment, and functional blood storage units to manage complicated pregnancies and obstetric emergencies. Setting up integrated MCH wing at high-caseload district hospitals and sub district facilities to provide quality obstetric and neonatal care. Focused implementation of programs in states and remote/tribal areas with historically poor maternal health indicators to bridge the gap with better-performing regions.

Ensuring reliable and timely transportation for pregnant women, especially those with high-risk pregnancies, form their homes to health facilities and back, free of cost. establishing homes near health facilities in remote areas so women can await delivery in a safe environment, thus promoting institutional births and reducing delays in receiving care.

Streamlining the direct benefit transfer (DBT) process for schemes like Pradhan Mantri Matru Vandana yojana (PMMVY) and Janani Suraksha yojana (JSY) to reduce financial barriers and ensure women receive funds when needed. Structures to not only focus on the number of women mobilized but also on the quality and continuity of care provided and achieved healthy outcomes. Strengthening the identification and dedicated tracking system for HRPs, ensuring they receive specialized care and follow-up through the Pradhan Mantri Surakshit Matritva Abhiyan(PMSMA).

Conducting robust campaigns to educate women and communities about the importance of early ANC registration, nutrition, institutional deliver, and danger signs in pregnancy, utilizing this monthly outreach

session effectively to provide comprehensive maternal and child health services and education at the grassroots level. Leveraging platforms like the RCH (reproductive and child health) portal and U-WIN to track beneficiaries seamlessly, ensuring no one is missed and services are delivered on time. Implementing receives dignified, respectful, and quality healthcare during delivery, which builds trust in the public health system.

METHODOLOGY

In 1965, L.A.Zadeh[1] created and introduced the idea of a fuzzy set. Eighteen years later, in 1983, Atanassov [2] introduced the concept of intuitionistic fuzzy sets. The fundamental distinction between these two ideas is that, in intuitionistic fuzzy set theory, hesitation margin is taken into account in addition to both membership function is taken into account.

There are circumstances in which fuzzy set is not the best fit and should be replaced with intuitionistic fuzzy set theory. Intuitionistic fuzzy set theory has been researched as a helpful resource for decision making issues, logic programming, etc. In this work, we establish a similarity measure between two intuitionistic fuzzy sets A and B and apply it to problem involving choosing a best alternative. The issue under consideration is choosing the best alternatives from n options based on m criteria in cases when the information at hand is intuitionistic fuzzy.

DEFINITION:

Let X be a nonempty set (the universe of discourse). An intuitionistic fuzzy set A in X is defined as an object of the form

A={⟨x, μ_A (x), ν_A(x)⟩: x Є X}, where the functions μ_A, ν_A:x→[0,1] define respectively,the degree of membership and degree of non-membership of the element $x \in X$ to the set A, which is a subset of X, and for every element $x \in X$, $0 \leq \mu A(x) + \nu A(x) \leq 1$.

Furthermore, we have $\pi A(x) = 1\text{-}\mu A(x)\text{-}\nu A(x)$ called the intuitionistic fuzzy set index or hesitation margin of x in A. $\pi A(x)$ is the degree of indeterminacy of $x \in X$ to the IFS A and $\pi A(x) \epsilon [0,1]$ that is $\pi A: x \rightarrow [0,1]$and $0 \leq \pi A(x) \leq 1$ for every $x \in X$.

$\boldsymbol{\pi A(x)}$ expresses the lack of knowledge of whether $\boldsymbol{x}$ belongs to IFS A or not.

Definition 2.2. [9] Let X be a nonempty set. If A is an IFS drawn from X, then the modal operators which are also termed as necessity and possibility operators can be defined as

1. $\Box A = \{\langle x, \mu A(x), 1 - \mu A(x)\rangle : x \in X\}$
2. $\Diamond A = \{\langle x, 1 - \nu A(x), \nu A(x)\rangle : x \in X\}$

For a proper IFS, $\Box A \subset A \subset \Diamond A$ and $\Box A \neq A \neq \Diamond A$.

Definition 2.3. [9] Let X be a nonempty set. If A is an IFS drawn from X, then,

1. $\boxplus A = \{\langle x, \frac{\mu A(x)}{2}, \frac{\nu A(x)+1}{2}\rangle : x \in X\}$
2. $\boxtimes A = \{\langle x, \frac{\mu A(x)+1}{2}, \frac{\nu A(x)}{2}\rangle : x \in X\}$

For a proper IFS, $\boxplus A \subset A \subset \boxtimes A$ *and* $\boxplus A \neq A \neq \boxtimes A$.

Definition 2.4. [32] Let $\propto \in [0,1]$ and let A be an IFS. Then the first extension of the operators $\boxplus$ and $\boxtimes$ can be defined as

1. $\boxplus \alpha A = \{\langle x, \alpha\mu A(x), \alpha\nu A(x) + 1 - \alpha\rangle : x \in X\}$

2. $\boxtimes \alpha A = \{\langle x, \alpha\mu A(x) + 1 - \alpha, \alpha v A(x)\rangle : x \in X\}$.

Definition 2.5. [13]
Let $\alpha, \beta, \alpha + \beta \in [0,1]$ *and let A be an IFS. Then the second extension of the operators* $\boxplus$ and $\boxtimes$ *can be defined as*

1. $\boxplus\ \alpha, \beta A = \{\langle x, \alpha\mu A(x), \alpha v A(x) + \beta\rangle : x \in X\}$
2. $\boxtimes\ \alpha, \beta A = \{\langle x, \alpha\mu A(x) + \beta, \alpha v A(x)\rangle : x \in X\}$

Definition 2.6. [33] Let us consider two IFSs A and B of a fixed set E. The similarity measure between A and B denoted by s (A, B) is defined by an interval $[e_{AB}, e_{AB}]$, *where*

$$e_{AB} = \max_{x \in E} \min\{\mu A(x), \mu B(x)\}$$

$$e'_{AB} = \max_{x \in E} \min\{\mu A(x) + \pi A(x), \mu B(x) + \mu B(x)\}$$

Here e_{AB} indicates the minimum amount of similarity and e'_{AB} indicates the maximum amount of similarity between A and B.
It can be noted that

1. s(A, B) ⊆ [0, 1].
2. s(A, B) = s(B, A).
3. If $\pi A(x) = 0$ and $\pi B(x) = 0$, ∀x ∈ E, then $e_{AB} = e'_{AB}$.

Moreover it may be mentioned that $e_{AB} \neq e'_{AB}$ for A = B.

ALGORITHM:
The steps of algorithm of this method are as follows:
Step 1: Construct the criteria-matrix using the standard and available alternatives.
Step 2: Calculate s(S,X) = $\frac{e_{SX}}{e'_{SX}}$
Step 3: Find all the similarity measures like s(S,X), where X = A, B,C, D and E.
Step 4: If s(S,X) has more than one value, choose that one corresponding to which the indeterministic part is greatest.
Step 5: Choose the optimal action.

TABLE 1.5: CRITERIA-MATRIX OF ALTERNATIVES BASED ON MEMBERSHIP FUNCTION (μ) AND NON MEMBERSHIP DEGREE (v)

x	S μS, vS	A μA, vA	B μB, vB	C μC, vC	D μD, vD
x1	(0.75, 0.10)	(0.6, 0.2)	(0.85, 0.10)	(0.6, 0.2)	(0.5, 0.1)
x2	(0.5, 0.3)	(0.4, 0.2)	(0.45, 0.2)	(0.85, 0.1)	(0.8, 0.05)

x3	(0.8, 0.05)	(0.7, 0.02)	(0.85, 0.05)	(0.80, 0.1)	(0.8, 0.1)
x4	(0.85, 0.05)	(0.5, 0.2)	(0.6, 0.1)	(0.7, 0.1)	(0.8, 0.05)

TABLE 1.6: HESITATION MARGINS AND UPPER/LOWER BOUNDARY MATRICES FOR MATRIX S

x	VS	μS	1-μS	μA	1-μA	μB	1-μB	μC	1-μC	μD	1-μD
x1	0.1	0.75	0.25	0.6	0.4	0.85	0.15	0.6	0.4	0.5	0.5
x2	0.3	0.5	0.5	0.4	0.6	0.45	0.55	0.85	0.15	0.8	0.2
x3	0.05	0.8	0.2	0.7	0.3	0.85	0.15	0.8	0.2	0.8	0.2
x4	0.05	0.85	0.15	0.5	0.5	0.6	0.4	0.7	0.3	0.84	0.16

TABLE 1.7: FINAL EVALUATION MATRIX AND PRIORITY RANKING FOR ALTERNATIVES A,B,C,D.

πS (x)	πA (x)	πB (x)	πC (x)	πD (x)
0.15	0.2	0.05	0.2	0.1
0.4	0.4	0.35	0.05	0.15
0.15	0.25	0.1	0.1	0.1
0.1	0.3	0.3	0.2	0.11

Now we calculate e(S,A),e(S,A) is defined as the minimum amount of similarity or the lower bound similarity coefficient between standard value S and alternatives A

$\boldsymbol{e\ (S, A)}$ **= max min**$\{\mu S(x), \mu A(x)\}$
= max min { (0.75.0.5,0.8,0.85),(0.6,0.4,0.7,0.5) }
=0.7

Similarly,
e (S, B) =0.8
e (S, C) = 0.8
e (S, D) = 0.84
AND

Now we calculate $\boldsymbol{e'(S, A)}$**,it is defined as the maximum amount of similarity or the upper bound similarity coefficient between standard value S and alternatives A**

$\boldsymbol{e'(S, A)}$**= max min(**$\mu_s(x) + \pi_s(x)$ **,** $\mu_A(x) + \pi_A(x)$**)**
= max min ((0.9,0.9,0.95,0.95) (0.8, 0.8, 0.95, 0.8)
=0.95

$e'(S, B)$= 0.95
$e'(S, C)$=0.9
$e'(S, D)$=0.95
S(S,A)IS DEFINES AS RELATIVE SIMILARITY MEASURE RATIO BETWEEN STANDARD VALUE A AND ALTERNATIVE A.
S(S,A) =$\frac{e\ (S,A)}{e'(S,A)}$= 0.7368
S(S,B) = 0.842
S(S,C) = 0.8888
S(S,D) = 0.8842
C IS THE BEST ALTERNATIVE.

CONCLUSION:

From the result C is the best alternative i.e, strengthening public health care facility in India minimizes the chances of caesarean delivery. But the value of alternative C is 0.8888 and the value of D is 0.8842.we observe that the value is closely relative. So government has to equally focus on strengthening the public health care system and also on enhancing the health care schemes. If government hospital is well equipped and infrastructure is better or equal to private hospital then people will prefer public health care system. If the payment for c-section and vaginal birth are equal then financial motive will be removed. Government should improve the public healthcare system. They should focus mainly on the proper distribution of work force in rural and urban areas. Public facilities frequently suffer from severe staffing gaps, such as a 77% vacancy in sanctioned obstetrician and gynaecologist posts in some regions. Equalising this ensures that medical decisions are driven by clinical need rather than limited availability of specialists. So government should make the public health care system with fully equipped physician team to attend the patients at night also. Many public facilities lack "signal functions" required for safe vaginal births, including reliable electricity, quality water, and advanced medical equipment. Improving these allows public hospitals to manage labour complications effectively without immediate surgical intervention. Many public primary centres lack motorised ambulances and paved roads, leading to dangerous delays that necessitate emergency surgery. Equalising transport and connectivity infrastructure ensures timely access to standard obstetric care. Government should improve the health care system to minimize the caesarean rate in India. Government has to take steps to enhance health schemes in India. Government should introduce public health schemes which benefit the women. They should design schemes in such a way women should prefer public health care system. They can even provide financial incentives for women who are choosing public health care rather than private hospitals. This will eliminate the chance of unnecessary caesarean delivery.

REFERENCES

[1] Zadeh LA. Fuzzy sets. Information and Control. 2018; 8: 338-353. DOI: https://doi.org/10.1016/S00199958(65)90241-X
[2] Atanassov KT. Intuitionistic Fuzzy sets. Int. J. Bioautomation, 2016, 20(S1), S1-S6.
[3] Bhattacharya J. Some special operations and related results on Intuitionistic fuzzy sets. Interna-tional Journal of Scientific Research in Mathematical and Statistical Sciences. 2021; 8(4): 10-13. DOI: https://doi.org/10.26438/ijsrmss/v8i4.1013
[4] Bhattacharya J. Some results on certain properties of Intuitionistic fuzzy sets. Journal of Fuzzy Extension and Applications. 2021; 2(4): 377-387. DOI: https://doi.org/10.22105/jfea.2021.290202.1155
[5] Citil M, Tugrul F. Some new equalities on the intuitionistic fuzzy modal operators. Sakarya University

Journal of Science. 2018; 22(6): 1524-1531. DOI: https://doi.org/10.16984/saufenbilder.338899
[6] Ejegwa PA, Akowe SO, Otene PM, Ikyule JM. An overview on intuitionistic fuzzy sets. Int. Journal of Scientific and Technology Research. 2014; 3(3): 142-145.
[7] Eker E, Tagrul F, Citil M. New equalities on the intuitionistic fuzzy operators and operations. Notes on Intuitionistic Fuzzy Sets. 2015; 21(4): 124-128.
[8] Tarsuslu S, Citil M, Dimirbas E, Aydin M. Some modal operators with intuitionistic fuzzy sets. Notes on Intuitionistic Fuzzy Sets. 2017; 23(5): 20-28.
[9] Atanassov KT. Intuitionistic fuzzy sets. Fuzzy Sets and Systems. 1986; 20(1): 87-96. DOI: https://doi.org/10.1016/S0165-0114(86)80034-3
[10] Atanassov KT. New operations defined over Intuitionistic fuzzy sets. Fuzzy Sets and Systems. 1994; 61(2): 137-142. DOI: https://doi.org/10.1016/0165-0114(94)90229-1
[11] Atanassov KT. Type-1 fuzzy sets and intuitionistic fuzzy sets. Algorithms. 2017; 10(3): 106. DOI: https://doi.org/10.3390/a10030106
[12] Bhattacharya J. A few more on Intuitionistic fuzzy set. Journal of Fuzzy set Valued Analysis. 2016; 3: 214-222. DOI: https://doi:10.5899/2016/jfsva-00322
[13] Dencheva K. Extension of intuitionistic fuzzy modal operators ⊞and ⊠. Proceedings of the Second Int. IEEE Symposium: Intelligent Systems, Varna. 2004; (3): 21-22. DOI: http://dx.doi.org/10.1109/IS.2004.1344843
[14] Xia M, Xu Z. Some new similarity measures for intuitionistic fuzzy values and their application in group decision making. Journal of Systems Science and Systems Engineering. 2010; 19(4): 430-452. DOI: https://doi.org/10.1007/s11518-010-5151-9
[15] Ye J. Cosine similarity measures for intuitionistic fuzzy sets and their applications. Mathematical and Computer Modelling. 2011; 53(1-2): 91-97. DOI: https://doi.org/10.1016/j.mcm.2010.07.022.
[16] Sung S, Mikes BA, Martingano DJ, Mahdy H. Cesarean Delivery. In Treasure Island (FL): Stat Pearls Publishing; 2025. Available from: http://www.ncbi.nlm.nih.gov/books/NBK546707/
[17]Sandall J, Tribe RM, Avery L, Mola G, Visser GH, Homer CS, et al. Short-term and long-term effects of caesarean section on the health of women and children. The Lancet [Internet]. 2018 Oct 13;392(10155):1349–57. Available from: https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(18)31930-5/abstract
[18] World Health Organization D of RH, Research. WHO statement on caesarean section rates [Internet]. 2015. Available from: https://www.who.int/publications/i/item/WHO-RHR15.02
[19] Neethi Mohan V, Shirisha P, Vaidyanathan G, Muraleedharan VR. Variations in the prevalence of caesarean section deliveries in India between 2016 and 2021 - an analysis of TamilNadu and Chhattisgarh. BMC pregnancy and childbirth. 2023 Aug 30;23(1):622.
[20] Singh SK, Vishwakarma D, Sharma SK. Prevalence and determinants of voluntary caesarean deliveries and socioeconomic inequalities in India: Evidence from national family health survey (2015-16). Clinical Epidemiology and Global Health [Internet]. 2020 Jun1;8(2):335–42. Availablefrom: https://www.sciencedirect.com/science/article/pii/S2213398419303707
[21] Bhatia M, Banerjee K, Dixit P, Dwivedi LK. Assessment of variation in cesarean delivery rates between public and private health facilities in India from 2005 to 2016. JAMA Network Open [Internet]. 2020 Aug 28;3(8): e2015022. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7455857/
[22] Tripathy B, Jena A, Pandey AK, Mishra SS, Mishra C. Caesarean Section Delivery in India: A Comparative Assessment of Geographical Variability Using Nationally Representative Survey Factsheet Data. National Journal of Community Medicine [Internet]. 2023 Apr 1;14(04):260–6. Available from: https://njcmindia.com/index.php/file/article/view/2650.
[23] Guilmoto CZ, Dumont A. Trends, Regional Variations, and Socioeconomic Disparities in Cesarean Births in India, 2010-2016. JAMA Network Open [Internet]. 2019 Mar [cited 2025 Mar 25];2(3): e190526. Available

from: https://doi.org/10.1001/jamanetworkopen.2019.0526
[24] Pandey AK, Raushan MR, Gautam D, Neogi SB. Alarming Trends of Cesarean Section—Time to Rethink: Evidence from a Large-Scale Cross-sectional Sample Survey in India. Journal of Medical Internet Research [Internet]. 2023 Feb [cited 2025Mar 25];25(1):e41892. Available from: https://www.jmir.org/2023/1/e41892
[25] Sahoo H, Jeermison RK. Repeated caesarean section delivery in India. Children and Youth Services Review [Internet]. 2020 Sep 1; 116:105258. Available from: https://www.sciencedirect.com/science/article/pii/S0190740920308513