



Construction of a Maternal and Child Health Care Service System in an Intelligent Healthcare Environment and Data Analysis Optimisation

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SUMMARY: *This study investigates the construction and performance of China's Maternal and Child Health (MCH) service system within an intelligent healthcare environment, with particular emphasis on data integration and system optimisation. Using nationally published secondary statistical data from 2019 to 2024, the study evaluates how digital transformation in healthcare has contributed to improvements in MCH outcomes. The findings demonstrate that China has realised enduring advantages from the comprehensive implementation of intelligent healthcare systems and data-driven service management. Key outcome indicators, including maternal mortality, infant mortality, and under-five mortality rates, have been exhibiting a consistent and steady decline over the six-year study period. The findings further reveal that the establishment of comprehensive digital health records covering pregnancies and prenatal care has enhanced access to telemedicine services, remote foetal monitoring, and integrated risk-screening mechanisms. These digital infrastructures have strengthened continuity of care by enabling improved follow-up, more efficient referral pathways, and coordinated service delivery across healthcare institutions. In addition, the digitalisation of healthcare records has reinforced emergency response capacity, contributing to a persistent reduction in maternal and neonatal mortality. Overall, the study demonstrates that the MCH service system in China has significantly benefited from the application of digital technologies, particularly through enhanced data availability that supports more effective surveillance of maternal complications and neonatal conditions. Although disparities between urban and rural areas in MCH service provision remain, trend analysis shows a continuous narrowing of these gaps over time. This indicates progressive improvement in equity-orientated MCH services and underscores the role of intelligent healthcare systems in promoting balanced and sustainable maternal and child health development nationwide.*

KEYWORDS: *Maternal and Child Health (MCH); Intelligent Healthcare Systems; Digital Health Records; Health Data Integration; Maternal Mortality*

1 Introduction

Maternal and child health (MCH) is the foundation of public health, as the overall wellbeing of a family and ultimately the community and entire nation rests on the health of mothers and children [1]. Policymakers at the national and international level pay particular attention to MCH, as not only does the overall life expectancy in a particular country depend on MCH, but also the overall socioeconomic development, human capital formation, and the success of

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poverty reduction in a community significantly depend on MCH [2]. There are different indicators that have been devised that give a quick viewpoint regarding MCH and ultimately health system and equity analysis, which include maternal mortality ratio, neonatal mortality rate, infant mortality rate, under-five mortality rate and low birthweight prevalence. These different statistics are monitored with the aim to reduce preventable deaths and disabilities and make tangible improvements that are essential for the better realisation of sustainable development goals [3].

In most parts of the world, MCH systems are devised using conventional thinking that lacks intelligent insight and proactive strategies to overcome maternal and neonatal mortality. The traditional MCH care systems that could be found in countries like China are not only characterised by structural and operational barriers, but also the MCH services are fragmented in nature [4]. In particular, [5] are of the view that the traditional MCH system lacked effective and intelligent insight because of low interoperability. In most of the cases, the traditional system relied on paper-based records or digital systems that lacked effective integration. As significant information pertaining to MCH is missing, relevant stakeholders experienced significant difficulties in tracking mother and child health records, which not only affected planning and resource allocation but also meant that effective strategies regarding MCH were missed out on. In particular, [6] are of the view that in the traditional system, risks pertaining to MCH are not known until the later stage; thus, the entire MCH initiative takes a reactive form, and thus, preventive strategies pertaining to MCH are lacking.

The recent development and wider penetration of digital technologies, particularly rapid development in the form of intelligent healthcare technologies, are associated with significant development in terms of MCH [7]. In particular, Western countries have experienced significant improvement in terms of MCH through the use of telemedicine, electronic health records, artificial intelligence (AI), big data analytics, and mobile health platforms. These technologies could certainly help in overcoming many of the inefficiencies witnessed in the Chinese MCH, as such technologies could be leveraged for optimum MCH service delivery, particularly in the rural and countryside areas of the country [8-10] are of the view that a data intelligence-based healthcare system characterised by effective use of data could not only help in continuous monitoring of MCH, but also the system could be leveraged for automatic risk identification, remote consultation, and integrated services delivery. Thus, significant improvement in terms of MCH could be realised through early risk identifications in the pregnancies and preventive actions pertaining to prenatal and postnatal care.

Unlike other parts of the world, Chinese public health has not yet accessed the extended benefits of intelligence-based healthcare because of data silos, non-standard data format, insufficient analytical capabilities, and a fragmented healthcare system [11]. It is believed that the optimisation of data processing and better integration could significantly contribute to the realisation of wider benefits associated with the intelligence-based healthcare data that could be used for better planning and execution of strategies pertaining to MCH [12]. This research has been organised with the aim to construct and evaluate an MCH service system within an intelligent healthcare environment that could result from the analysis and optimisation of data analysis that contributes to improved MCH outcomes. The research thus not only analyses the association between intelligent healthcare integration and key MCH results but also analyses the impact of optimised data analysis capability on MCH service delivery efficiency and outcome improvement.

2 Materials and Methods

2.1 Research Design

For investigating the MCH service system within an intelligent healthcare environment that could result from the analysis and optimisation of data analysis, the research design adopted in the current research could be described as a retrospective quantitative observational design. The research analyses data pertaining to MCH in China from 2019 to 2024 to evaluate how MCH has benefited from the emergence of intelligent healthcare environment development in the country. The analysis conducted in the study is based on time-series analysis, whereas descriptive analysis and correlational analysis have been conducted to analyse how the MCH service system within an intelligent healthcare environment could result from the analysis and optimisation of data analysis pertaining to MCH in the country.

2.2 Study Population and Setting

The study regarding the MCH service system within an intelligent healthcare environment that could result from the analysis and optimisation of data analysis covered China, for which the population includes mothers, pregnant women, neonates, infants and children who are under five years of age. The data for the research concerned private and public healthcare, hospitals, maternity homes, health centres, and childcare services. The analysis has been conducted on the basis of aggregate data, rather than individual-level patient data. The investigation under review is based on time series analysis, whereas the analysis pertains to the period from 2019 to 2024. The five-year period has been selected for the study because in this period significant development in the form of digital healthcare service and technology application has been witnessed throughout the country. Additionally, the period has been selected because of the data availability, as credible data sources could have been easily accessed for the selected period.

2.3 Data Sources

The data sources utilised for analysing the MCH service system within an intelligent healthcare environment that could result from the analysis and optimisation of data analysis could be categorised as secondary data sources. Thus, credible official and authoritative data sources have been accessed for this research, which in turn could also add significant value to the validity and reliability of research. As diverse data sources have been accessed in the study, efforts within the research have been made to ensure data triangulation; thus, the data used has been confirmed from more than single sources. Some of the major data sources that have been used in this study include the China Health Statistics Yearbook, official hospital information system summaries, the National Maternal and Child Health Surveillance System, provincial and municipal health commission annual reports, and data compiled and published by the National Bureau of Statistics of China. Data pertaining to different variables have been collected and analysed, which include Maternal Mortality Ratio, Infant Mortality Ratio, Prenatal Care Coverage Ratio, Institutional Delivery Rate, and Under-Five Mortality Rate.

2.4 Data Analysis

For analysing the collected data pertaining to the MCH service system within an intelligent healthcare environment that could result from the analysis, there are different data analyses utilised in this study. This includes descriptive trend analysis, which has been calculated through mean, minimum, maximum and annual change values. Furthermore, linear trend regression analysis has been conducted in the study with the aim to analyse relations between

time and outcome indicators. For this purpose, a simple linear regression model has been utilised in this study. The analysis has been conducted using the following formula:

$$Y_t = \beta_0 + \beta_1 t + \epsilon_t$$

In the above formula, Y_t denotes health outcomes expressed in the form of Maternal Mortality Ratio, Infant Mortality Ratio, Prenatal Care Coverage Ratio, Institutional Delivery Rate, and Under-Five Mortality Rate. t denotes year, which in the present study may range from 2019 to 2024. β_1 denotes the slope coefficient, signifying annual changes, while ϵ_t denotes the error term.

3 Results

3.1 Key Maternal and Child Health Indicator

Statistics pertaining to China's maternal and child health for the period 2019 to 2024 have been summarised in the following Table 1:

Table 1: Key Maternal and Child Health Indicator [13,14]

Year	Maternal Mortality Ratio (Per 100,000)	Infant Mortality	Under-Five Mortality	Prenatal Care	Hospital Delivery
2019	17.8	5.6%	7.0%	98%	99.9%
2020	17.0	5.4%	6.8%	98.1%	99.9%
2021	16.5	5.2%	6.6%	98.1%	99.9%
2022	15.7	4.9%	6.3%	98.2%	99.9%
2023	15.1	4.5%	6.2%	98.2%	99.9%
2024	14.3	4.0%	5.6%	98.3%	99.9%

The above Table 1 provided a summary of the key MCH indicator in China from the period 2019 to 2024. Key factors analysed in Table 1 first include the maternal mortality ratio, which declined from 17.8 per 100,000 live births to 14.3 live births. This in turn means that in the six-year period, starting from 2019 and ending in 2024, a total of 3.5 deaths per 100,000 live births have been decreased. This in turn indicates significant improvement in maternal safety and better obstetric care opportunities emerging with the passage of time. However, irrespective of the more consistent trends witnessed, disparities could still be witnessed in the urban and rural areas of the country. Unlike the urban areas, the rural areas of the country are still lacking the desired maternal care infrastructure. A better viewpoint regarding this could be developed on the basis of Figure 1, which indicates the maternal mortality rate in 2024 by residence.

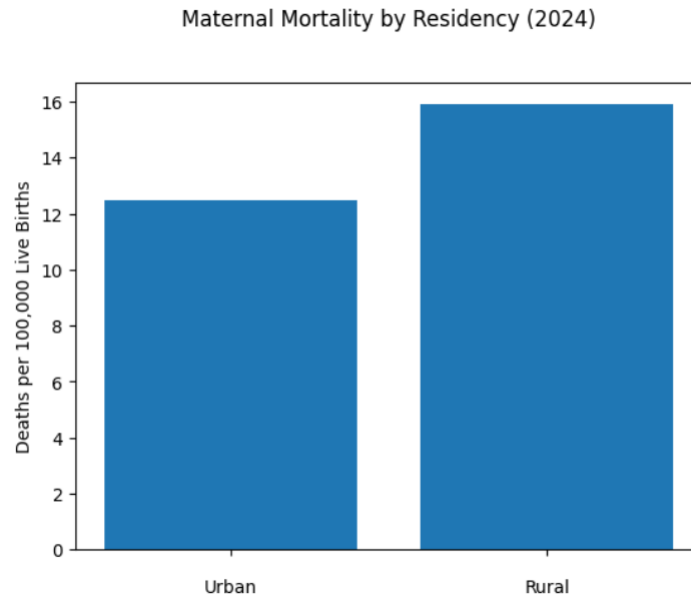


Figure 1: Maternal Mortality by Region 2024 [15]

Furthermore, the infant mortality rate in the country has decreased from 5.6 in 2019 to 4.0 deaths per 1,000 live births in 2024. Although a consistent decline in the infant mortality rate has been witnessed, the analysis in this regard indicates that the largest drop has been witnessed in the year 2021. The year corresponds with significant strength in neonatal care and a digital follow-up system introduced throughout the country.

Another key benchmark that has been analysed in Table 1 is under-five mortality rate, which has been showing significant declining trends. The rate that was once 7.0 has dropped down to 5.6, indicating significant improvement and development in terms of immunisation, early detection of childhood illnesses, and nutritional management that could not have been possible in the absence of better healthcare technologies and data-based intelligence systems leveraged in the Chinese healthcare industry.

Additionally, Table 1 also reflects prenatal care coverage, which has remained about 98% throughout the six-year period. The slight improvement witnessed in the figure indicates better access supported through the use of virtual and online healthcare facilities, particularly the tele-consultations, now accessed throughout the country.

The last column of Table 1 indicates hospital delivery coverage, which has remained almost 99.9% throughout the last six years. The figures in turn indicate a better and more mature maternal healthcare infrastructure throughout the country.

3.2 Descriptive Statistical Analysis of Maternal and Child Health Indicators

From the analysis of Table 2, which exhibits descriptive statistics regarding key dynamics concerning MCH, one could find out that mortality has been showing declining trends; however, the variation in this regard is significantly lower in nature. As the standard deviation varies in the range of 0.5 to 1.26, the low degree of smaller standard deviation in turn also confirmed lesser variation between different variables during the six years analysed in this study. Nevertheless, as per the changes from 2019 to 2024, one could see that the stable and steady improvement could be witnessed in the range of different benchmarks analysed in Table 2. The largest annual improvement has been however witnessed in the case of maternal mortality rate,

which decreased by 3.50 per 100,000 live births. Furthermore, from the analysis of the coverage ratio, one could see that the penetration of MCH centres in the China has significantly increased and full coverage could be witnessed throughout the country. About 99.91% of the hospitals have delivery facilities, while 98.18% of the centres have prenatal care coverage. These key benchmarks discovered in this study in turn indicate not only high availability of MCH-related services, but also equitable access and better enforcement of the Chinese government's health policies throughout the country. Additionally, the high degree of coverage of the MCH centres and the falling mortality rate indicate that the country has certainly benefited from the use of digital healthcare technologies. In particular, optimisation of healthcare facilities and efficiency could be witnessed in the Chinese healthcare industry.

Table 2: Descriptive Statistical Analysis of Maternal and Child Health Indicators

Description	Min	Max	Mean	Standard Deviation	Change 2019 - 2024
Maternal Mortality Ratio	14.3	17.8	16.07	1.26	-3.50
Infant Mortality Rate	4.0	5.6	5.10	0.57	-1.60
Under-Five Mortality Rate	5.6	7.0	6.42	0.50	-1.40
Prenatal Care Coverage	98.0	98.3	98.18	0.11	+0.30
Hospital Delivery Coverage	99.9	99.95	99.91	0.02	+0.05

3.3 Linear Regression Results for Indicator 2019-2024

The linear regression results for the six-year period starting from 2019 to 2024 have been summarised in the following Table 3:

Table 3: Linear Regression Results

Indicator	Slope (Annual Change)	Intercept	R ²
Maternal Mortality Ratio	-0.6857	17.781	0.997
Infant Mortality Rate	-0.3143	5.719	0.964
Under-Five Mortality Rate	-0.260	7.068	0.948
Prenatal Care Coverage	+0.0543	98.014	0.938
Hospital Delivery Coverage	+0.007	99.891	0.429

From the analysis of Table 3, one could see that the maternal mortality rate has shown a significant decline, as the MMR slope is -0.6857, in turn indicating a decrease of approximately 0.69 per year during the six-year period. Furthermore, other key benchmarks analysed in Table 3 also show similar trends, as the infant mortality rate has showed downward trend of -0.3143, under-five mortality has shown a slope of -0.2600, and the R² value is above 0.94, showing greater consistency and linear trends during the six-year review period. Contrary to these trends, in the coverage trends analysed in this study, positive upward movement could be witnessed during the six-year period. In this regard, the prenatal coverage slope has shown +0.0543, and the hospital delivery slope is 0.071. The R² for prenatal coverage is significantly high, which in turn indicates stable and sustainable improvement. On the other hand, the low degree of R² for hospital coverage, which has been recorded as 0.429, indicates a suturing ceiling effect, as greater healthcare facilities could now be accessed throughout the country.

4 Discussions

4.1 Maternal and Child Health Trends in China

From the analysis of the results presented and analysed in the previous section, one could see that China has been reaping the benefits of data optimisation and the establishment of intelligent healthcare systems throughout the country. The results demonstrated in the form of maternal mortality, infant mortality and under-five mortality rate have been showing consistent and steady improvement over the six-year period starting from 2019 to 2024. The results showed that not only has a continuous reduction in the maternal mortality rate been witnessed throughout the country, but also infant mortality and under-five mortality have been consistently declining. On the other hand, the results also demonstrate significantly higher coverage for maternity centres and prenatal care centres throughout the country, which have been translating into institutional delivery.

Although some disparities have been found in the urban and rural areas of the country, the gaps and differences in the form of unequal access to MCH facilities have been constantly decreasing and narrowing down with the passage of time. The findings of the current study in this regard are in line with the findings of [16] and [17], who have also found the emergence of digital healthcare technologies as the key factors contributing to better MCH facilities in the country.

4.2 Impact of Data Optimisation and Intelligent Healthcare System Construction

From the results presented in this study, the intelligent healthcare system that has been constructed in China has been contributing to better healthcare facilities and a decrease in the number of maternal and prenatal deaths. The Chinese healthcare industry has developed digital records of all pregnancies and prenatal children in the country, which in turn has been helping in the better access of telemedicine, remote foetal monitoring, and integrated risk screening. The results of such a digital healthcare system and database system have been emerging in the form of enhanced continuity of care, as better follow-up and improved referrals could have been witnessed throughout the country. Moreover, as the healthcare record in the country has now been digitalised, this has strengthened emergency response capacity, in turn leading to a persistent decline in the maternity and neonatal death rates. In particular, the use of smart triage systems, teleconsultation, and access to specialists and specialist facilities during obstetric emergencies have been helping in reducing the preventable maternal and neonatal deaths and have certainly contributed to the improved MCH quality of care in China. Additionally, as advanced digital healthcare technologies and monitoring processes are utilised in the country these days, this in turn has been contributing to earlier identification of high-risk cases in the country, which is subsequently given priority-based interventions and referrals to higher-level facilities that have certainly contributed to the declining mortality rate in the country.

4.3 Impact of Data Analysis and Optimisation

The study clearly indicates that MCH has significantly benefited from the use of digital technologies, particularly the availability of data that has led to improved surveillance of maternal complications and neonatal conditions. As timely decisions could now be made, particularly in the case of high-risk pregnancies, the availability and use of data and intelligence in this regard could be termed as the key factor that has contributed to the betterment of MCH in the country. In particular, it could be argued that through the use of digital technologies, real-

time monitoring and service utilisation could now be ensured throughout the country, which has been leading to a consistent decline in the maternity-related mortalities and neonatal mortality rates in the country.

Furthermore, better resource allocation has been ensured throughout the country, as the high-risk population and region of the country have now been receiving greater human, financial, information and technological resources that have been resulting in a consistent decline in the number of casualties and deaths recorded in the country. Moreover, as the policymakers in the country could get the results of the decisions that they made concerning MCH, the availability of data and feedback loops has been allowing rapid and effective changes in MCH-related policies. As a result, more effective MCH policies are formed that are based on real data and changing trends, enabling the policymakers to make better decisions that suit the unique needs of different regions. The findings of the current study in this regard align with the findings of [18], who have also found that better data accumulation and analysis, resulting from the use of digital technologies, have been contributing to better healthcare decisions.

4.4 Urban-Rural Disparities

Although the study discovered that there are still some disparities between the urban and rural areas of China in terms of MCH facilities, the analysis of trends in this regard reveals a consistent decline in gaps between the urban and rural areas of the country. This in turn means that the gaps between the rural and urban areas of the country in terms of MCH are closing down with the passage of time, and equity-based services could be witnessed throughout the country. The gaps that have been witnessed in the country could be attributed to the lesser attractiveness of the rural areas of the country for the top-ranked obstetric and neonatal specialists; besides, the lack of solid infrastructure facilities, lower health literacy, and the lack of digital infrastructure have contributed to such disparities in the rural areas of the country. However, with the passage of time, gaps found in the rural areas have been closing as telemedicine and teleconsultation opportunities are largely leveraged these days in the rural areas. Besides remote diagnosis technology, foetal heart rate monitoring, and the establishment of mobile health units in the rural areas of China, they have contributed to the betterment of MCH facilities in the rural areas.

5 Conclusion

This study examined the construction and evaluation of the MCH service system within an intelligent healthcare environment, resulting from the analysis and optimisation of data analysis that contributes to improved MCH outcomes. The findings of the study are based on the secondary data for which Chinese national-level statistics have been analysed from the period 2019 to 2024. From the analysis of the results, it is clear that China has been reaping the benefits of data optimisation and the establishment of an intelligent healthcare system throughout the country. The results demonstrated in the form of maternal mortality, infant mortality and under-five mortality rate have been showing consistent and steady improvement over the six-year period starting from 2019 to 2024. It has been found that the Chinese healthcare industry has developed a digital record of all pregnancies and prenatal children in the country, which in turn has been helping in the better access of telemedicine, remote foetal monitoring, and integrated risk screening. The results of such a digital healthcare system and database system have been emerging in the form of enhanced continuity of care, as better follow-up and improved referrals could have been witnessed throughout the country. Moreover, as the healthcare record in the country has now been digitalised, this has strengthened emergency response capacity, in turn

leading to a persistent decline in the maternity and neonatal death rates. The study clearly indicates that MCH has significantly benefited from the use of digital technologies, particularly the availability of data that has led to improved surveillance of maternal complications and neonatal conditions. Additionally, although the study discovered that there are still some disparities between the urban and rural areas of China in terms of MCH facilities, the analysis of trends in this regard reveals a consistent decline in gaps between the urban and rural areas of the country. This in turn means that the gaps between the rural and urban areas of the country in terms of MCH are closing down with the passage of time, and equity-based services could be witnessed throughout the country.

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