Examination of infant deaths occurring in Yozgat province during the COVID-19 pandemic and before (2014-2022)

COVID-19 pandemisi sırasında ve öncesinde (2014-2022) Yozgat ilinde meydana gelen bebek ölümlerinin incelenmesi

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doi.org/10.35232/estudamhsd.1777705

ESTUDAM Public Health Journal. 2026;11(1):41-54

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***Geliş Tarihi / Received:** 03.10.2025*

***Kabul Tarihi / Accepted:** 12.01.2026*

Abstract

Infant mortality is a critical indicator of the health system and social well-being. This study aimed to examine the characteristics and any changes of infant deaths in Yozgat province, during the COVID-19 pandemic compared with the preceding years. Yozgat Province Infant Mortality Commission data were examined in detail through a standardized data collection form. The limit of statistical significance was accepted as (alpha) 0.05. When the number of infant deaths during the COVID-19 pandemic period was evaluated by corresponding values of the pre-pandemic years, no statistically significant association was found with infants' gender, birth week, birth weight, mothers' method of conception, delivery method, pregnancy follow-up and the gestational month of infant's death. The proportion of pregnant women with adequate pregnancy follow-up (i.e., 4 and above) increased compared to the pre-COVID-19 period and this increase was statistically significant (p = 0.036). It is noteworthy that the number of applications for possible risky pregnancies could have increased during the pandemic period, considering the impact of COVID-19 on health care services. Thus, it was valuable to interpret infant deaths in Yozgat province by comparing them with the previous 6 years, instead of examining them only during the pandemic period, with regards to possible changes, and examining their causes. Examining the national and provincial infant mortality indices from this perspective, with comparisons, would be a valuable practice in terms of consistency or heterogeneity of findings for better preparation against future pandemic-related service delivery planning.

Keywords: Infant deaths, COVID-19, pandemic

Özet

Bebek ölümleri, sağlık sistemi ve toplumsal refahın en önemli göstergelerinden biridir. Bu çalışma, Yozgat ilinde COVID-19 pandemisi döneminde meydana gelen bebek ölümlerinin özelliklerini ve önceki yıllarla karşılaştırıldığında olası değişikliklerini incelemeyi amaçlamaktadır. Yozgat İl Bebek Ölümleri Komisyonu verileri, standartlaştırılmış veri toplama formu aracılığıyla ayrıntılı olarak incelenmiştir. İstatistiksel anlamlılık düzeyi alfa=0,05 olarak kabul edilmiştir. Pandemi dönemindeki bebek ölümleri, önceki yıllarla karşılaştırıldığında; bebeğin cinsiyeti, doğum haftası, doğum ağırlığı, annenin gebeliği elde etme yöntemi, doğum şekli, gebelik takibi ve ölümün gerçekleştiği gebelik ayı açısından istatistiksel olarak anlamlı bir fark göstermemiştir. Ancak, yeterli gebelik takibine (≥4 izlem) sahip gebelerin oranı pandemi öncesi döneme göre artmış ve bu artış istatistiksel olarak anlamlı bulunmuştur (p=0,036). Bu bulgu, COVID-19'un sağlık hizmetlerine etkisi dikkate alındığında, riskli gebelik başvurularının da artmış olabileceğini düşündürmektedir. Bebek ölümlerinin yalnızca pandemi dönemi özelinde değil, önceki altı yıl ile karşılaştırmalı olarak incelenmesi olası değişikliklerin ve nedenlerinin daha sağlıklı değerlendirilmesine olanak sağlamıştır. Ulusal ve il düzeyindeki bebek ölümleri göstergelerinin bu bakış açısıyla değerlendirilmesi, bulgular arasındaki tutarlılık veya farklılıkların ortaya konması açısından önem taşımakta ve gelecekte olası pandemi koşullarında sağlık hizmeti planlamalarına katkı sunabilecek niteliktedir.

Anahtar Kelimeler: Bebek ölümü, COVID-19, pandemi

Introduction

The infant mortality rate (IMR) is a valuable criterion for comparing the level of development and progress in health between and within countries, besides its vital role as an indicator of infant and women's health (1). According to the Turkish Statistical Institute (TSI) statistics, the infant mortality rate in Türkiye was 13.9 per thousand in 2009, decreasing down to 9.2 per thousand in 2021 (2). The decrease in rates could be affected by the changes in parents' desire for a baby as well as improvements in maternal health, pregnancy care and infancy follow-up (3). Negative changes in IMRs might have been expected as a result of many factors that directly or indirectly affect health, including difficulties and delays in accessing health care services, difficulties in periodic care and follow-up of expectant mothers, increase in socioeconomic difficulties and disruptions/delays in infancy follow-up and vaccinations, apart from maternal or infant deaths directly caused by COVID-19 infection, during the pandemic period.

Children are among the most vulnerable groups in disasters and it is important to monitor the health of this highly vulnerable group in a large-scale phenomenon, such as a pandemic, which negatively affects society socially, spiritually and economically, as well as physically. In addition to pregnancy and birth, the pandemic has been a very important impact to the growth of children (4, 5). In a study discussing the effects of the COVID-19 epidemic on healthcare systems, a three-fold increase in newborn and maternal deaths compared to previous years was detected due to the disruptions experienced in the pandemic (6). Another study based in Latin America also pointed out that infant deaths increased significantly during the pandemic compared to the pre-COVID-19 period (7).

Although there is no fully effective treatment for COVID-19, pandemic-related infant deaths are considered preventable through non-pharmacological measures and parental vaccination (8). Masks, distancing, and hygiene strengthened protection, while vaccines, widely used with emergency approvals, reduced the severity of COVID-19. Since January 2021, Türkiye's Ministry of Health and medical associations have recommended vaccination for those planning pregnancy, pregnant women, and breastfeeding mothers. After June 2021, expectant mothers received free COVID-19 vaccines (9). Pregnant women face higher risks from COVID-19, particularly with gestational diabetes, and may transmit the virus to babies during birth and breastfeeding. Anti-SARS-CoV-2 antibodies from vaccinated or infected mothers can pass to babies and offer protection. The pandemic also worsened underlying health problems and impacted healthcare access for babies (8, 10).

Since the distribution of COVID-19 cases and related deaths by age groups cannot be officially reached in our country, a national number/rate regarding how much babies under 365 days of age are affected by the COVID-19 pandemic is unknown. Similarly, the burden of accompanying health problems and deaths (i.e., collateral deaths) in infancy cannot be predicted. In this research, specifically for Yozgat province, it is aimed to investigate:

1. the change in the infant mortality rate over the years,
2. the number of infant deaths during and before the COVID-19 pandemic, with further evaluation of the potential risk factors,
3. the possible relationships between

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Nasıl Atıf Yaparım / How to Cite:
Kara ŞA, Erik HE, Çakır B. Examination of infant deaths occurring in Yozgat province during the COVID-19 pandemic and before (2014-2022). ESTUDAM Public Health Journal. 2026;11(1):41-54

mothers' COVID-19 vaccination status and some variables related to the baby and the mother,

4. the factors that may affect the time of infant death, when detected.

Material and Method

In this descriptive study, we examined certain factors related to infant deaths occurring within the borders of Yozgat province between 2014 and 2022, and compared them across the timeline with respect to March 11, 2020 (the official onset of COVID-19 infection in the country). Data on infant deaths were obtained through Yozgat Provincial Health Directorate's Infant Death Commission Forms and Death Notification System, whilst the data on the number of live births for relevant years were obtained from the TSI website (11). No sample was selected and all babies who were registered in this time period as examined by a family doctor, resided in Yozgat, and were born alive were included in the study population.

The population of Yozgat city center is 484,206 as of 2023 (12). It consists of 14 districts in total (13).

With the data obtained, annual infant mortality rate, neonatal mortality rate, early neonatal, late neonatal and post neonatal mortality rates for Yozgat province were calculated according to the formulas below, and their relationship with some characteristics of the mother and the baby was further investigated (14).

Babies with a gestational age between 37 weeks and 41 weeks are considered as "*term*" (on time); babies who are 42 weeks and above are called "*post-term*"; mid and late "*pre-term*" between 32 weeks and 36 weeks; "*early pre-term*" between 28 weeks and 31 weeks; 28 weeks and below is considered as "*very early pre-term*" birth (15). Babies whose weight at birth is over 4500 grams are considered as "*high-*"; those between 2500g and 4500g as a "*normal-*" birth weight; and those weighing less than 2500 grams were defined as "*low-*" birth weight babies. Babies weighing between 1499 and 1000 grams at birth are considered "*very low-*" birth weight, and those weighing less than 1000 grams were considered to have "*extremely low-*" birth weight (16). Pregnant women who were examined at any health institution at least four times during pregnancy were considered as "*sufficient follow-up*" (17).

Infant deaths were evaluated across two time periods, as before and during COVID-19, with reference to the date of March 11, 2020 (18). Accordingly, the two periods were set as:

- During the COVID-19 pandemic: Between March 11, 2020 and December 31, 2022 (pandemic period, through the end of data collection)
- Before the COVID-19 pandemic: Between June 18, 2017 and March 10, 2020 (comparison period)

The study protocol was approved by the Non-Interventional Clinical Research Ethics Committee of Hacettepe University (Date: 16.12.2022, Approval number: GO 22/997), and written permission was also obtained from the Yozgat Provincial Health Directorate.

Normal distribution tests were performed for continuous variables, and continuous variables that did not comply with normal distribution were divided into quartiles in further analysis. For categorical variables, differences between groups were evaluated with Chi-Square test and Fisher Exact test. Alpha was set at 0.05, for statistical significance. "Statistics Package for Social Sciences" (SPSS 24.0) statistical package program and Microsoft Excel were used for data entry and statistical analyses.

Results

A total of 358 infant deaths were detected in Yozgat between 2014 and 2022. Of those, 54.2% were males, 57.7% had low birth weights, 56.1% were preterm, and 64.3% were born via cesarean section. Of all births, 66.9% of births took place in public hospitals, so as the 47.4% of all deaths detected. It is the first pregnancy for 30.1% of the mothers studied and 85.2% of them have a single fetus in their pregnancy. 13.8% of babies have parents who are relatives. 7.1% of babies have blood incompatibility. (Supplementary Table 1-2).

A statistically significant relationship was found between the period when the baby died and the mother's number of pregnancies; 38.3% of the infants who died in the early neonatal period were seen to be the first pregnancy (p=0.021). Of all

infants studied. 73.9% of preterm. and 75.4% of low-birth-weight infants died in the early neonatal period (p<0.001). Mother of the 24.6% of the infants who died in the early neonatal period had insufficient follow-up during gestation (p=0.033) (Table 1).

Table 1: Distribution of some characteristics of the baby, mother and birth according to the time of death of the infants

Characteristics	Early neonatal n (%)	Late neonatal n (%)	Post-neonatal n (%)	Total n (%)	p-value*
Infant's gender (n=358)					
Female	62 (43.7)	37 (42.5)	65 (50.4)	164 (45.8)	0.421
Male	80 (56.3)	50 (57.5)	64 (49.6)	194 (54.2)	
Mother's age (n=358)					
34 years and younger	117 (82.4)	73 (83.9)	113 (87.6)	303 (84.6)	0.483
35 years and older	25 (17.6)	14 (16.1)	16 (12.4)	55 (15.4)	
First pregnancy (n=356)					
Yes	54 (38.3)	23 (26.4)	30 (23.4)	107 (30.1)	**0.021**
No	87 (61.7)	64 (73.6)	98 (76.6)	249 (69.9)	
Week of birth (n=358)					
<37	105 (73.9)	49 (56.3)	47 (36.4)	201 (56.1)	**<0.001**
≥37	37 (26.1)	38 (43.7)	82 (63.6)	157 (43.9)	
Weight of birth (n=358)					
<2500 gram	107 (75.4)	54 (62.1)	46 (35.7)	207 (57.8)	**<0.001**
≥2500 gram	35 (24.6)	33 (37.9)	83 (64.3)	151 (42.2)	
Pregnancy follow-up (n=358)					
4 and more	107 (75.4)	76 (87.4)	110 (85.3)	293 (81.8)	**0.033**
3 and less	35 (24.6)	11 (12.6)	19 (14.7)	65 (18.2)	

**Chi-square p-value is presented. Since the children included in the sample are considered based on deaths and the distribution of the relevant characteristics in the society is unknown, the percentages in the table are taken from the total column.*

When the number of infant deaths during the COVID-19 pandemic period was compared with that before, distributions were not statistically significant across babies' gender, birth week, birth weight, method of conception, delivery method, pregnancy follow-up and/or the time of infant death.

The percentage of pregnant women with sufficient follow-up (i.e., 4 and above) increased compared to the pre-COVID-19 period, and this increase was found to be statistically significant (p=0.036, Table 2).

Table 2: Distribution of infant death characteristics during the COVID-19 pandemic and before

Characteristics	During COVID-19 (18.06.2017- 10.03.2020) n (%)	Pandemic period (11.03.2020- 31.12.2022) n (%)	p-value*
Infant's gender			
Female	39 (39.4)	49 (45.4)	0.385
Male	60 (60.6)	59 (54.6)	
Birth week			
Term	53 (53.5)	68 (63.0)	0.169
Preterm	46 (46.5)	40 (37.0)	

Birth weight			
Normal birth weight	42 (42.4)	42 (38.9)	0.605
Low birth weight	57 (57.6)	66 (61.1)	
Delivery method			
Normal vaginal route	29 (29.6)	37 (34.6)	0.445
Cesarean section	69 (70.4)	70 (65.4)	
Pregnancy method			
Normal, physiological	89 (89.9)	100 (93.5)	0.354
In-vitro fertilization	10 (10.1)	7 (6.5)	
Pregnancy follow-up			
4 and more	81 (81.8)	99 (91.7)	**0.036**
3 and less	18 (18.2)	9 (8.3)	
Time of death (period)			
Early neonatal	40 (40.4)	45 (41.7)	0.942
Late neonatal	24 (24.2)	24 (22.2)	
Postnatal	35 (35.4)	39 (36.1)	

**Pearson Chi-square test, Column percentage taken.*

Regardless of the cause of deaths, when the distribution of infant deaths during the pandemic period was examined according to the mother's COVID-19 vaccination status, no statistically significant relationship was found with the baby's gestational age, birth weight, pregnancy follow-up and the timing of death (Supplementary Table 3).

When the pandemic process is evaluated, it is seen that the infant mortality rate, which was 8.47 per thousand in 2020, 7.33 per thousand in 2021 and 9.01 per thousand in 2022. In 2022, which includes the pandemic period, the infant mortality rate in the neonatal period (6.24 per thousand), the infant mortality rate in the early neonatal period (3.7 per thousand), and the infant mortality rate in the late neonatal period (2.54 per thousand) increased compared to the previous year (Figure 1).

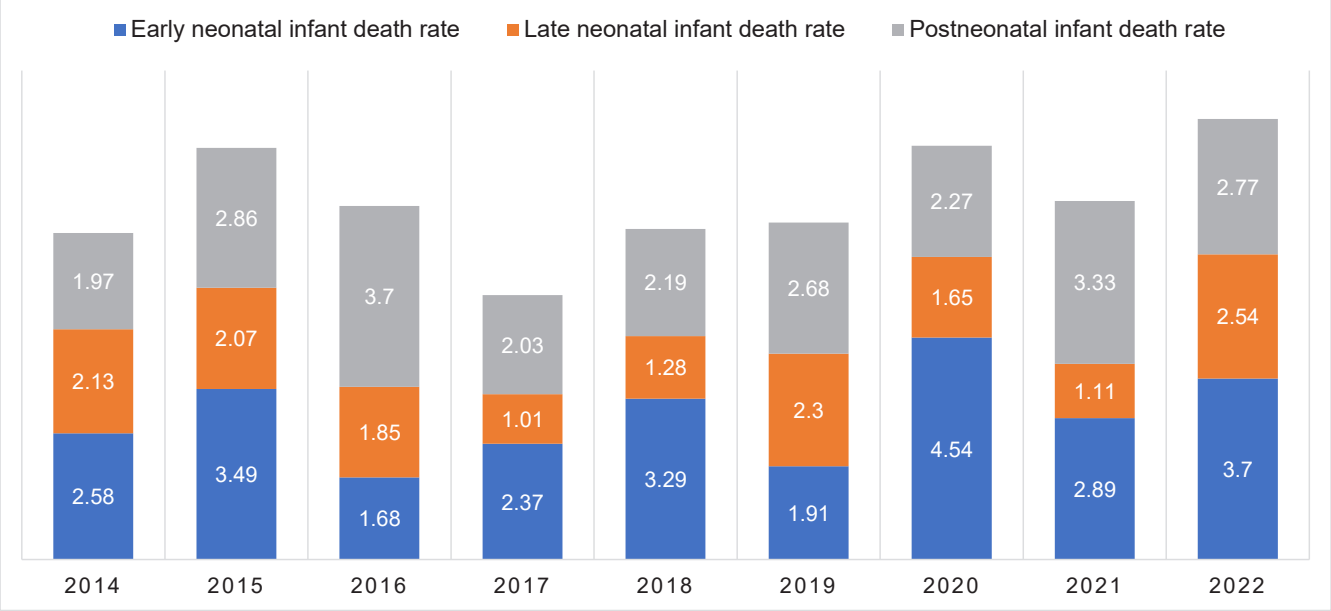

Figure 1: Distribution of infant mortality rates in Yozgat province by years (2014-2022)

While the infant mortality rate in Yozgat province was 6.7 per thousand in 2014, it was 9.0 per thousand in 2022. According to TSI data, the infant mortality rate in Yozgat province was 10.2 per thousand in 2014, and 9.6 per thousand in 2022. IMRs of Yozgat province was below the Türkiye average in 2020 and 2022 (Figure 2).

When the causes of infant death between 2014-2022 in Yozgat province are examined, infections were the leading cause of infant deaths (20.7%) (Figure 3).

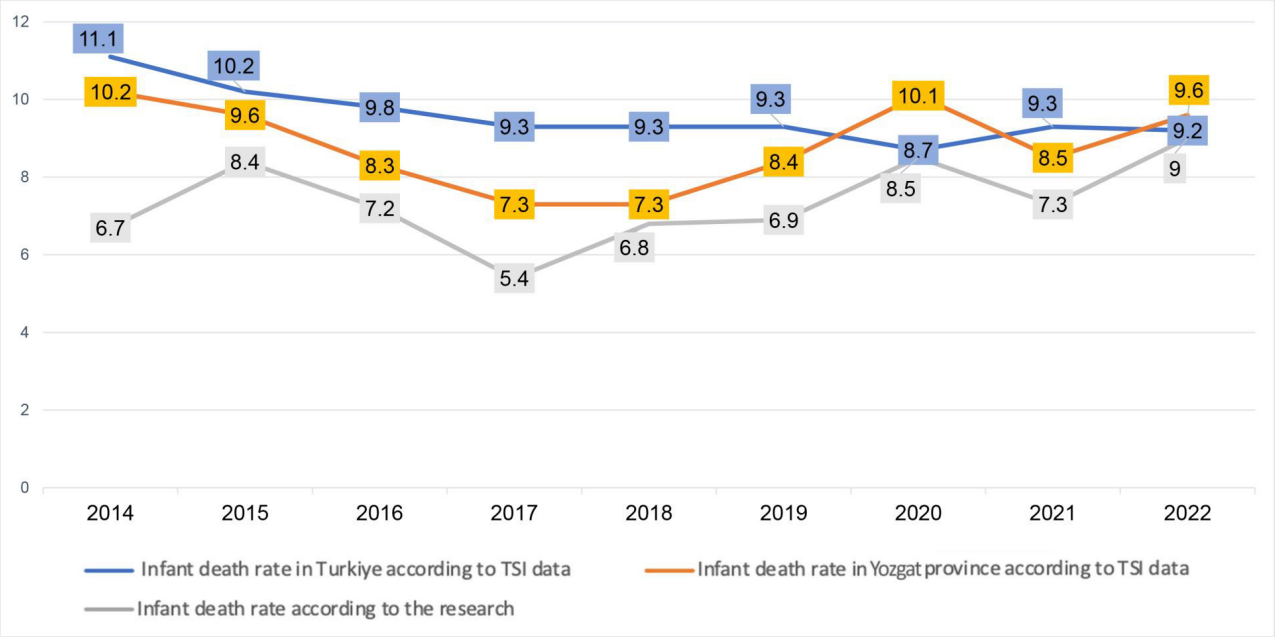

Figure 2: The change in the infant mortality rate according to the research and the infant mortality rate in Türkiye and Yozgat province based on TSI statistics for years 2014 through 2022

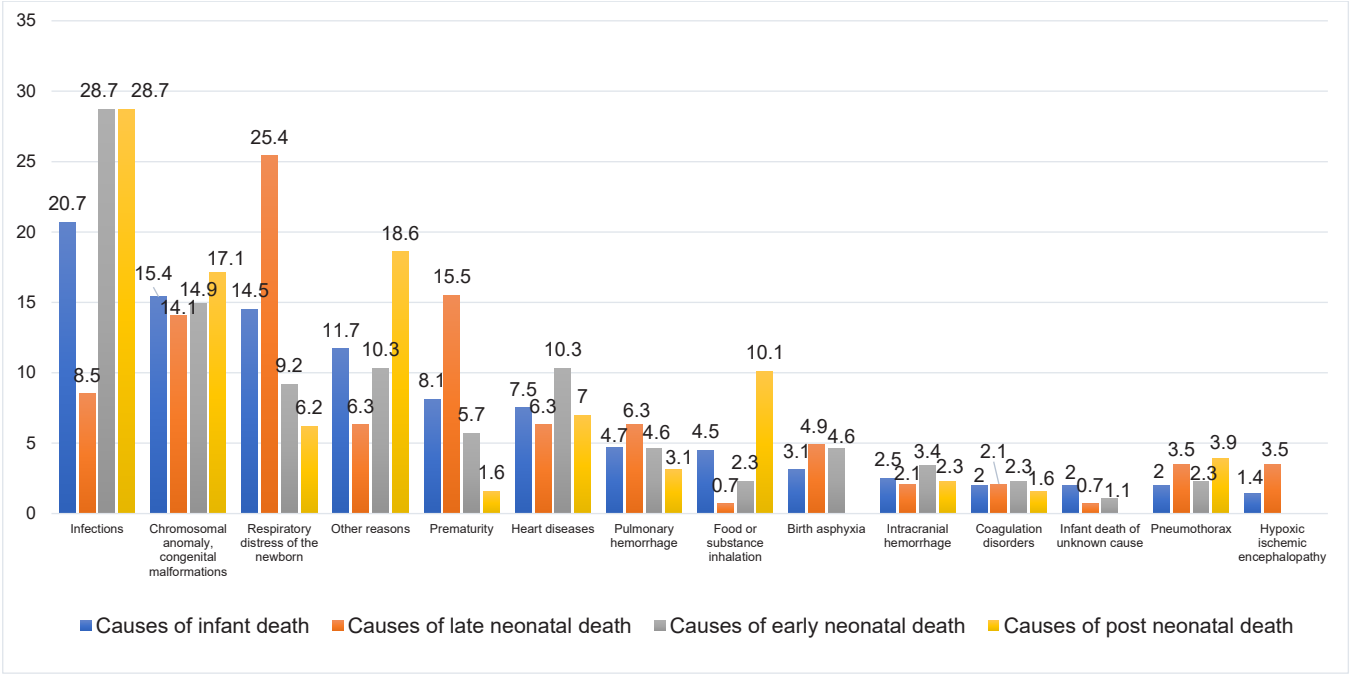

Figure 3: Reasons of infant deaths 2014-2022, Yozgat

Discussion

Of the infant deaths recorded in Yozgat province between the years 2014 and 2022, infant mortality was higher among male infants (54.2%), those with low birth w eight (57.7%), preterm births (56.1%), infants born to mothers under 35 years of age (84.6%), and those born after the first pregnancy (69.9%).

Findings of a similar study on infant deaths occurring between 2013 and 2020 in Sivas province, also revealed higher risk among male infants (54.4%), births weighing less than 2500 grams (61.3%), births under 37 weeks (62.4%), infants of mothers younger than 35 years old (81.1%), and in second and third pregnancies of the mothers (42.3%) (19). This similarity in the order and size of detected risk factors associated with infant deaths did not change during the COVID-19 pandemic.

In our study, 64.0% of infant deaths occurred in the neonatal period and 62% of neonatal deaths occurred in the early neonatal period. In a study conducted in Bursa in 2019, 51% of infant deaths occurred in the early neonatal period (20). Early neonatal infant death was reported as 48% in a study conducted in Düzce province (2014-2017), while late neonatal infant death rate was 22.6% (21). These findings are in line with the World Health Organization report that the majority of infant deaths (75%) occur in the neonatal period, this proportion increases as the development status of the country/region increases. Infant deaths during the neonatal period are not only caused by lack of quality care at the time of birth or in the early period after birth, but also related to congenital anomalies and negative health conditions of the mother during pregnancy. That is, neonatal deaths are not only an important indicator of the baby's health, but also point at the negativities in the mother's health.

Although hospital and outpatient services were generally restricted during the COVID-19 pandemic, our findings indicate that the proportion of mothers with adequate pregnancy follow-up (≥4 visits) among infants who died was higher in the pandemic period. This observation should not be interpreted as an overall improvement in prenatal care during the pandemic. Rather, it may reflect a shift in service delivery, with greater attention being directed toward pregnancies considered to be high-risk under pandemic conditions. In this context, physicians may have monitored such pregnancies more closely because of the uncertainties surrounding COVID-19 infection during pregnancy, while pregnant women themselves may have become more careful about attending scheduled follow-up visits due to fear of adverse outcomes.

The literature identifies inadequate pregnancy monitoring, unqualified delivery, and insufficient maternal–infant nutrition as major predictors of maternal and infant mortality (22). Although almost all deliveries in our study occurred in healthcare institutions (99.1%), the overall adequacy of prenatal follow-up at the population level appears to have declined during the pandemic. National Health Statistics Yearbook data show a slight decrease in the proportion of pregnant women receiving adequate follow-up in Türkiye during 2020 and 2021 (96.2% and 96.1%, respectively) (23, 24). These findings are in line with national reports indicating reduced use of prenatal care services during the pandemic, largely due to fear of COVID-19 infection, healthcare restrictions, changes in health policies, quarantine measures, and transportation limitations (25). It should also be noted that our study population consisted only of pregnancies resulting in live births; therefore, these results may not fully represent prenatal care patterns in the entire pregnant population.

In our study conducted in Yozgat province, no statistically significant relationship was found between the gender of the baby, the age of the mother, and the timing of infant death. This finding is consistent with the results of the study conducted in Sivas between 2013 and 2020, which similarly reported no significant association between these variables (19). In addition, in our study, premature and low birth weight infants born to mothers in their first pregnancy constituted the highest proportion of neonatal deaths; this pattern also corresponds to the findings of the Sivas infant mortality study, where these characteristics were most prominent in early neonatal deaths (19). Furthermore, during the first two years of the pandemic in Adıyaman province, the distribution of infant deaths did not differ significantly according to maternal age, infant sex, birth weight, timing of death, gestational week, number of fetuses, first pregnancy status,

birth method, or the number of pregnancy follow-ups, which is also in line with the overall pattern observed in our findings (26).

When the pandemic process is evaluated, it is seen that the infant mortality rates for Yozgat province were calculated as which was 8.47 per thousand in 2020, 7.33 per thousand in 2021 and 9.02 per thousand in 2022. In 2022, which includes the pandemic period, the infant mortality rate in the neonatal period (6.24 per thousand), the infant mortality rate in the early neonatal period (3.7 per thousand), and the infant mortality rate in the late neonatal period (2.54 per thousand) increased compared to the previous year. Especially when looking at previous years, the upward trend observed in 2020 and 2022 is particularly striking. The increases observed in 2020 and 2022 may be indicative of the indirect impact of the COVID-19 pandemic on maternal and neonatal health, potentially attributable to disruptions in healthcare service delivery and reduced access to routine maternal and newborn care, particularly during the initial phase of the pandemic.

According to the Health Statistics Yearbook 2020, the infant mortality rate is 8.5 per thousand, which is above the WHO European Region value (5.7 per thousand) (24). In 2021, there was a decline in the infant mortality rate in the WHO European Region (5.6 per thousand), where our country is located, and an increase in the infant mortality rate was observed in our country's data (9.1 per thousand) (12). While the infant mortality rate in Yozgat province was 8.47 per thousand in 2020, it decreased to 7.93 per thousand in 2021 and increased to 9.02 per thousand in 2022. These fluctuations in infant mortality rates may reflect temporal, location-specific variations in the burden of COVID-19 and differences in healthcare service delivery; however, potential deviations arising from limitations in the quality and completeness of health statistics, including the documentation of pregnancies and deaths, cannot be ruled out. In a study conducted by examining infant deaths in Adıyaman province for 2020-2021, the infant mortality rate was 9.9 per thousand in 2020 and increased by 24% to 12.3 per thousand in 2021. Based on Turkish Statistical Institute data sheets, the decreasing trend of IMR between 2019 and 2020 (9.3 and 8.7 per thousand), increased in the coming 2 years to 9.3 to 9.2 per thousand (27). The COVID-19 pandemic may have affected maternal and infant health through infection of pregnant women. In a meta-analysis examining 517 pregnant women with COVID-19, having COVID-19 in the pregnancy was shown to cause negative effects for both mothers and babies, including premature birth, caesarean delivery, low birth weight, fetal distress, admission to the neonatal intensive care unit, and maternal and infant deaths (28). It is also known that the significant use of healthcare services for COVID-19-related problems during the COVID-19 pandemic has resulted in a decrease in pregnant follow-up all over the world, leading to delays in referrals, with reduced access to special care for high-risk pregnancies (22). During the pandemic, service delivery in newborn care was also disrupted and basic newborn care services, such as breastfeeding support and vaccination programs were interrupted. Mothers' stress and anxiety have increased due to restrictions on visiting policies in neonatal intensive care units. These factors may have all contributed to increased rates of premature births, low birth weight infants, and infant mortality (22).

World Health Organization reports that newborn deaths are often caused by preterm labor, perinatal causes (asphyxia at birth or shortness of breath at birth), infections and congenital anomalies (29). In developed countries, infants generally die in the early neonatal period due to congenital anomalies and perinatal causes resulting from premature birth. In developing countries, in contrary, neonatal mortality frequently occurs at birth and following birth and is due to low birth weight and low standards of care. In these countries, postneonatal mortality is more prominent and often linked to due to lack of immunization and infectious diseases, such as pneumonia and diarrhea (22). In our study, when the causes of infant deaths in Yozgat province between 2014 and 2022 were examined, infections were identified as the leading cause of infant mortality (20.7%), particularly in the late neonatal and post-neonatal periods, whereas respiratory distress of the newborn was the most common cause of death in the early neonatal period (Figure 3). In Adıyaman IMR study (2020-2021), the most common causes

of death were found to be congenital anomalies, prematurity and sepsis (26). Sivas IMR records (2013-2021) revealed the top reasons of IMR as congenital anomalies, lung failure and respiratory distress syndrome (19). In a community-based study conducted in Alabama, with data from 325,036 individuals, COVID-19 pandemic did not have a statistical effect on the causes and/or the numbers of infant deaths (30).

Strengths

This study examines infant mortality in Yozgat province across a continuous six-year period, allowing a robust comparison of trends before and during the COVID-19 pandemic.

The combined use of provincial Infant Mortality Commission records and national statistical data enhances the methodological rigor and credibility of the findings.

The concurrent evaluation of maternal, neonatal, and healthcare-related variables provides a comprehensive framework for understanding the multifactorial nature of infant mortality.

By contextualizing local results within national statistics and existing provincial evidence, the study contributes meaningful insights for health system planning and preparedness in the context of future public health emergencies.

Limitations

In every province in our country, the Infant Mortality Commission evaluates each infant death in the province and records are archieved. Accordingly, Yozgat-based infants who died outside of Yozgat are not expected to be archieved by the Province Infant Mortality Commission. Although some of the out-of-province deaths were accessed through the national Death Notification System, it was not possible to access all. The relatively low infant mortality rate in our study compared to TSI data might be related to the inability to reach all infant deaths in Yozgat province (Figure 2).

Death notifications can be written manually or by selecting ICD-10 coding. Since all death notifications, especially old ones, are not made according to ICD-10 coding, the main and root causes of death are not clearly stated. This situation prevented the making of internationally comparable groupings of causes of death. From now on, it will be valuable to base/support standard ICD-10 coding when recording infant deaths across the country.

The order and magnitude of factors associated with infant death were similar in the period before the COVID-19 pandemic: however, it is not possible to distinguish COVID-19-related maternal of infant deaths, the direct effect of COVID-19 infection on infant deaths in Yozgat province could not be validly evaluated.

Retrospective analysis of data hindered our ability to further investigation of (either periodic or on demand) admissions of pregnant women to health care facilities during the pandemic.

In published literature, only one study has examined the effects of COVID-19 on the infant mortality rate using data from 2020-2021. Our study with comparative evaluation of 6 successive years is a valuable addition to current knowledge in this respect. As a one-province-based study, our findings have low generalizability for the effect of the pandemic on infant mortality rate. A Type II-related error cannot be ruled out in determining the low effects of the pandemic, in presence of low death numbers, in particular. The impact of the pandemic on the infant mortality rate nationwide infant mortality data can be studied.

Conclusions

In conclusion, secondary analysis of mortality data of Yozgat province enabled us to investigate IMRs over 6 successive years, to scrutinize the potential effect of the COVID-19 pandemic on infant deaths. Access to health services, adequacy of prenatal visits, treatment and rehabilitation services have all been affected under pandemic conditions, and it is valuable to examine the changes in the infant mortality rate in this sense, as an important health criterion that shows the mother-child health level of the country. Notably, the increase in early neonatal deaths observed in 2020 compared to other years was striking. We found no significant association with infant mortality with any of the infant/maternal characteristics studied. The adequacy of prenatal follow-up visits was unexpectedly higher in the pandemic period, thus, could not explain the increasing death rate trend during the pandemic.

In summary, our findings suggest that the pandemic period (especially the initial phase when it was unprepared for) may have had an adverse effect on infant mortality, potentially through its impact on maternal health and early developmental stages of the children, possibly due to infections during pregnancy.

To enhance the reliability and comparability of infant mortality data, national standardization of death registration systems should be reinforced, ensuring the consistent and accurate application of ICD-10 coding. Regular capacity-building for healthcare personnel on cause-of-death classification and integration of maternal–neonatal surveillance systems would further strengthen data quality and facilitate early identification of preventable causes. Moreover, establishing structured feedback mechanisms between provincial mortality commissions and national authorities could substantially improve the monitoring and reporting of infant deaths (22).

Author contribution

The authors confirm contribution to the paper as follows: study conception and design: BÇ, HEE, ŞAK; data collection: HEE; analysis and interpretation of results: HEE, ŞAK; draft manuscript preparation: BÇ, ŞAK, HEE. All authors reviewed the results and approved the final version of the manuscript.

Conflict of Interest

The authors have no conflict of interest with any person and/or institution.

Source of funding

No funding support was received from any person and/or institution for this study.

Ethical approval

Hacettepe University Non-invasive Clinical Research Ethics Committee and Yozgat Provincial Health Directorate Scientific Research Advisory Board for their contribution to the realization of the research.

Consent to participate: Not applicable.

Consent for publication: Not applicable.

References

1. General Directorate of Public Health. Perinatal and Infant Mortality Information Form Filling Guide 2022. Available from: https://hsgm.saglik.gov.tr/depo/birimler/cocuk_ergen_db/dokumanlar/Doldurma_Klavuzu.pdf
2. Turkish Statistical Institute. Children in Statistics, 2022 2022. Available from: https://data.tuik.gov.tr/Bulten/Index?p=Istatistiklerle-Cocuk-2022-49674
3. Bodur S, Durduran Y, Küçükkendirci H, Doğan C. The Relationship of Infant Mortality with Prenatal-Natal Healthcare Utilization and Demographic Characteristics: A Case-Control Study. Dicle Medical Journal. 2009;36(4):288-93.
4. UNICEF. The Impact of the COVID-19 Pandemic on Children 2022. Available from: https://www.unicef.org/turkiye/documents/covid-19-salg%C4%B1n%C4%B1n%C4%B1n-%C3%A7ocuklar-%C3%BCzerindeki-etkileri
5. Sadeghloo T, Mikhak H. Analyzing the impacts and experiences of children in disaster. International Journal of Disaster Risk Reduction. 2022;76:103000.
6. Chmielewska B, Barratt I, Townsend R, Kalafat E, van der Meulen J, Gurol-Urganci I, et al. Effects of the COVID-19 pandemic on maternal and perinatal outcomes: a systematic review and meta-analysis. The Lancet Global Health. 2021;9(6):e759-e72.
7. Maza-Arnedo F, Paternina-Caicedo A, Sosa CG, Mucio B de, Rojas-Suarez J, Say L, et al. Maternal mortality linked to COVID-19 in Latin America: Results from a multi-country collaborative database of 447 deaths. The Lancet Regional Health–Americas. 2022;12.
8. TTB T, and HASUDER,. Current Status Assessment of COVID-19 Vaccination During Pregnancy by TTB, TJOD, and HASUDER 2022. Available from: https://www.ttb.org.tr/haber_goster.php?Guid=909cdc60-0fd4-11ec-94d8-6894aead55a3
9. Republic of Turkey Ministry of Health. COVID-19 Vaccination in Pregnant Women 2021 [cited at 2024 Apr 2]. Available from: https://covid19asi.saglik.gov.tr/Eklenti/41526/0/gebeliktecovid19asilariafis50x70cmpdf.pdf?_tag1=91C44E1A7CA4A2D5717F1079B7F2A3721C81784B
10. Republic of Turkey Ministry of Health. Mask,

distance, and hygiene. Now is the time to unite in precaution 2022. Available from: https://covid19.saglik.gov.tr/TR-73286/maske-mesafe-ve-temizlik-simdi-tedbirde-birlik-olma-zamani.html
11. Turkish Statistical Institute. Central Distribution System 2023. Available from: https://biruni.tuik.gov.tr/medas/
12. Turkish Statistical Institute. Yozgat Population. 2022.
13. Yozgat Governorship. Provincial Directorate of Environment, Urbanization and Climate Change 2023 [cited at 2024 Apr 2]. Available from: https://yozgat.csb.gov.tr/ilimiz-cografyasi-i-2341
14. Güler Ç, Akın L. Fundamentals of Public Health, 2nd Edition, 3. Hacettepe Publications. 2012;1841.
15. Blencowe H, Cousens S, Chou D. Born Too Soon: The global epidemiology of 15 million preterm births. Reproductive Health. 2013;10(1):S2.
16. Özgen D, Şahin S. Characteristics of Mothers of Low Birth Weight Infants. Journal of Human Rhythm. 2016;2(2):73-7.
17. Republic of Turkey Ministry of Health. Antenatal Care Monitoring Protocol Circular 2023. Available from: https://www.saglik.gov.tr/TR,11104/dogum-oncesi-bakim-izlem-protokolu-genelgesi-2008--13.html
18. Republic of Turkey Ministry of Health. Minister Koca Evaluated Turkey's 1-Year Struggle Against COVID-19. 2020.
19. Akova İ, Güneş Bal Ş, Arslaner S, Uygun T, Hasta S. Investigation of Infant Mortality and Causes in Sivas, Turkey. ESTUDAM Public Health Journal. 2022;7(3):436-43.
20. Çatak B, Öner C. Are the Main Causes of Infant Mortality Changing? A Registry-Based Cross-Sectional Study. Turkish Journal Of Family Medicine And Primary Care. 2019;13(3):311-7.
21. Yılmaz M, Bayraktar F. Evaluation of Perinatal and Infant Mortality Data in Düzce Between 2014-2017. ESTUDAM Public Health Journal. 2020;5(1):35-42.
22. Theodore H, Tulchinsky V, Elena A. New Public Health: Elsevier Academic Press; 2019.
23. Republic of Turkey Ministry of Health. Health Statistics Yearbook, 2021. 2021.
24. Republic of Turkey Ministry of Health. Health Statistics Yearbook 2020. 2020. Available from: https://dosyasb.saglik.gov.tr/Eklenti/43399,siy2020-tur-26052022pdf.pdf?0
25. Townsend R, Chmielewska B, Barratt I, Kalafat E, van der Meulen J, Gurol-Urganci I, et al. Global changes in maternity care provision during the COVID-19 pandemic: a systematic review and meta-analysis. EClinicalMedicine. 2021;37.
26. Öz E, Küçükkelepçe O, Almış H, Parlak ME, Kurt O. Evaluation of infant deaths during Covid-19 pandemic in Adıyaman, a southeastern province of Turkey 2020.
27. Turkish Statistical Institute. Central Distribution System, Child Statistics - Health. 2022.
28. Karaçam Z, Kizilca-Çakaloz D, Güneş-Öztürk G, Çoban A.Maternal and perinatal outcomes of pregnancy associated with COVID-19: systematic review and meta-analysis. European Journal of Midwifery. 2022;6.
29. World Health Organization. Newborn Mortality 2021. Available from: https://www.who.int/news-room/fact-sheets/detail/levels-and-trends-in-child-mortality-report-2021.
30. Shukla VV, Rahman AKMF, Shen X, Black A, Arora N, Lal CV, et al. Trends in fetal and neonatal outcomes during the COVID-19 pandemic in Alabama. Pediatric research. 2023;94(2):756-61.

Supplementary Materials

Supplementary Table 1: Evaluation of some characteristics of parents
**A person's kinship level is not specified.*

Characteristic	Number	Percent (%)
Mother's age		
23 and younger	100	27.9
24 - 27	84	23.5
28 - 32	90	25.1
33 and older	84	23.5
Minimum - Maximum: 17-49 Median (Q1-Q3): 27 (23-32)		
Mother's education		
Illiterate	9	2.6
Literate	10	2.9
Primary or secondary school graduate	211	59.6
High school graduate	77	22.2
College graduate	44	12.7
Father's education		
Illiterate	1	0.3
Literate	9	2.6
Primary or secondary school graduate	185	53.2
High school graduate	96	27.6
College graduate	57	15.5
Mother's smoking		
Yes	15	4.3
No	337	95.7
Kinship between spouses		
No	305	86.2
Yes**	49	13.8
First degree	*27*	*56.2*
Second degree	*7*	*14.6*
Third degree	*11*	*22.9*
Fourth degree	*3*	*6.3*
Blood incompatibility between spouses		
Yes	326	7.1
No	25	92.9
Mother's tetanus vaccination		
Yes	294	83.2
Incompletely vaccinated	45	12.8
No	14	4.0
Mother's COVID-19 vaccination		
Yes	27	75.4
No	311	24.6

Supplementary Table 2: Evaluation of some characteristics of infants who died in Yozgat between 2014 and 2022

Characteristics	Before COVID-19		Pandemic Period		Total	
	Number	Percent	Number	Percent	Number	Percent
Infant's gender						
Female	115	46.0	49	45.4	164	45.8
Male	135	54.0	59	54.6	194	54.2
Infant birth weight[a]						
Low birth weight[b]	141	56.4	65	60.8	206	57.7
Extremely low birth weight	59	23.6	33	30.8	92	25.8
Very low birth weight	26	10.4	15	14.0	41	11.5
Normal birth weight	108	43.2	41	38.3	149	41.7
Excess birth weight	1	0.4	1	0.9	2	0.6
Pregnancy Week						
Preterm					201	56.1
Extreme preterm <28 weeks	61	24.4	41	38.0	102	28.5
Early preterm 28-<32 weeks	25	10.0	12	11.1	37	10.3
Medium late preterm 32- <37	47	18.8	15	14.0	62	17.3
Term 37-<42	117	46.8	39	36.1	156	43.6
Post term 42 weeks and over	-	-	1	0.9	1	0.3
Delivery method[a]						
Normal vaginal route	90	36.1	37	34.6	127	35.7
Cesarean section	159	63.9	70	65.4	229	64.3
Place of Delivery[a]						
Public hospital	157	63.1	82	75.9	239	66.9
University hospital	56	22.4	18	16.7	74	20.7
Private hospital	34	13.7	7	6.5	41	11.5
Outside of healthcare facility	2	0.8	1	0.9	3	0.9
Place of Death[a]						
Public hospital	106	43.4	61	56.5	167	47.4
University hospital	80	32.8	21	19.4	101	28.7
Private hospital	34	13.9	20	18.5	54	8.5
Outside of healthcare facility	24	9.8	6	5.6	30	15.3
Period of Death						
Neonatal	160	64.0	69	63.9	229	64.0
Early neonatal	97	38.8	45	41.7	142	62.0
Late neonatal	63	25.2	24	22.2	87	38.0
Postneonatal	90	36.0	39	36.1	129	36.0
Pregnancy follow-up of mother[c]						
Sufficient follow-up	194	77.6	99	91.7	293	81.8
Not sufficient	56	22.4	9	8.3	65	18.2

Mother's first pregnancy[a]						
Yes	77	30.9	30	28.0	107	30.1
No*	172	69.1	77	72.0	249	69.9
Miscarriage	72	39.0	39	50.0	111	31.9
Stillbirth	8	1.0	1	1.3	9	2.6
Miscarriage and stillbirth	7	-	-	-	7	2.0
Number of fetuses at pregnancy[a]						
One	209	83.9	95	88.0	304	85.2
Two	31	12.4	13	12.0	44	12.3
Three	9	3.6	-	-	9	2.5
Method of conception[a]						
Normal, physiological	226	90.4	100	93.5	326	91.3
Required infertility treatment	24	9.6	7	6.5	31	8.7
Mother's age						
34 years and younger	214	85.9	89	82.4	303	84.6
35 years and older	36	14.4	19	17.6	55	15.4

**Except for live birth, miscarriage and stillbirth are listed. There are mothers who experience a situation more than once.*
[a]There is missing data.
[b]It is presented as the sum of all births with a birth weight of 2499 g and below.
[c]Pregnant women who had three or fewer follow-up visits were considered unfollowed.
x= Chi square test. y= Fisher exact test

Supplementary Table 3: Distribution of some characteristics of infants who died during the pandemic by mother's COVID-19 vaccination status

Characteristic	COVID-19 vaccinated mother	COVID-19 unvaccinated mother	p-value*
	n (%)	n (%)	
Birth week			
Term	18 (66.7)	50 (61.7)	0.645[a]
Preterm	9 (33.3)	31 (38.3)	
Birth weight			
Normal birth weight	11 (40.7)	31 (38.3)	0.820[a]
Low birth weight	16 (59.3)	50 (61.7)	
Delivery method			
Normal vaginal route	7 (25.9)	30 (37.5)	0.274[a]
Cesarean section	20 (74.1)	50 (62.5)	
Pregnancy follow-up			
Sufficient	24 (88.9)	75 (92.6)	0.546[b]
Not sufficient	3 (11.1)	6 (7.4)	
Time of death			
Early neonatal period	11 (40.7)	34 (42.0)	0.219[a]
Late neonatal period	9 (33.3)	15 (18.5)	
Postnatal period	7 (25.9)	32 (39.5)	

**Column percentages are presented.*
[a]Pearson Chi-square test p-value [b]Fisher Exact test p-value