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A SPATIAL PERSPECTIVE OF BIRTH DELAY IN CROATIA: IS RURAL POPULATION DECLINE A LIMITING FACTOR OF NATIONAL FERTILITY RATES?

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The purpose of this study is to explore urban-rural differences in fertility levels and timing in Croatia, and to explore the spatial evolution of birth delay. Data from 556 local units at three time points were used. The units were classified into cities, towns and suburbs, and rural areas. For comparison, data from Croatian regions and European countries were utilised. The research is based on descriptive statistics, spatial statistics, and geovisualisations. A specific methodological framework relying on the ratio of age-specific fertility rates of older and younger age groups was employed to monitor birth timing. In the period 2001–2011, urban-rural fertility level differences decreased due to increased births in urban areas at older ages. In the period 2011–2021, with the rise of later births in rural areas, differences increased again. The Zagreb region, cities, Istria, the Croatian Littoral, and Dalmatia lead in later births. Urban-rural differences in cohort fertility are greater than those in period fertility. Further shifting towards reducing the proportion of rural population could gradually have a negative impact on the national fertility level.

Keywords: fertility, cities, rural areas, birth delay, Croatia

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INTRODUCTION

The persistence of low fertility is one of the main characteristics and challenges of developed societies, placing this phenomenon at the centre of numerous studies (Balbo et al., 2013). The underlying reasons are complex, with dominant explanations coming from the second demographic transition theory, which encompasses sociocultural factors (Lesthaeghe, 2014), the economic theory (Becker, 1991), and the important role of gender equality (Esping-Andersen & Billari, 2015). Next to low fertility, another common phenomenon in developed societies is birth postponement (Kohler et al., 2002). During the shift in birth timing, period fertility temporarily decreases, only to rise again with compensatory late births at the end of the postponement (Goldstein et al., 2009). In the recent period, late childbearing across Europe is rapidly increasing (Beaujouan & Sobotka, 2022), but in most developed countries, this trend has not been sufficient to offset the negative impact of delaying first childbirth on the final cohort fertility (Beaujouan et al., 2023).

Birth delay is commonly studied at the national-level, but various spatial fertility patterns across Europe indicate the need for a greater number of studies at lower levels (Campisi et al., 2020; Buelens, 2021). Furthermore, decomposing data according to urban-rural characteristics reveals different patterns in cities and rural areas (Campisi et al., 2022). In cities, delayed childbirth is more common, and the realisation of fertility intentions is lower (Riederer & Buber-Ennser, 2019). With a methodological shift from the urban-rural dichotomy to the urban-rural continuum (Riederer & Beaujouan, 2024), there is also a need for research at even lower spatial levels.

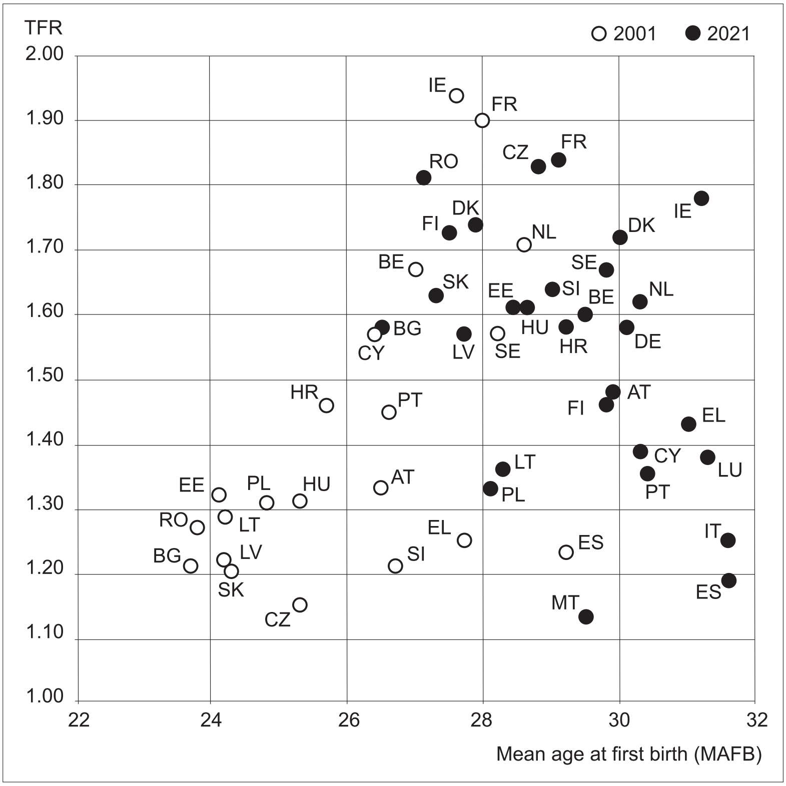
In a large number of countries fertility levels are higher in rural areas and small towns, while lower in large cities (Campisi et al., 2020). Similar patterns apply to Croatia as well (Nejašmić, 1996; Akrap et al., 2003). Although there is no clear answer why there are spatial differences in fertility, two main hypotheses are mentioned in most studies (Basten et al., 2012). The compositional hypothesis claims that fertility rates vary in space because of different population structures in different settlements, meaning the sum of individuals with different characteristics. For example, the proportion of highly educated individuals is higher in cities, and highly educated individuals generally have lower fertility (Andersson et al., 2009). The contextual hypothesis refers to economic or cultural factors in the local environment that encourage or discourage individuals in fertility decisions. Both direct and indirect costs of raising children are higher in cities, while on the other hand, cities are sources of postmodern values and they support or tolerate childlessness culture (Belić & Mišetić, 2021). In addition to these hypotheses, the role of selective migrations is emphasised, where couples with the intention of having children may move to smaller places that are more suitable for raising children (Kulu & Washbrook, 2014).

Examining differences in fertility levels and birth delay patterns between rural and urban areas can reveal internal processes not clearly visible in aggregated data and help understand the country's fertility. The primary objective of this study is to examine urban-rural differences in fertility level and fertility timing in Croatia. Data from 556 local administrative units were used at three recent census points. Due to the lack of more precise data, a specific method for monitoring birth delay through the Age-Specific Fertility Rates was developed. Furthermore, the spatial evolution of birth delay was explored. Based on previous findings, a hypothesis about birth delay spreading from cities to rural areas and reducing urban-rural differences in late fertility was formulated. Considering urban-rural differences in fertility levels, the second objective is to consider the impact of rural decline on the national fertility rate.

Fertility trends in Croatia

The Total Fertility Rate (TFR) of Croatia in the 21st century stabilised at values around 1.5, but the tempo-adjusted fertility rate is on average higher by 0.2 children per woman (Čipin et al., 2024). The Cohort Fertility Rate (CFR) for 1970s cohorts fell below 1.9, while for the cohort born in the early 1980s there is a trend of decline to around 1.7 children per woman (Čipin et al., 2020; 2024). In 2001, the initial year of the study period, Croatia had the highest TFR among Central and Eastern European (CEE) countries, as well as the second highest mean age at first birth (MAFB) (Figure 1). Moreover, Croatia's TFR has never been lower than 1.33, making it an exception among EU CEE countries (Sobotka, 2011). In 2021, Croatia stands out with the highest MAFB (29.2) among CEE countries.

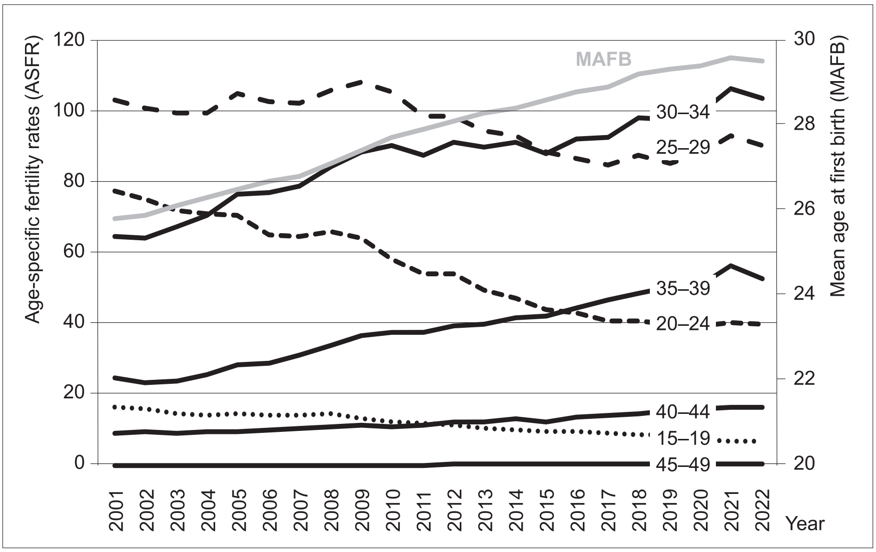
Since the beginning of the 21st century, significant changes in Age-Specific Fertility Rates (ASFR) have occurred alongside the shift in MAFB (Figure 2). ASFR30-34 has become dominant. Additionally, ASFR35-39 has surpassed ASFR20-24, and ASFR40-44 is higher compared to ASFR15-19. An intriguing observation is the decline in MAFB in 2022, the first time since the 1980s (Human Fertility Collection, 2024). However, it is challenging to declare the end of birth postponement based on this data. Unusual patterns of "pandemic births" in the previous year are a likely reason for this unexpected phenomenon (Nitsche et al., 2022).



Source:
Eurostat (2024d)

FIGURE 1
Total fertility rate and mean age at first birth in European Union countries in 2001 and 2021

FIGURE 2
Age-specific fertility rates and mean age at first birth in Croatia 2001–2021



Source: Eurostat (2024a); Croatian Bureau of Statistics (CBS, 2023a)

If we sum ASFR for age groups from 15 to 29 years, the proportion of Croatia's birth delay from 2001 to 2021 are even more highlighted (Figure 3). In 2001, Croatia was at the top among CEE countries in terms of births before the age of thirty, but in the period 2015–2020, it was at the bottom. The reasons for such a decline are undoubtedly complex and multifaceted, and this study will attempt to explore them. However, it is noticeable that the decline started after 2009 when the TFR of Croatia also began to decrease. The significant economic crisis most affected the postponement of first births (Goldstein et al., 2013), so it is undoubtedly responsible for part of the decline.

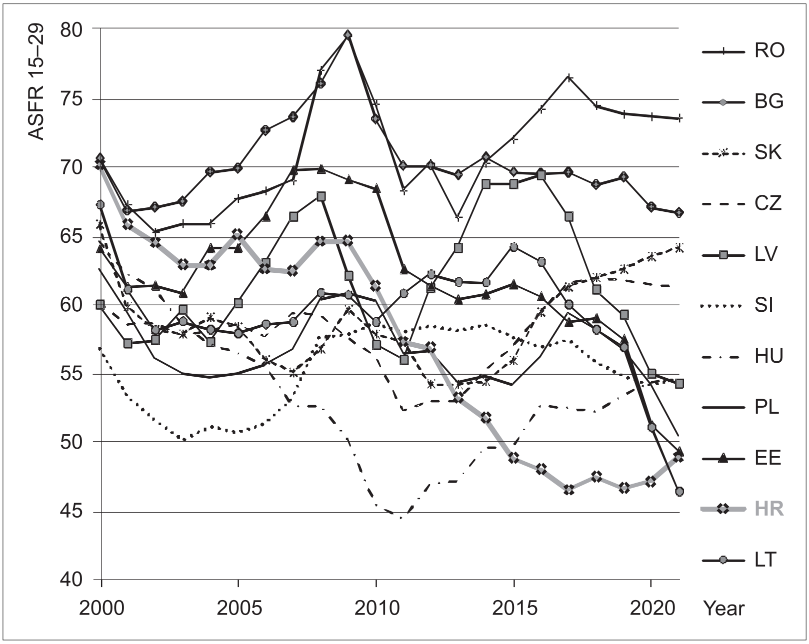


FIGURE 3
Age-specific fertility rate in Central and Eastern European countries 2000–2021

DATA AND METHODS

This research covers three spatial levels – national, regional and local. Data were collected from several diverse sources. Fertility and population data at the national level were obtained from the Eurostat database (Eurostat, 2024a; 2024b; 2024c; 2024d; 2024e). The age-sex structure at the local (municipal) and regional (county) levels was derived from the 2001, 2011, and 2021 censuses (CBS 2005; 2013b; 2022b). Live birth data by mothers' age were collected from Annual Statistical Reports (CBS, 2002a; …; 2023a).

Due to the lack of more precise indicators at the local spatial level, a specific methodological framework was devised as a substitute method for monitoring fertility timing. In order to explore the spatiotemporal evolution of birth delay in Croatia, specific fertility rates for younger ($ASFR_{15-29}$) and older ($ASFR_{30-49}$) age groups were calculated at the local and regional levels at three points in time (2000–2002, 2010–2012, 2020–2022). The use of a three-year average of live births around census years reduced large year-to-year relative variations in small municipalities.[1] Furthermore, the year 2021 exhibited highly unusual fertility patterns (Nitsche et al., 2022). Croatia recorded a noticeably above-average TFR, thus, utilising a three-year average smoothed the data and made the comparison with earlier periods more relevant.

Additionally, the study formed three analytical units based on the degree of urbanisation, using the Eurostat DEGURBA 2021 classification (Eurostat, 2021).[2] The first group (cities – densely populated areas) consists of the seven largest cities: Zagreb, Split, Rijeka, Osijek, Zadar, Slavonski Brod, and Pula. The second group, towns and suburbs (intermediate density areas), comprises 103 local units. The remaining 446 units are classified as rural areas – thinly populated areas (CBS, 2024). According to the 2021 census, approximately one-third of the Croatian population resides in each of the three mentioned categories (Table 1).

Different intensities of decline in $ASFR_{15-29}$ and growth in $ASFR_{30-49}$ in various periods, in different regions of Croatia, and in different analytical units, should illustrate the evolution of birth delay. Fertility timing data at the local level are scarce. Therefore, a new indicator has been utilised as a potential substitute for the Mean Age at Birth (MAB) in studies of lower spatial levels – the Age-Specific Fertility Rates Index. The Index (IASFR) is a synthetic measure and provides the ratio of fertility rates between the older (30-49) and younger (15-29) age groups (Belić, 2023b):

$$I_{ASFR} = \frac{ASFR_{30\text{-}49}}{ASFR_{15\text{-}29}} \cdot 100 \qquad (1)$$

As there is no straightforward relationship between fertility level and timing (Buelens, 2021), it is advisable to use IASFR in conjunction with fertility indicators. In its initial introduction, the main advantages of using the index are highlighted (Belić, 2023b): due to the expanded measurement scale, the index can assist in more detailed visualisations, detecting differences among regions, and modeling spatial patterns of fertility timing, which is its primary purpose; by adding a time component to the index, the long-term development of fertility can be monitored and projected across countries and regions; finally, the simplicity of calculation can make this index a substitute indicator for fertility timing in the absence of more detailed data.

At the local spatial level in Croatia, birth data according to maternal age is grouped into the age categories of 15–19, 20–29, 30–39, and 40–49 years, which hinders a more precise calculation of the TFR. Using regional level data, differences between the actual TFR values and estimated values obtained through several methods have been tested. The summation of ASFR for the four aforementioned age groups proved to be more accurate compared to some other proposed methods for estimating TFR (Hauer, 2013). Therefore, the TFR was estimated as follows:

$$TFR = 5\,ASFR_{15\text{-}19} + 10\,(ASFR_{20\text{-}29} + ASFR_{30\text{-}39} + ASFR_{40\text{-}49}) \quad (2)$$

The cohort fertility rate was calculated based on the 2021 Census data (CBS, 2023b) as follows:

$$CFR = \frac{\sum_{i=0}^{10} (i \cdot B_i)}{W} \quad (3)$$

Where: i = parity, Bi = number of women at parity i, W = total number of women in the cohort.

Alongside descriptive statistics, essential tools in this research are spatial analyses and geovisualisations. The spatio-temporal evolution of birth delay is presented using two sets of choropleth maps. In addition to the maps, the calculation of Moran's spatial autocorrelation index is conducted, indicating whether values are randomly distributed or if there is a statistically significant clustering of high or low values (Goodchild, 1986). To compare the intensity of spatial autocorrelation among different datasets ($ASFR_{15\text{-}29}$, $ASFR_{30\text{-}49}$, and TFR at three time points), it is necessary to utilise standardised Z-scores (Chapman McGrew et al., 2014). To compute the index, 'queen' contiguity of the 1st order was used.

The processes of rural out-migration and polarisation in Croatia have been present for decades (Friganović & Živić, 1994; Sić, 2003). In order to better illustrate the development of these processes in the studied period in the context of their relationship with local fertility rates, continuous area cartograms (anamorphic maps) were created. These types of maps distort original maps to emphasise the uneven spatial distribution of a particular feature without compromising the topology of the original map (the algorithm of construction is explained in Dougenik et al., 1985). Instead of the population number, the basic feature of the constructed cartograms in this study is the female fertile population. This provides not only an impression of the demographic mass of each unit but also more relevant information in terms of bioreproductive potential because the age structure is taken into account. Additionally, the age structure indicates the migration character of the unit. Therefore, on the constructed cartograms, the size of polygons represents the number of women aged 15 to 49, and shades of colour depict the fertility level. By comparing the cartograms from the beginning and the end of the study period, changes can be identified, and future developments can be projected.

To prevent the research from being hermetic and focused solely on Croatia, a third level has been introduced with some data at the national level. The aim is not to conduct a full comparative analysis but rather to position Croatia within the European context, expanding and complementing the insights gathered at the local and regional levels.

RESULTS

Urban-rural fertility differences

Between the last two censuses, the population of Croatia has decreased by over half a million (Table 1). More than half of the total decline is attributed to rural areas, even though they constitute about a third of the total population according to this classification.[3] In two decades, rural areas have lost about a fifth of their population. The two urban categories are similar in the intensity of total depopulation – it is lower compared to rural areas and amounts to just under 10%.

TABLE 1
Population change by the degree of urbanisation from 2001 to 2021

Degurba type	Population in thousands			Change: Absolute (thousands)			Change: Relative (%)			Share of the population (%)		
	2001	2011	2021	2001–2011	2011–2021	2001–2021	2001–2011	2011–2021	2001–2021	2001	2011	2021
Cities	1.422	1.396	1.305	-26	-92	-118	-1.8	-6.6	-8.3	32.1	32.6	33.7
Towns and suburbs	1.405	1.391	1.271	-14	-120	-134	-1.0	-8.6	-9.6	31.7	32.5	32.8
Rural areas	1.610	1.497	1.296	-112	-201	-314	-7.0	-13.4	-19.5	36.3	34.9	33.5
Croatia	4.437	4.285	3.872	-153	-413	-566	-3.4	-9.6	-12.7	100.0	100.0	100.0

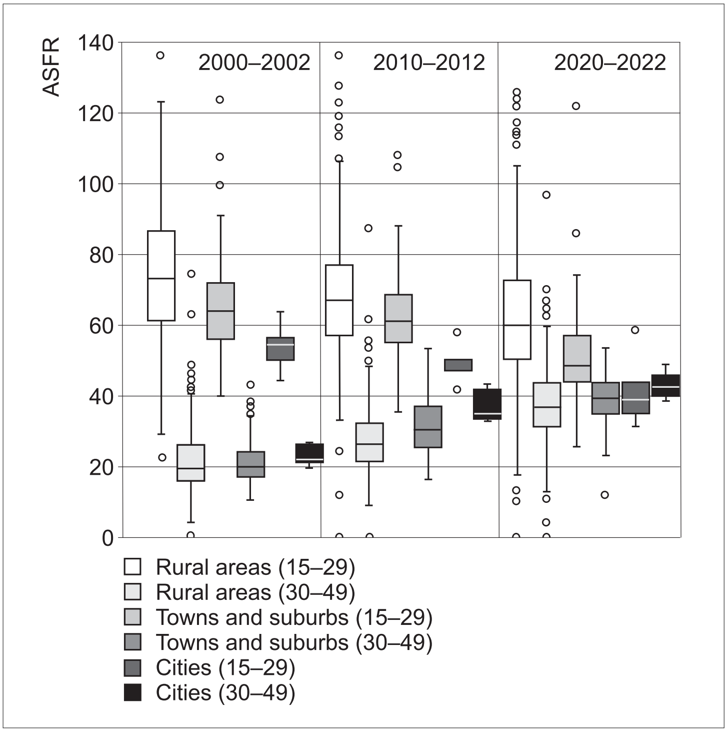
During the study period, TFR in Croatia experienced a slight increase. The difference in the estimated TFR between urban and rural areas decreased in the first decade, only to rise again in the second decade (Table 2). According to period fertility, the urban-rural difference is 0.2 children per woman, but according to cohort fertility, the difference is almost 0.5 children per woman.

The level of Age-Specific Fertility Rates (ASFR) in the younger and older age groups at three time points vividly demonstrate a gradual progression of postponement transition from cities, through towns and suburbs, to rural areas (Table 2; Figure 4). In all three categories, an inversion pattern is observed – $ASFR_{15-29}$ continuously declines, while $ASFR_{30-49}$ continuously rises. In cities, the fertility rate of the older age group has already surpassed that of the younger age group. Observing $ASFR_{15-29}$, rural areas "lag behind" roughly 10 years compared to towns and suburbs, which, in turn, lag behind cities. When considering $ASFR_{30-49}$, the differences are much smaller. At the initial and final points, there is almost no difference between towns and suburbs compared to rural areas. ASFR Index values summarise the values of two ASFR indicators in a single number, vividly illustrating differences among categories. For all indicators, the patterns for Croatia and towns and suburbs are almost aligned.

➊ TABLE 2
Fertility indicators in 2001, 2011 and 2021

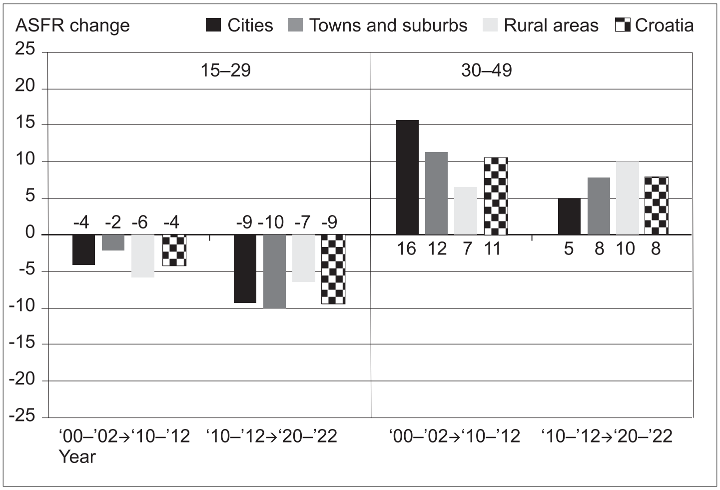
	TFR			$ASFR_{15-29}$			$ASFR_{30-49}$			ASFR Index			CFR	
Degurba type	2001	2011	2021	2001	2011	2021	2001	2011	2021	2001	2011	2021	1967–1971	1972–1976
Cities	1.27	1.45	1.47	52.0	47.5	38.4	24.1	39.8	44.8	46.4	83.8	116.7	1.64	1.56
Towns and suburbs	1.37	1.53	1.57	62.1	59.9	50.1	20.7	32.3	39.9	33.3	53.8	79.6	1.89	1.80
Rural areas	1.53	1.58	1.67	73.5	67.6	61.1	20.3	26.8	36.9	27.6	39.6	60.4	2.11	2.02
Croatia	1.39	1.53	1.57	62.6	58.5	49.8	21.7	33.1	40.8	34.7	56.7	82.0	1.88	1.78

➲ FIGURE 4
$ASFR_{15-29}$ and $ASFR_{30-49}$ in local units of Croatia by degree of urbanisation at three time points

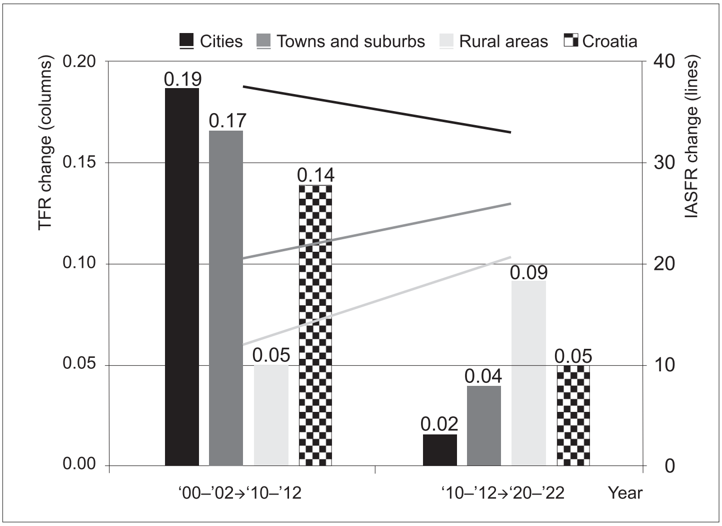


The changes in ASFR over two decades provide a deeper insight into the dynamics of birth timing differences in the three categories (Figure 5). In the first decade, there was not a significant difference in the decline of $ASFR_{15\text{-}29}$, but urban areas recorded a more pronounced increase in $ASFR_{30\text{-}49}$ compared to rural areas. These changes are ultimately evident in a noticeably greater increase in the TFR between 2001 and 2011 in urban areas (Figure 6).

➲ FIGURE 5
$ASFR_{15\text{-}29}$ and $ASFR_{30\text{-}49}$ changes by degree of urbanisation



➲ FIGURE 6
TFR and ASFR Index changes from 2001 to 2021



In the second decade, conversely, rural areas experienced the most pronounced decline in $ASFR_{15\text{-}29}$ and an increase in $ASFR_{30\text{-}49}$, leading to the highest increase in TFR. Moreover, during this period, the decline in the fertility rate in the younger age group in Croatia was more intense compared to the increase in the older age group, yet TFR slightly increased. The reason for this is the fact that in that decade, the total number of births after the age of thirty became dominant.

The overall changes in the TFR confirm a higher increase in urban areas, mainly due to later births between 2001 and 2011. The ASFR index, in addition to being the highest in cities, also recorded the largest increase there. This fact confirms that birth delay is still most widespread in large cities, but the intensity of the shift slowed down in the second decade, while it is on the rise in towns and suburbs, as well as in rural areas.

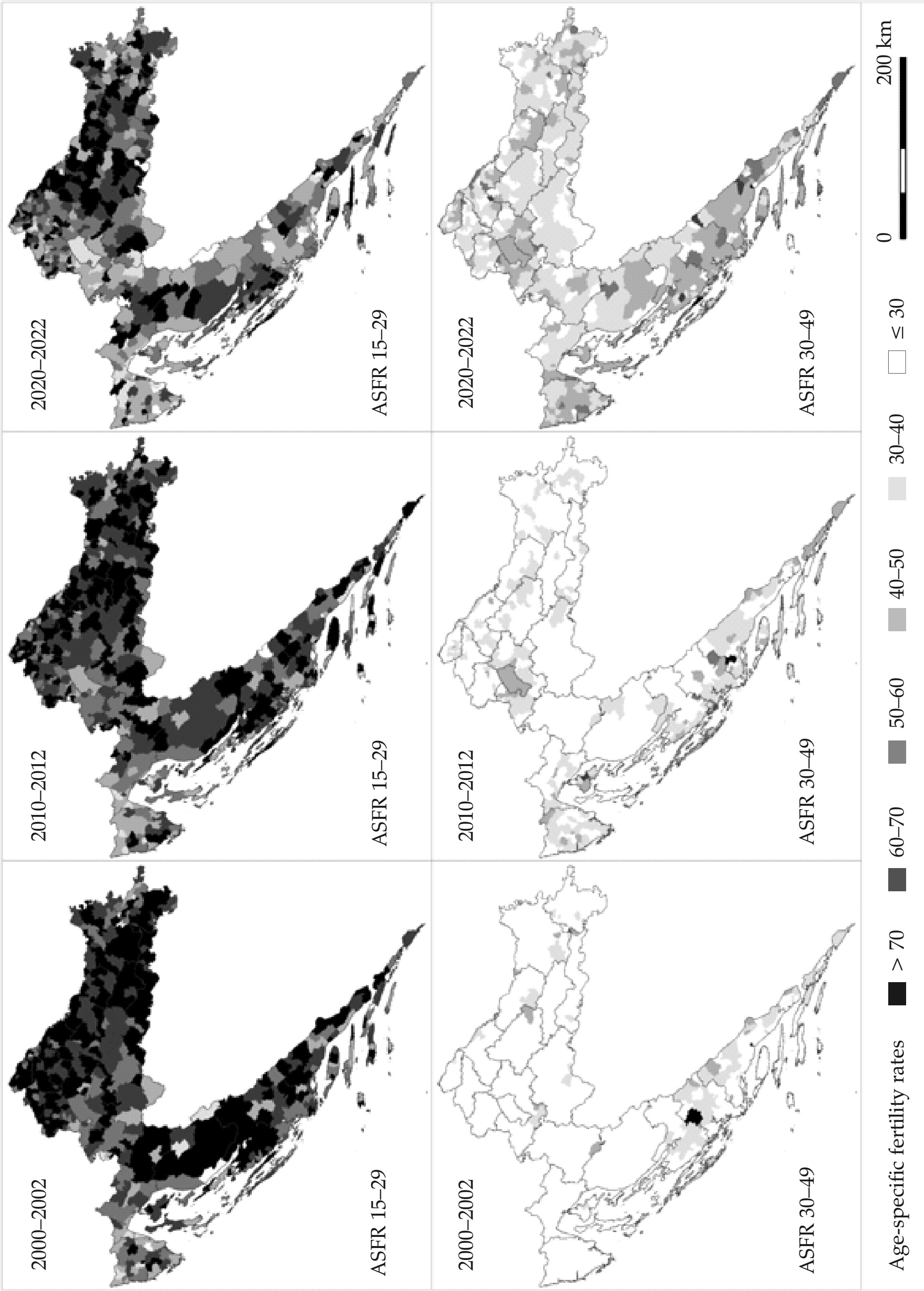
Spatiotemporal evolution of birth delay on a local level

At the beginning of the 21st century, the fertility rate below the age of thirty was high in most parts of Croatia (Figure 7). Apart from the broader Zagreb area, the regions with the lowest $ASFR_{15-29}$ are Istria and the Croatian Littoral. In addition to the aforementioned developed areas, large cities and some depopulated rural municipalities in different parts of the country should be considered as low $ASFR_{15-29}$ areas. At the same time, there had not yet been a significant increase in $ASFR_{30-49}$, even in large cities. Small municipalities with significantly higher $ASFR_{30-49}$ values stand out, where these high values result from small populations, as well as municipalities with traditionally high fertility, where a considerable number of higher-order births is still notable during the 2000–2002 period.

Up until the period of 2010–2012, the decline in $ASFR_{15-29}$ spatially expanded to an even larger part of the region, but the overall spatial pattern does not differ significantly from the first map. However, significant changes occurred in $ASFR_{30-49}$. Given the inverse nature of $ASFR_{15-29}$ and $ASFR_{30-49}$, areas with the lowest fertility in younger age groups further emphasise the highest fertility in older age groups. The exception includes certain depopulated areas that continue to register very low fertility rates in the older age group. Higher older age fertility is also present in high fertility areas, predominantly in Dalmatia. The pronounced highlighting of especially Zagreb and other cities provides a spatial representation of the compensation increase in $ASFR_{30-49}$ in cities in the first decade of the observed period.

Until 2020–2022, spatial patterns of ASFR underwent significant changes. The inversion of two spatial patterns is still present, but the contours become less noticeable. $ASFR_{15-29}$ rates have notably declined in many areas. The space of lower fertility has expanded from the Zagreb area to a broader region, and this expansion is also noticeable in the Dalmatian region. Generally, fertility of the younger age group is lower in the previously mentioned developed areas and depopulated areas. Changes in $ASFR_{30-49}$ are even more pronounced. Comparison with the earlier period gives the impression that almost the whole of Croatia has elevated in fertility by one level. This provides spatial confirmation of the compensation increase in $ASFR_{30-49}$ in rural areas. The highest values are found in more developed, high-fertility, and some small municipalities.

FIGURE 7
Spatiotemporal evolution of $ASFR_{15-29}$ and $ASFR_{30-49}$ on a local level in Croatia



The ASFR Index represents the ratio of fertility rates of the older and younger age groups. Therefore, its spatial patterns actually consolidate but further highlight the previously mentioned findings (Figure 8).

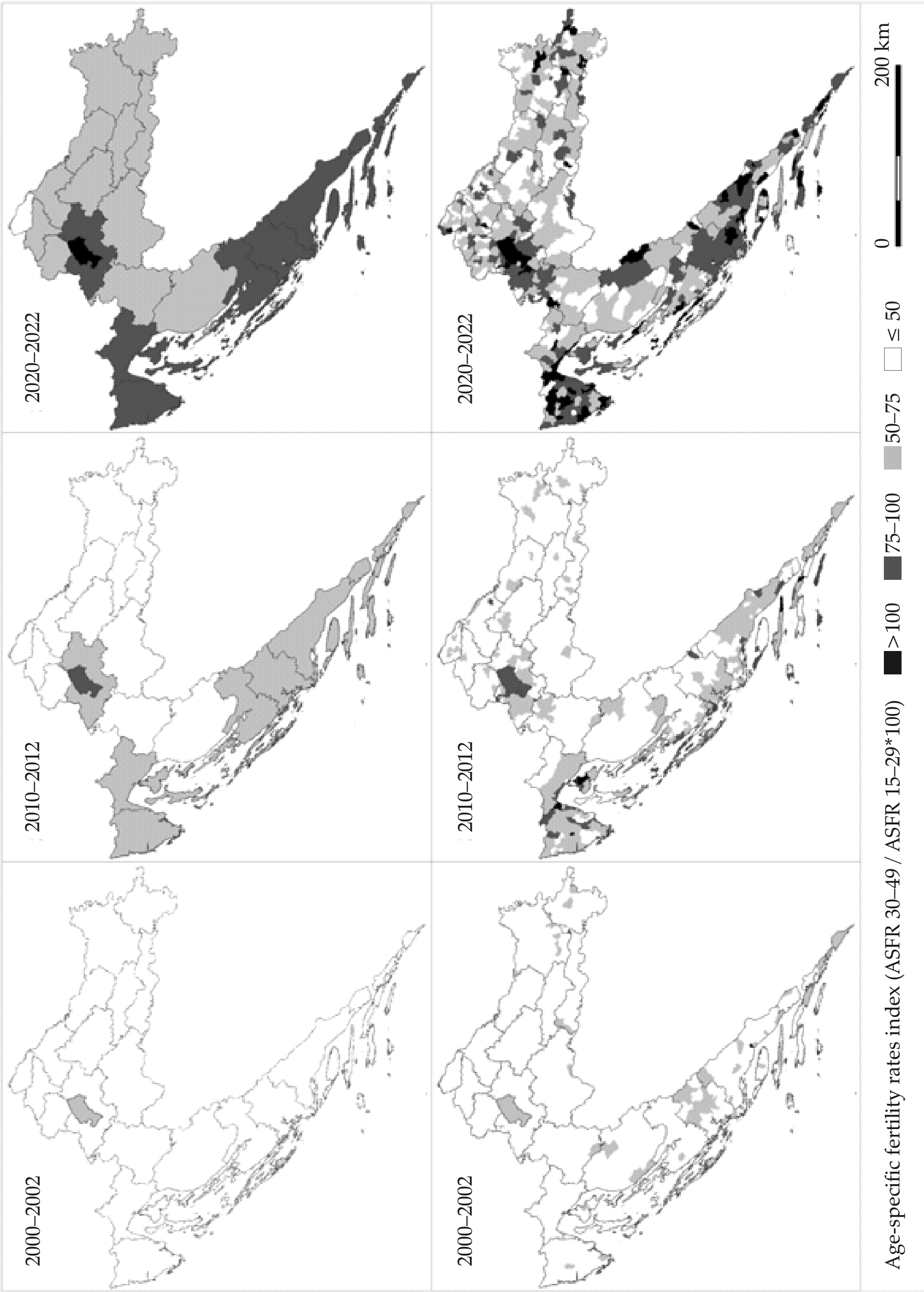


FIGURE 8
Spatiotemporal evolution of ASFR Index on a regional, and local level in Croatia

Comparing spatial patterns of birth timing at two spatial levels provides straightforward and general insights on a regional level and more detailed insights on a local level. At the beginning of the century, only Zagreb stands out in later births in regional-level data, but when zooming in on the local level, other major cities become prominent, along with some rural areas due to small numbers. In the second time point, the Zagreb region and coastal counties are distinctly highlighted. When examining municipalities, the importance of the coast becomes even clearer, and cities stand out.

In the period 2020–2022 at the county level, patterns are the same as ten years earlier, with the difference of the index increasing by one level across the entire area. An exception is Međimurje County. The local-level map provides a detailed depiction of birth timing in the recent period. In the areas marked in black, fertility rates are higher after the age of thirty. In conclusion, birth delay is more common in large cities, in the broader Zagreb region, most of the Northern Adriatic, large parts of Dalmatia, and in certain small municipalities.

Additional insight into understanding the spatial patterns of ASFR is provided by Moran's Spatial Autocorrelation Index (Table 3). For all three fertility indicators, there is a significant positive autocorrelation, but it diminishes. The Z-score has decreased the most for TFR, indicating a reduction in the importance of the location of each municipality in relation to its fertility level. Throughout the entire research period, the values are highest for $ASFR_{30-49}$, suggesting that fertility in this age group is more spatially dependent compared to $ASFR_{15-29}$.

➲ TABLE 3
Z-Score of Global Moran's Index

	2000–2002	2010–2012	2020–2022
TFR	10.7	6.2	4.2
$ASFR_{15-29}$	7.1	6.7	5.1
$ASFR_{30-49}$	11.6	11.7	7.1

The comparison of $ASFR_{15-29}$ and $ASFR_{30-49}$ in Croatian regions at two time points with recent values for European Union countries provides a wide scope of insights (Figure 9). The diagonal line represents the level of the ASFR Index at 100. The diagram illustrates the heterogeneity of counties in terms of birth timing. About twenty years ago, the City of Zagreb, Istria, and Primorje-Gorski Kotar counties had $ASFR_{15-29}$ lower than most post-socialist countries have today but with significantly lower $ASFR_{30-49}$. The impact of these regions, along with Split-Dalmatia, are one of the main reasons for Croatia's very low fertility in the younger age group. Primorje-Gorski Kotar, in these characteristics, is very close to Mediterranean countries. Zagreb is closest to the characteristics of

Finland and Cyprus, positioning it between Southern Europe and Nordic countries. On the other hand, Međimurje and Bjelovar-Bilogora have characteristics similar to Romania.

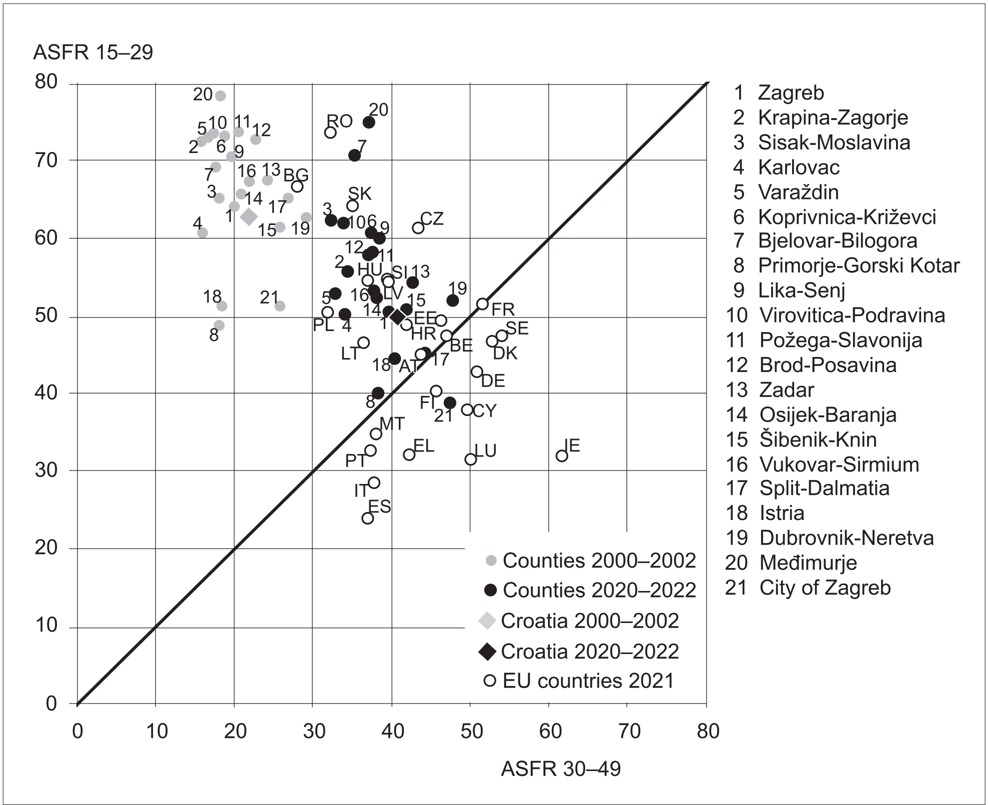
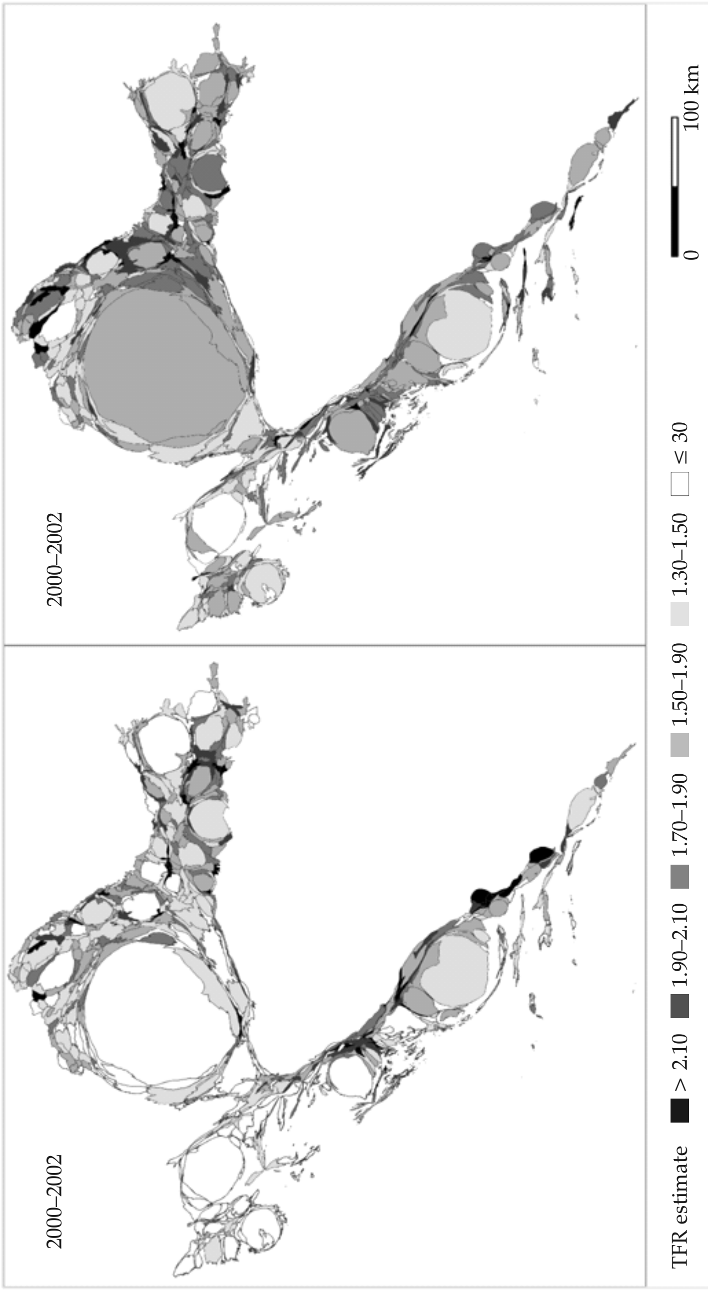


FIGURE 9
$ASFR_{15-29}$ and $ASFR_{30-49}$ in counties of Croatia compared to European Union countries

The continuous area cartogram illustrates local units distorted based on the number of the female fertile population, while the shades of colour represent the TFR estimate (Figure 10). The map shows the spatial disparities in population concentration. The dominance of Zagreb and other urban centres is clearly illustrated. Conversely, the spatially extensive Mountainous Croatia is reduced to a narrow corridor. The importance of this representation is even greater when considering the changes that occurred over two decades. Since the population has decreased, the spatial enlargement of units on the right map (2020–2022) does not necessarily imply an increase in the number of inhabitants but an increase in the share of the total fertile female population of Croatia. An illustrative example concerns Zagreb, which, despite the decrease in the number of fertile females, increased its share in Croatia's fertile contingent from 18.7% to 21.9%. In contrast, the shares of fertile contingents of Split, Rijeka and Osijek in Croatia's fertile contingent have decreased. The shares of Zadar, Varaždin, Dubrovnik, and several suburbs (e.g., Velika Gorica, Samobor, Kaštela, Zaprešić, Solin, Sveta Nedelja, Dugo Selo, Viškovo, and Podstrana) have slightly increased. The most visible change in reducing the fertile contingent is in Slavonia, which is significantly narrowed on the second map.

➲ FIGURE 10
Concentration of the female fertile population and fertility levels in Croatia using continuous area cartogram



The levels of estimated TFR at the beginning of the century clearly confirm the spatial pattern of very low fertility in large cities (Zagreb 1.28; Split 1.37; Rijeka 1.06; Osijek 1.23), and higher fertility in small municipalities. The entire Rijeka macroregion stands out as a region of low fertility, larger parts of Dalmatia and Slavonia as higher fertility regions, while Central Croatia remains heterogeneous. Until the recent period, fertility has increased in all parts of the country, and regional disparities have decreased. However, large cities still have significantly lower fertility (Zagreb 1.51; Split 1.41; Rijeka 1.21; Osijek 1.36).

DISCUSSION

Lower fertility in large cities and higher fertility in small towns and rural areas is almost a universal pattern confirmed in numerous studies (Campisi, 2020). This research confirms this pattern for Croatia as well. During the first decade of the 21st century, the difference in fertility between rural areas and large cities decreased from almost 0.3 children per woman to just over 0.1. Croatia's fertility rate increased until 2009, and the second point of the studied period (2010–2012) coincides with the period of economic crisis associated with a decline in fertility across Europe (Goldstein et al., 2013; Comolli, 2017). Studies across Europe for that period confirm fertility convergence (Sabater & Graham, 2019) but also greater resistance of urban fertility to crises (Halbac-Cotoara-Zamfir et al., 2021; Campisi et al., 2022). Similar conclusions are drawn for Croatia based on Crude Birth Rate data (Belić, 2023a). Likewise, the findings from these studies support a similar conclusion. However, by decomposing fertility into two age groups, it was found that older age births in urban areas were notably responsible for convergence (Figure 5). Therefore, the finding confirms that urban-rural differences in birth timing may distort period fertility rates and lead to misleading conclusions. Due to a lack of precise data on age structure outside census years, we cannot reliably determine what the differences were in 2009 or whether the decline in $ASFR_{15-29}$ in rural areas was predominantly the result of "regular birth postponement" or if the crisis itself was the trigger.

Up until 2020–2022, the disparities increased again: the estimated TFR for rural areas was 1.67, while for cities it was 1.47. Fertility rate was on the rise throughout the country,[4] but the increased disparity was a result of a notable increase in later births in rural areas (Figure 5). The extent of these changes is most vividly illustrated by the spatial pattern of $ASFR_{30-49}$, which underwent significant changes (Figure 7), and this is statistically confirmed by Moran's index (Table 3). The increase in later fertility in rural areas led to a reduction in distinct spatial patterns, but the spatial autocorrelation of $ASFR_{30-49}$ is still present and stronger than that of $ASFR_{15-29}$. This finding aligns with the results of a pan-European study, concluding that fertility in the younger age group is more influenced by local and regional characteristics, resulting in irregular spatial patterns (Belić, 2023b). In contrast, in the older age group, fertility is more influenced by neighbouring regions, indicating more pronounced social interactions among regions. Social interactions between neighbouring regions can facilitate the spread of ideas, norms, and behaviours (Watkins, 1991). Using Zagreb as an example, the expansion of fertility patterns to its suburbs is clearly visible, highlighting the rule that the fertility level in Zagreb in older age is more similar to the surrounding areas than in younger age (Figure 7). Furthermore, the higher fertility in the City of Zagreb compared to Split, Rijeka, and Osijek may be a combination of immigrant population structure (Čipin, 2022), long-standing policy measures, and cultural differences (Figure 9).

By following the gradual shift in birth timing (Figure 4) and ASFR differences by decades (Figure 5), it is possible to track the birth delay of specific groups, as well as the potential role of these changes in the dynamics of Croatia's fertility. Although it seems that rural areas will gradually follow the patterns of urban areas, research on the same phenomenon across Europe has shown this conclusion to be uncertain (Belić, 2023b). Despite a significant increase in the fertility of rural areas in later ages, it is expected that cities will continue to have notably lower fertility at younger ages. The second demographic transition has begun in cities, and they serve as a stronghold for "postmodern" values (Lesthaege & Neels, 2002; Kulu, 2013) Even though urban and rural areas will likely converge in terms of fertility in the future, significantly lower fertility in younger ages should be the reason why cities should continue to be "islands of lower fertility". Differences in cohort fertility confirm that the degree of urbanisation can be a significant composite factor of fertility in Croatia (Table 2).

The low $ASFR_{15-29}$ in Croatia can be explained by other reasons as well. The delayed departure from the parental home by young Croats compared to residents of any other European Union country (Eurostat, 2024e) may be influenced, at least in part, by cultural factors. Nevertheless, it undeniably represents one of the major contributing factors to the inadequacies observed in Croatia's housing policy (Čipin & Akrap, 2008). Housing affordability is one of the main prerequisites for starting a family (Mulder, 2006), and given the lower availability of suitable family-forming housing in cities, it is possible that the "housing crisis" is lowering Croatia's $ASFR_{15-29}$. An additional reason for the low $ASFR_{15-29}$ could be the emigration wave from Croatia after joining the European Union in 2013, which particularly affected the young and fertile population (Mesarić Žabčić, 2021). A small portion of them returned after a few years and started families in Croatia, thus their absence contributed to birth delay. Furthermore, a large number of emigrants did not deregister their residence in Croatia – hence, they remained in the population registry but did not participate in births. It is possible that this methodological reason slightly and seemingly reduced the $ASFR_{15-29}$.

The distorted maps illustrated spatial disparities in the concentration of fertile population and fertility levels (Figure 10). Furthermore, these disparities continue to grow over time. Based on the compositional mechanism, it can be anticipated that the more intensified future increase in the proportion of urban and decrease in rural population would negatively impact Croatia's national fertility rate. These changes may either decrease the fertility level or impede potential future fertility growth. Due to the ongoing dynamics of fertility in urban and rural areas, providing a precise assessment of the impact of rural decline on national fertility is challenging. Such calculation would necessitate year-to-year settlement level data. Based on the results of this study, we only know that cohort fertility in rural areas is higher than in cities by approximately 0.4 to 0.5 children per woman. Considering that certain rural settlements are classified as urban areas in this classification, it is plausible to conclude that the actual difference in fertility is somewhat larger.

The impact of rural decline on national fertility rates, as the focus of this research, is momentous for the future demographic and socio-economic development of Croatia. However, it is important to note that rural decline itself is an immeasurably significant subject. The historical development, territorial shape, unfavourable settlement network, lack of medium-sized cities, and rapid processes of industrialisation, deruralisation, and urbanisation have made Croatia extremely unevenly populated (Magaš, 2015). The cartogram map has provided a new perspective on the continuation of these processes (Figure 10). In the map, rural areas resemble the circulatory system of Croatia, symbolically representing their historical role as a reproductive incubator for cities, supplying them with a workforce. Today, rural areas have weakened to the extent that they can no longer adequately supply cities, and the workforce is increasingly being replaced by foreign workers. The fact that increasing the share of the rural population in Croatia's total population is one of the goals of the Demographic Revitalisation Strategy is a positive step (Central State Office for Demography and Youth, 2024). However, the actual results of the strategy's implementation are yet to be seen. Achieving real results would require a reversal of existing forces driving both reproductive and migratory dynamics.

CONCLUSION

Rural areas in Croatia exhibit significantly higher fertility compared to urban areas, but due to the unfavourable age structure and migration dynamics, they are experiencing a rapid population decline. Further redistribution of the population in favour of urban areas could potentially result in a reduction in the national fertility rate or limit its potential increase. Moreover, the uneven distribution of population is becoming increasingly unfavourable, representing a broader developmental challenge for Croatia. Mitigating and potentially stopping population decline in rural areas should become a developmental priority for Croatia. The main limitation of this study lies in the use of an imprecise TFR, an insufficiently long time span, and an estimated birth timing indicator. However, the methodological framework has proven useful for low spatial scale research of a similar nature. Fertility decomposition into younger and older age groups revealed that urban-rural differences in fertility timing influence urban-rural differences in period fertility. Therefore, caution is necessary when examining spatial variation in the TFR, as the values may be partially distorted. In future studies, it would be interesting to explore spatial patterns of fertility at the settlement level, providing insights into fertility along the urban-rural continuum.

NOTES

[1] The same procedure has proven to be a useful practice in similar studies (Nejašmić et al., 2008; Belić, 2023a).

[2] The classification of urban and rural areas is a complex topic. The number of models for their delineation varies from country to country, and the definition of rural itself depends on the discourse of interpretation, the purpose of the definition, specific geographical space and time, as well as the definition of urban as a reference point (Lukić, 2012). Ideally, differentiation is conducted at the settlement level. In the context of this study, considering the unavailability of required data at the settlement level, Eurostat's classification of LAU units (DEGURBA) was deemed the most suitable for research. This enables the use of the same classification for other countries, ensuring comparability of results with similar studies.

[3] The official data of 42% rural population in 2021 (CBS, 2024) is obtained through settlement-level classification.

[4] Due to the negative population momentum, despite a slight increase in the TFR, the number of live births is continuously declining.

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Prostorni aspekt odgode rađanja u Hrvatskoj: je li depopulacija ruralnih područja ograničavajući faktor nacionalne stope fertiliteta?

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Svrha rada jest istražiti urbano-ruralne razlike u visini fertiliteta i vremenu rađanja u Hrvatskoj te istražiti prostorno širenje odgode rađanja. Upotrijebljeni su podaci 556 jedinica lokalne samouprave u tri vremenske točke (2001., 2011. i 2021. godine). Jedinice su klasificirane u gradove, manje gradove i predgrađa te ruralna područja. Za širi kontekst uzeti su podaci na razini županija i europskih država. Analiza se oslanja na deskriptivnu statistiku, prostornu statistiku i geovizualizacije. Za praćenje vremena i odgode rađanja na lokalnoj razini upotrijebljen je poseban metodološki okvir koji se oslanja na omjer specifičnih stopa fertiliteta starije i mlađe dobi. Od 2001. do 2011. godine urbano-ruralne razlike u visini fertiliteta smanjile su se zahvaljujući rađanjima u urbanim područjima u kasnijoj dobi. Od 2011. do 2021. godine porastom kasnijih rađanja u ruralnim područjima razlike su se opet povećale. Zagrebačka regija, gradovi, Sjeverno primorje i velik dio Dalmacije predvodnici su kasnijih rađanja. Urbano-ruralne razlike u kohortnoj stopi fertiliteta veće su nego u periodskoj stopi fertiliteta. Daljnje smanjenje udjela ruralnoga stanovništva moglo bi dugoročno negativno utjecati na razinu nacionalnoga fertiliteta.

Ključne riječi: fertilitet, gradovi, ruralna područja, odgoda rađanja, Hrvatska