Vietnam's Missing Female Births: Insights from Geographical Differences, Trends, and Cultural Preferences

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Abstract

The sex ratio at birth (SRB) imbalance, primarily resulting from sex-selective abortion, is considered one of the most pressing demographic issues in Vietnam, as denoted by persistent high SRB for more than two decades. The government's efforts are challenged by cultural, demographic, and socioeconomic diversity across geographical locations and sub-groups inside the country. For example, son preference is biased towards Northern Vietnam. This study seeks to better understand this diversity by estimating missing female births (MiFB) in count and percentage in all geographical locations from 2009 to 2019 in Vietnam and to further analyze the annual MiFB trend and integrate it with the lunar years of birth. The number of MiFB is the difference between the estimated female births and the expected female births that would have been born if prenatal sex selection practices were absent in Vietnam. We found that MiFB was prevalent and universal in Vietnam in the observed period, with no signal of downturn in the national percentage of MiFB. The negative impacts of MiFB in the past decades are expected to emerge soon in Vietnam's society, like other earlier affected Asian countries. Thus, urgent actions are needed.

Keywords

Introduction

Nobel laureate Amartya Sen first introduced the concept of 'missing women' to highlight the gender imbalance resulting from sex discrimination in 1990, including factors such as sex-selective abortion or excess female mortality (Sen, 1990). This imbalance is expected to result in approximately 147.2 million missing women globally by 2025, predominantly in China and India, where strong son preferences persist (Bongaarts & Guilmoto, 2015). For Vietnam, a recent analysis of the imbalance sex ratio at birth (SRB) using the crude birth rate (CBR) method showed that 45,900 female births were missing in 2019 (General Statistics Office [GSO], 2020b). These disparities have led to profound social issues, such as daughter neglect, early marriage, marriage squeeze, trafficking of women and girls, and domestic violence against women (United Nations Population Fund [UNFPA], 2012), necessitating global attention towards gender equality, as emphasized in the 2030 Sustainable Development Goals (United Nations, 2023).

There are three principal methods to estimate the number of missing women in a population. Even though the three approaches differ significantly in data requirements and computational process, they all apply Sen's original computation of the missing female births (MiFB), considered the most precise and consistent estimate of the number of female births (Guilmoto et al., 2020). Known for its minimal data requirements and most straightforward calculations, Sen's original method requires only population or birth counts by sex. This method compared the observed SRB in the interested population and the expected SRB of the standard population, where gender discrimination was considered negligible. The basic concept of missing women is the difference between the number of women and those who would have been alive if the expected SRB were observed in the interested population, holding the number of males constant (Sen, 1990). The most challenging part of this method is choosing or constructing the gender-neutral standard population to get the expected SRB precisely. Thus, following the same concept, later studies adopted several modifications in selecting the standard population (Coale, 1991; Klasen, 1994; Klasen & Wink, 2003; UNFPA, 2012) or calculating more precise expected SRB for specific countries involving life expectancy (Anderson & Ray, 2010; Bongaarts & Guilmoto, 2015; Datt et al., 2022), that aimed to provide the better estimation of missing women compared to Sen's original method.

The second method is the CBR method, which Kulkarni (2007) developed. Several studies adopted this method using birth statistics derived from civil registration data (Saikia et al., 2021) or the CBR indicators from censuses (GSO, 2020b; UNFPA, 2015). The method follows Sen's concept in calculating the MiFB in the count, but the estimated female births are calculated using the CBR indicator and the mid-year population in censuses. While this method is straightforward, its accuracy can be significantly influenced by the reliability of birth statistics derived from the civil registration data or the CBR indicators obtained from censuses (GSO, 2020b; Kulkarni, 2007; UNFPA, 2015).

The last method is the reverse survival method, developed by Yadav (2013) and applied in this study. The estimation method for MiFB in this study combined several concepts. First, using life table techniques, the reverse survival method is used to retrospectively estimate the number of male and female births in specific preceding years (Siegel & Swanson, 2004). Next, Sen's original method is adopted to calculate the number of MiFB (Nguyen, 2021; Yadav, 2013). The term 'reverse survival method' was consistently used in this study to distinguish the current method from the other methods.

In addition, this method offers several advantages. It accounts for the effects of gender differences in survivorship probabilities using age-specific survival rates from life tables to obtain the estimated female and male births (Nguyen, 2021; Timæus & Moultrie, 2013; United Nations, 1983; Yadav, 2013). Given the unavailability and inaccessibility of civil registration data and the potential undercount of children in the 2019 Census of Vietnam (Chao et al., 2021; GSO, 2020b), the method can provide a more accurate estimate of births compared to the CBR method (Nguyen & Pothisiri, 2024), resulting in better MiFB estimates. Furthermore, with approximately 10% of Vietnamese provinces reporting fewer than 10,000 births per year (GSO, 2020a), using the MiFB estimates can avoid misinterpretation in the SRB variation caused by the small sample size in each province (UNFPA, 2012). A smoother pattern was observed in single-year MiFB estimates (Nguyen & Pothisiri, 2024) compared to possible variations in the annual SRB over time (GSO, 2020b; Mei & Jiang, 2021). Lastly, this method considered the natural variation of SRB, which was less likely addressed in previous studies.

This study contributes to the literature in several ways. First, using the two latest censuses in Vietnam that offer the most complete counts of children aged 0–9 and life tables, the MiFB trends across all geographic locations in Vietnam from 2009 to 2019 were investigated. This allows us to examine the potential impact of son preference, demographic, and socioeconomic characteristics on the MiFB across geographic locations. Second, this study examines a crucial cultural preference for Vietnamese lunar years derived from the Chinese zodiac, which is less likely to be discussed in previous studies. Based on the single-year MiFB estimates, the lunar years of birth with significant peaks in MiFB can be associated with gender-specific preference. Finally, some recent studies have suggested a potential downward trend toward a normal sex ratio at birth (NSRB) from 2014 to 2019 in some parts of Vietnam (Chao et al., 2021; GSO, 2020b). This study aims to lend robust evidence to this ongoing direction.

The study context of Vietnam

Prenatal sex selection across Asia can related to several reasons, such as the one-child policy (China), unequal marriage exchanges (India), patriarchal family systems (China, South Korea, India, and Vietnam), and economic downturns (Caucasus) (Das Gupta et al., 2003; Guilmoto, 2009). The skewed SRB in those countries is explained by the existence of three preconditions, including son preference, low fertility, and accessibility to prenatal sex selection technologies, referred to as "ready, willing, and able" for couples to undergo sex selection in the country. Among them, the culture of son preference is considered the root cause (Guilmoto, 2009). This theory is valid for Vietnam as the SRB onset at 107.3 in 2000 (Guilmoto et al., 2009), when ultrasound scans were widely available (Gammeltoft, 2014) and the total fertility rate (TFR) dropped to 2.25 children per woman in 2001 (GSO, 2011b).

In Vietnam, son preference driven by Confucianism is the most crucial reason for the persistent imbalance of SRB for more than two decades (GSO, 2020b; Guilmoto, 2009). Confucianism lasted for 1,900 years and significantly impacted spiritual practices in Vietnam. It was considered a national religion in the Nguyen Dynasty. Confucianism and Han culture united at the household level to establish a patrilineal kinship system in the Vietnamese traditional culture (Hieu, 2015). Moreover, Vietnamese Confucianism differed from Chinese Confucianism as it was mixed up with Vietnamese folk culture derived from other religions such as Buddhism and Taoism.

Furthermore, women were the most vulnerable group in this society because they had to live with their husband's household after married and were controlled under many Confucianism's "moral standards" such as three obedience (obedience to father, husband, and sons in widowhood) and four virtues (morality, good speech, modesty, and diligence). All these criteria enabled women to serve men effectively. Women's education was also limited as Confucian education and examinations were only available to men, resulting in women's low status in family and society (Hieu, 2015).

Even though Confucianism ended in the early 20th century after the conquering of French colonists and is no longer considered an official ideology or religion in Vietnam (Hieu, 2015), some applications of Confucianism remain universal in Vietnamese society, such as male offspring are always more valued than females for their roles in perpetuating the family name, performing religious duties, and providing parental support due to coresident with married sons (GSO, 2011c, 2016; Guilmoto, 2012; Guilmoto et al., 2009; UNFPA, 2011, 2012, 2018). This cultural bias has significantly and persistently influenced the reproductive needs of having at least one son, as highlighted by the 2019 Census in Vietnam (GSO, 2020b). Compared to China, where the one-child policy restricts the number of children (Jiang & Zhang, 2021), Vietnamese couples have more chances to obtain sons under the two-child policy (Government of Vietnam, 2019). However, they do target to obtain sons for the first child as SRB was high at this birth order, while approximately normal for the second child and highest at the third one (GSO, 2011c, 2020b; Institute for Social Development Studies of Vietnam, 2007; Le et al., 2017), which is similar to the current situation in China (Jiang & Zhang, 2021), but contrast with South Korea (Boer & Hudson, 2017), suggesting that son preference has shifted to a 'son requirement' in the contemporary societal setting of Vietnam (Hang, 2018).

Furthermore, gender preference in Vietnam is complex, as not all girls are unwanted. Besides the universal need for at least one son, the ideal gender preference in Vietnam is two children, including one boy and one girl (Guilmoto, 2012), known as mixed-gender preference (Nguyen & Sukontamarn, 2022) or *Du nep du te* in Vietnamese. In addition, the lunar year of birth also heavily influenced gender preference in Vietnam (Do & Phung, 2010), like other Asian nations (Lee & Paik, 2006; Yip et al., 2002). For example, couples prefer to give birth to a son in the Year of the Dragon or avoid having a daughter in the Year of the Tiger (Do & Phung, 2010). Vietnamese people often believe that the lunar years of birth would determine the horoscopes of a particular sex of children in the future regarding love, education, and success (Do & Phung, 2010). It explains why some parents even go as far as to misreport birth dates to avoid registering their children's birthdates in inauspicious lunar years (Pham et al., 2010). Therefore, understanding these cultural preferences could help predict the SRB's trend and appropriately select the target population for interventions.

Vietnam is a unique country with heterogeneities in gender imbalance across geographical locations, ethnicity, and culture (GSO, 2020b). It explains why a universal intervention program for the whole country was ineffective in comprehensively addressing this diversity, apart from the challenges in the legal abortion context (Nguyen, 2021). Table 1 illustrates the differences in demographic and socioeconomic characteristics of various geographic locations in Vietnam. Note that the classification into six regions adopted in this study was based on the 138/NQ-CP resolution dated October 25, 2022, according to the socioeconomic and demographic characteristics (Government of Vietnam, 2022). The six regions include the Red River Delta (11 provinces), Northern Midlands and Mountain (14 provinces), North Central and Central Coastal (14 provinces), Central Highlands (5 provinces), Southeast (6 provinces), and Mekong River Delta (13 provinces), as illustrated in Figure 4. Northern Vietnam is commonly used to combine the Red River Delta and Northern Midlands and Mountains.

Table 1: Descriptive Statistics of Demographic and Socioeconomic Indicators in Different Geographical Locations: Vietnam (2018–2021)

Indicators	Year	Nation	Urban	Rural	Red River Delta (Ha Noi)	Northern Midlands and Mountains	North Central and Central Coast	Central Highlands	Southeast (Ho Chi Minh)	Mekong River Delta
Imbalanced SRB										
SRB (males per 100 females)	2019	110.5	110..3	110.6	114.4	112.4	108.9	106.5	110.0	107.2
*Know the sex of fetuses under 15 weeks (%)	2021	38.7	38.1	39.0	55.7	45.9	43.5	26.3	17.2	17.4
*Abortion and menstrual regulation rate (%)	2021	0.5	0.5	0.5	0.7	1.0	0.3	0.2	0.5	0.3
Demographic characteristics										
Population size (million)	2019	96	33	63	22.5	12.5	20.2	5.8	17.8	17.2
Net migration rate (‰)	2019	//	//	//	7.5	-17.8	-24.6	-12.0	72.8	-39.9
Ethnicity (% of minorities)	2019	14.7	5.9	19.3	2.1	56.2	10.3	37.7	5.8	7.6
Household size (persons)	2019	3.6	3.4	3.6	3.4	3.9	3.6	3.8	3.4	3.6
**TFR (children per woman)	2019	2.1	1.8	2.3	2.4	2.4	2.3	2.4	1.6	1.8
*Life expectancy at birth (years)	2021	73.6	76.7	73.7	75.2	71.2	73.4	71.1	76.1	75.9
Socioeconomic characteristics										
*University and higher education (%)	2021	10.2	18.6	4.9	14.3	6.9	9.3	7.5	12.9	5.9
#Monthly average income per capita (thousand dongs)	2019	4,295	6,022	3,399	5,191	2,640	3,331	3,095	6,280	3,886
#Number of doctors (persons)	2018	84,788	//	//	22,056	12,079	17,604	3,990	15,391	13,668

Note: //: unavailable or inapplicable. Percentage of women aged 15–49 knowing the sex of the fetus in their last birth. The net migration rate is defined as (the number of in-migrants minus the number of out-migrants) per 1,000 population five years before the 2019 Census. Ethnicity of the household head. Percentage of the population aged 15 and over who attained university and higher education. Doctors have completed a six-year medical degree and are currently employed in Vietnamese public and private health facilities, both local and central. * GSO (2022); ** GSO (2021); # custom data acquired via GSO's website https://www.gso.gov.vn/en/health-culture-sport-living-standards-social-order-safety-and-environment/; *Remaining indicators: GSO (2020a).*

The urban-rural difference of the national SRB in Vietnam has not been established in the 2009 and 2019 Censuses (GSO, 2011c, 2020b). The only trend identified was the prenatal sex selection initially practiced among urban, rich, and educated couples with lower fertility who had access to information and could afford quality ultrasounds at the onset of skewed SRB in Vietnam. After that, this practice spread to rural areas and other social subgroups (GSO, 2011c, 2020b).

In contrast, the north-south difference is clear and consistent throughout the two recent censuses (GSO, 2011c, 2020b). A consistently high SRB was observed in the north, regardless of the data sources used (Pham et al., 2010). Previous studies indicated several reasons for this difference. First, Northern Vietnam exhibited a stronger son preference, affected by the neighbor China, where Confucianism, patrilineal kinship systems, and beliefs related to lunar years influenced social practices (GSO, 2020b). Southern Vietnam more closely resembled its neighboring countries, such as Thailand, Lao People's Democratic Republic, and Cambodia (GSO, 2020b), influenced by the enduring impact of Khmer culture, with no gender preference for children (Chao et al., 2021). The son preference in the north was reflected in many social practices, such as early searching for fetal sex before the 15th week of gestation (GSO, 2011b, 2022), a higher percentage of older parents living with married sons (GSO, 2011c, 2020b), highly extending fertility to obtain sons (sons as last birth), and a lower proportion of families with only girls (GSO, 2020b). The geographical differences in Vietnam also led to the SRB variation across provinces. The provinces with lower SRBs were more likely to be less developed, consisting of minority groups, and located in the Central Highlands and the Mekong River Delta in Southern Vietnam (GSO, 2011c, 2016; Guilmoto, 2012).

Materials and methods

Data

Survival rate: We calculated the survival rates using abridged life tables obtained from the Vietnam General Statistics Office (GSO). The 2009 abridged life tables taken from provided comprehensive data segregated by sex at the national and sub-national levels (GSO, 2012). The 2019 abridged life tables taken from (GSO, 2019) offered data only at the national level.

Number of Children aged 0–9 Years: These data, disaggregated by age and sex, were derived from the 2019 Census report (GSO, 2020a). The figures covered sub-national levels, including provinces and areas of residence.

Calculation steps for estimating missing female births

In this study, the census counts of males and females aged 0–9 years in 2019 were used to estimate the numbers of male and female births between 2009 and 2019 by reversing the survival rates. Before applying the reverse survival method, it is important to acknowledge two specific limitations. First, an accurate estimation of MiFB over ten years would ideally require an abridged life table constructed from the total deaths by age and sex from 2009 to 2019. However, constructing such an abridged life table was not feasible due to challenges in accessing reliable annual mortality data disaggregated by age and sex and the quality of death data compromised by under-registration. Second, our research aimed to explore variations in MiFB by provinces and areas of residence, which necessitated abridged life tables at these

specific levels but were also unavailable in 2019. Given these constraints, the subsequent sections discuss the reverse survival method employed and how it was adapted to address these shortcomings. The estimation process was divided into three main steps:

Step 1: Calculation of the survival rates

In population research, survival rates are typically calculated for a five-year age group and five years. The general formula is:

$$_5S_x^5 = \frac{_5L_{x+5}}{_5L_x} \tag{1}$$

However, for the youngest age groups, including 0–1, 0–4, 1–4, and 5–9 years, which were needed for this study, Siegel and Swanson (2004) suggested the following formulas:

$$_1S_0^{(i,j,t)} = \frac{_1L_0^{(i,j,t)}}{l_0} \tag{2}$$

$$_4S_1^{(i,j,t)} = \frac{_4L_1^{(i,j,t)}}{4 \times l_0} \tag{3}$$

$$_5S_0^{(i,j,t)} = \frac{T_0^{(i,j,t)} - T_5^{(i,j,t)}}{5 \times l_0} \tag{4}$$

$$_5S_5^{(i,j,t)} = \frac{_5L_5^{(i,j,t)}}{5 \times l_0} \tag{5}$$

Where x refers to age, n represents the age interval, and l_0 represents the radix population of 100,000. $_nL_x^{(i,j,t)}$ and $_nS_x^{(i,j,t)}$ denote the person-years lived and the survival rate, respectively, from age x to $x + n$ of sex i at geographic location j in year t. $T_0^{(i,j,t)}$ and $T_5^{(i,j,t)}$ represent the total person-years who lived beyond ages 0 and 5, respectively, for sex i in province j in year t.

Calculating the survival rates in Equations 2 to 5 for two sub-national levels, namely provinces and areas of residence, required several additional steps and assumptions. Since the life table for 2019 was available only at the national level, the ratio method was adopted to estimate the survival rates for urban-rural areas of residence and provinces in 2019 (Siegel & Swanson, 2004). In this approach, the national-level survival rates from 2019 were compared with those from 2009. A relative change, represented as z, was then calculated using the following equation:

$$_nz_x^{(i)} = \frac{_nS_x^{(i,nation,2019)}}{_nS_x^{(i,nation,2009)}} \tag{6}$$

where $_nz_x^{(i)}$ is the ratio between the survival rate from age x to x+n in 2019 and its corresponding survival rate in 2009 of sex i at the national level.

The age-specific and sex-specific z values for males and females at the national level were obtained and subsequently applied to the survival rates in 2009. This projection method was used to estimate the survival rates for 2019 at the sub-national levels using the following formula:

$$_nS_x^{(i,j,2019)} = {}_nz_x^{(i)} \times {}_nS_x^{(i,j,2009)} \tag{7}$$

In some cases, sub-national areas would not change at the same rate as the nation. However, when examining the z values in another mortality indicator among children in Vietnam for 2009–2019 under-five mortality rate (U5MR) using the data from the GSO (GSO, 2012, 2019). This study found that z values of both sexes U5MR surrounded 1 at all geographical locations, and the variation was below 0.01. Therefore, given the data constraints, our study could apply the ratio method to fulfill the survival rates of sub-national locations in 2019 without meeting considerable problems with this assumption.

Next, the survival rates in Equations 2 to 5 calculated for both 2009 and 2019 at individual geographic locations were averaged to determine the average survival rates for these locations, following the suggestion by Rowland (2003). While we acknowledge the limitations of this method, such as equally weighting the two estimates, it was deemed the most appropriate approach for calculating survival rates of all geographical locations from 2009 to 2019, given the data constraints. The equation used to calculate the average survival rates at both the national level and for different provinces and areas of residence was:

$$_nS_x^{(i,j)*} = \frac{{}_nS_x^{(i,j,2009)} + {}_nS_x^{(i,j,2019)}}{2} \tag{8}$$

where $_nS_x^{(i,j)*}$ is the average survival rate of sex i at location j.

Notice the average survival rates for the five-year age groups: $_5S_0^{(i,j)*}$ and $_5S_5^{(i,j)*}$ were consistently used to obtain the MiFB estimates in two consecutive five-year periods, 2009–2014 and 2015–2019. The ten-year MiFB estimates were then obtained as the sum of the two five-year MiFB estimates for the whole country, the urban-rural areas of residence, and all provinces. Meanwhile, the survival rates for a single-year age group: i.e., $_1S_0^{(i,j)*}$– were only used to examine the annual trend of MiFB for the country and the urban-rural areas of residence as it involved more calculations and assumptions.

In Equation 1, the average survival rate for the first single-year age group (0–1) was calculated separately due to its higher survival rate than other age groups. To obtain the average survival rates for other single-year age groups from 1–2 to 4–5, Equation 3 was used to obtain $_4S_1^{(i,j)*}$. By assuming equal survival rates among each single-year age group between ages 1-5, the survival rate for a single-year age group was taken as the nth root of the n-year age survival rate. For instance, $_1S_1^{(i,j)*} = {}_1S_2^{(i,j)*} = {}_1S_3^{(i,j)*} = {}_1S_4^{(i,j)*}$ = the 4th root of $_4S_1^{(i,j)*}$. A similar approach was applied to estimate the survival rates for the single-year age groups from 5-6 to 9-10 as the 5th root of $_5S_5^{(i,j)*}$.

Step 2: Calculation of the number of births

In the second step, the average survival rates in Step 1 were applied to the number of children aged 0–9 years to estimate the likely number of male and female births over the period from 2009 to 2019, termed estimated male births (EMB) and estimated female births (EFB), respectively. From the 2019 Census data, we obtained the counts of children aged 0–9 years. Using this information, the five-year estimated births (EB) by sex were calculated using the five-year age group survival rates to obtain the ten-year MiFB count for all geographical

locations in Vietnam. The single-year EB by sex was derived using the single-year age group survival rates to obtain the single-year MiFB count for the country and the urban-rural residence areas. This restriction in locations was due to the availability of children counts in the 2019 Census for single-year age only for the country and the urban-rural areas of residence.

The equation used to calculate EB, as demonstrated by Siegel and Swanson (2004), was:

$$_nEB_x^{(i,j,t)} = \frac{_nN_x^{(i,j,t)}}{_nS_x^{(i,j)*}} \tag{9}$$

where $_nN_x^{(i,j,t)}$ represents the count of children aged x to x+n of sex i at location j in time t, enumerated in the 2019 Census. $_nS_x^{(i,j)*}$ is the average survival rate of children of sex i at location j in the same age group as the numerator and $_nEB_x^{(i,j,t)}$ denotes the estimated number of births of sex i at location j in time t. Note that t represents a specific year (i.e., 2019) or five-year duration (i.e., 2009–2014 or 2015–2019).

In this step, we assumed no migration among children aged between 0 and 9 years in the 2019 Census to obtain the estimate of EB by sex. Most migrants in Vietnam are between 20 and 49 working ages. In addition, the number of international adoption cases in Vietnam was relatively small, with 578 children annually between 2012 and 2016 (International Organization for Migration, 2017).

Step 3: Calculation of the MiFB estimates

The final step involved calculating MiFB in count and percentage. This study provided several types of MiFB for different geographical locations, such as five-year, ten-year, and single-year MiFB, depending on the study's purposes and data availability. It was assumed that the SRB in Vietnam remained normal from 2009 to 2019, indicating no prenatal sex selection practices across the country. Consequently, the number of female births calculated using the normal sex ratio at birth (NSRB) was assumed to correspond to the number of expected female births (ExFB). Based on this assumption, the expected natural occurrence of female births, unaffected by sex-selective practices, could be estimated and compared with actual counts of female births to determine the extent of MiFB.

The calculation of ExFB was performed using the following equation:

$$_nExFB_x^{(j,t)} = _nEMB_x^{(j,t)} \times \frac{100}{NSRB} \tag{10}$$

Where $_nExFB_x^{(j,t)}$ represents the expected number of female births at location j in time t, and $_nEMB_x^{(j,t)}$ denotes the estimated number of male births at location j in time t.

Next, the calculation for MiFB in count proceeded as follows:

$$_nMiFB_x^{(j,t)} = _nExFB_x^{(j,t)} - _nEFB_x^{(j,t)} \tag{11}$$

Where $_nMiFB_x^{(j,t)}$ represents the number of missing female births at location j in time t, and $_nEFB_x^{(j,t)}$ is the estimated number of female births at location j in time t.

The MiFB count can be affected by the prevalence of prenatal sex selection practices and the number of births at specific geographical locations and times. Thus, the percentage MiFB (%MiFB) was also calculated to compare the MiFB estimates between different geographical locations by the following equation (Cai & Lavely, 2003; UNFPA, 2015):

$$_n\%MiFB_x^{(j,t)} = \frac{_nMiFB_x^{(j,t)}}{_nExFB_x^{(j,t)}} \times 100 \tag{12}$$

Where $_n\%MiFB_x^{(j,t)}$ denotes the percentage of missing female births at location j in time t.

For results presentation, this study presented MiFB estimates at national and sub-national levels with their 95% confidence intervals (CI) to indicate the precision and reliability of the estimates. The 95% CI for the estimated MiFB count was calculated as $N_1 \pm 1.96 \times SE_1$, where N_1 represented the MiFB count, and 1.96 denoted the z-score corresponding to a 95% confidence level, while SE_1 was the standard error, determined using the Poisson distribution as $\sqrt{N_1}$ (Pezzullo, 2013). Meanwhile, the 95% CI for the estimated percentage of MiFB was calculated as $(p_2 \pm 1.96 \times SE_2) \times 100$, where p_2 represented the proportion of estimated MiFB count to the corresponding ExFB, and SE_2 was derived from a binominal proportion as $\sqrt{\frac{p_2 \times (1-p_2)}{N_2}}$, with N_2 denoting the computed ExFB (Wackerly et al., 2008).

For results visualization, provincial ten-year MiFB estimates were plotted in the Vietnam maps to explore sub-national geographic location differences. Maps were generated using Geographic Information System software (QGIS 3.36.0), and the estimation results were categorized into quintiles for mapping purposes. The QGIS software does not have information on the two archipelagos of Hoang Sa and Truong Sa; therefore, this information was collected from the GSO monograph (GSO, 2020b). All calculations were performed using spreadsheets. Thus, the estimated results are presented in tables and figures as rounded numbers in the next section.

Finally, to address variations in NSRB, our study employed four different NSRB values from 104 to 107, facilitating an evaluation of how these variations impact the MiFB count. We calculated the average change in the ten-year MiFB count for each incremental point change in NSRB and its proportion to the total ten-year MiFB count with an NSRB of 105. However, scholars often adopt an SRB of 105 as the standard for a balanced sex ratio (Kulkarni, 2007; Nguyen, 2021; UNFPA, 2012; Yadav, 2013). Thus, 105 was primarily used in our subsequent results and discussion to maintain consistency with previous research.

Results

Geographical differences in ten-year MiFB estimates

This section presents the ten-year MiFB estimates (2009–2019) as the sum of two five-year MiFB estimates (2009–2014) and (2015–2019) using five-year age group survival rates from the GSO abridged life tables. The MiFB in absolute and relative terms are addressed with their 95% CI for the entire nation first, then urban-rural areas of residence, and followed by provinces.

Referring to the nation, Figure 1 presents the ten-year MiFB count and percentage based on various NSRB values. Using an NSRB value of 105, the total MiFB count of 467,282 (95% CI [465,942–468,622]) was estimated between 2009 and 2019 in Vietnam. This figure represented 5.65% (95% CI [5.63–5.66%]) of the ExFB in Vietnam in the absence of prenatal sex selection. Moreover, the variation in NSRB significantly influenced the estimated ten-year MiFB count, as indicated by non-overlapping CI for different NSRB values. An NSRB value of 104 resulted in a higher estimate of a ten-year MiFB count compared to an NSRB of 105 or lower estimates with NSRB values of 106 or 107. In other words, decreasing the NSRB by one unit added 78,181 missing females over ten years, accounting for nearly 16.7% of the total ten-year MiFB count (467,282).

Figure 1: Ten-Year MiFB Count by Various NSRB Values Nationwide, Vietnam (2009–2019)
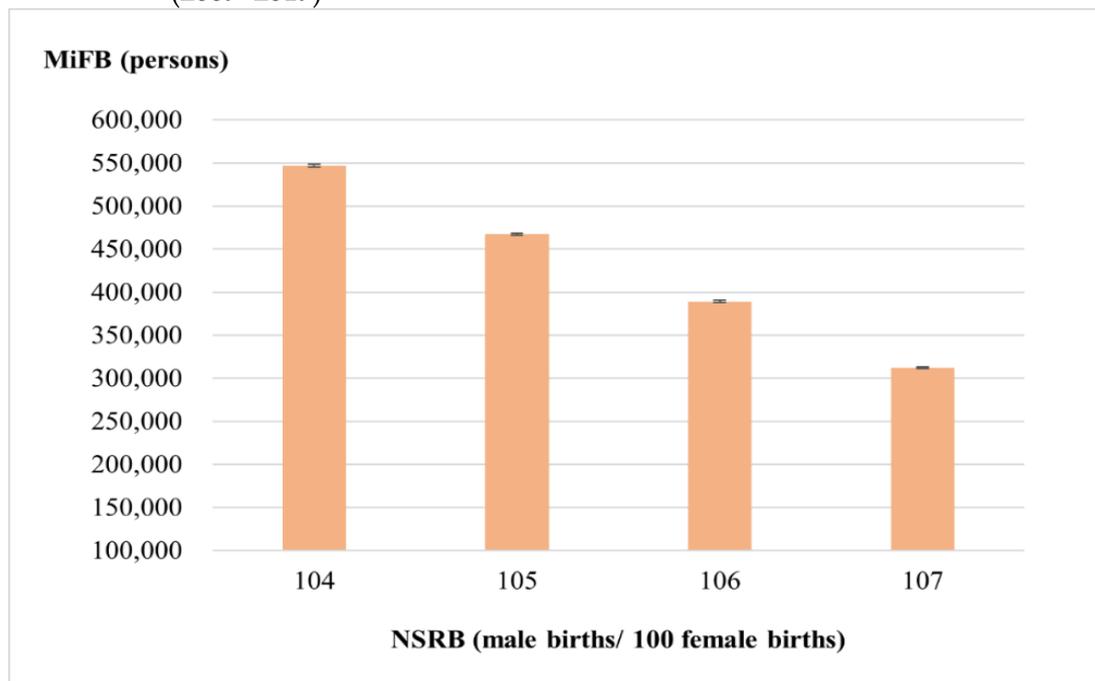
Note: 95% confidence intervals are presented; Database of GSO, authors' construction.

In terms of areas of residence, Figure 2 illustrates that the number of ten-year MiFB count in rural areas was 2.13 times higher than in urban areas due to the higher number of births estimated in rural areas, as the rural population typically comprises 70% of the total population in Vietnam (GSO, 2019). Regarding the intensity of prenatal sex selection, the ten-year percentage of MiFB in urban areas was 5.76% (95% CI [5.73–5.79%]), slightly higher than in rural areas by 0.21%. This slight difference could not be negligible when considering non-overlapping confidence intervals.

**Figure 2:** Ten-Year MiFB Estimates by Areas of Residence, Vietnam (2009–2019)
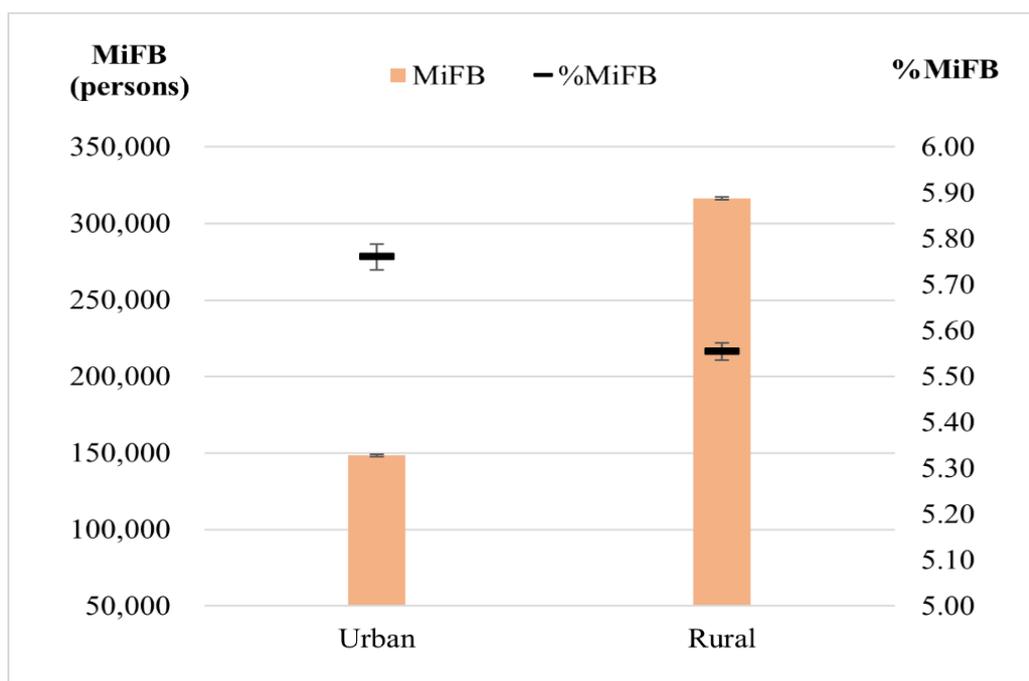
Note: NSRB equals 105, and 95% confidence intervals are presented; Database of GSO, authors' construction.

To show variations across regions and provinces, the provincial ten-year MiFB count and percentage of MiFB were plotted using different colors by quintile on the map of Vietnam in Figures 3 and 4, respectively. The darker-colored areas indicate a higher prevalence or percentage of MiFB. In general, MiFB remained universal throughout the country, potentially indicating the prevalence of prenatal sex selection. However, the distribution was not uniform across provinces, with a higher concentration in Northern Vietnam.

As shown in Figure 3, the top ten provinces with the highest MiFB counts between 2009 and 2019 were Ha Noi, Ho Chi Minh, Thanh Hoa, Bac Giang, Nghe An, Hai Duong, Bac Ninh, Dong Nai, Hung Yen, and Vinh Phuc (province names shown in red color). These provinces collectively accounted for approximately half of Vietnam's total MiFB and should be the priorities of the government's interventions. Ha Noi, the capital of Vietnam located in the Red River Delta, reported the highest MiFB at 69,209 (95% CI [68,694–69,725]). The second rank of MiFB belonged to Ho Chi Minh, the most populous and developed megacity at 30,482 (95% CI [30,140–30,824]) (GSO, 2020a). Notice that Ho Chi Minh and Dong Nai from the Southeast are excluded from the top ten list when considering their percentage of MiFB due to eliminating the effect of the large population size (GSO, 2020a). In addition, Bac Ninh, the homeland of traditional festivals and rich cultural history in Vietnam (Bac Ninh Portal, 2020), is located in the Red River Delta and had the highest percentage of MiFB at 12.78% (95% CI [12.60–12.96%]). On the other hand, Bac Kan, a mountainous province with 88% minorities and the smallest population size in Vietnam (GSO, 2020a), also located in the north but had the lowest MiFB estimates with a count of 418 (95% CI [378–458]) and a percentage of 1.46% (95% CI [1.32–1.59%]) (see the province noted in yellow in Figure 3).

Figure 3: Distribution of Ten-Year MiFB Count Across Provinces, Vietnam (2009–2019)
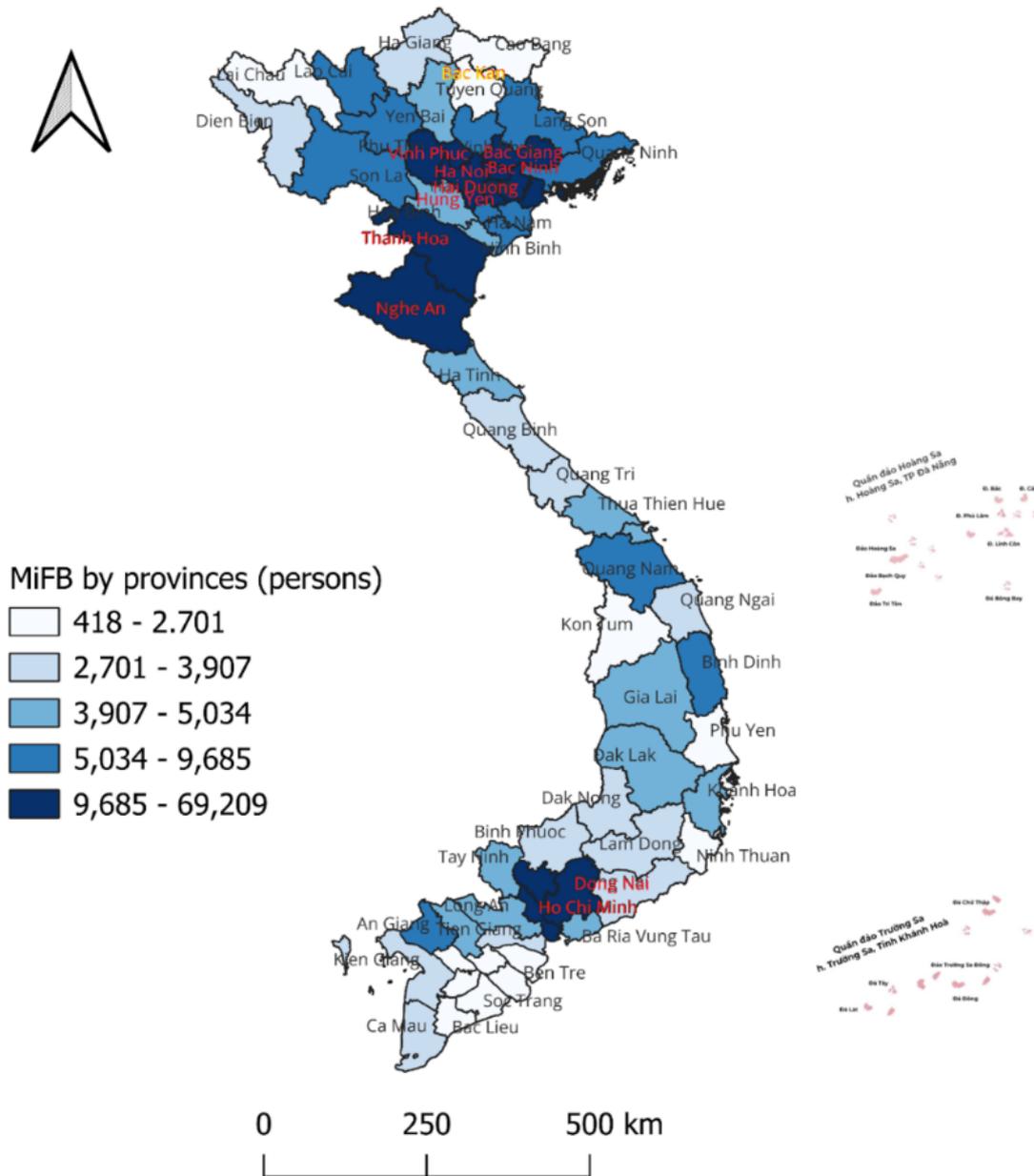
Note: The top ten provinces with the highest MiFB count are indicated in red. Bac Kan, which had the lowest MiFB count, is noted in yellow. Quintile is used to classify MiFB in different colors, and NSRB equals 105; Database of GSO, authors' construction.

As can be seen from Figure 4, the bias towards the Northern provinces was more pronounced, as the darkest-colored areas were all in the Red River Delta and Northern Midlands and Mountains of Northern Vietnam, except for Thanh Hoa, one of the Vietnamese traditional cultural origin with enormous spiritual activities (An, 2016), located in North Central and Central Coast. In contrast, the provinces with the lowest percentage of MiFB were biased towards Southern Vietnam and located in various regions, including Northern Midlands and Mountains, Central Highlands, and Mekong River Delta (the lightest-colored areas in Figure 4). This suggests that prenatal sex selection is less prevalent in these regions and provinces.

Figure 4: Distribution of Ten-Year percentage of MiFB Across Provinces, Vietnam (2009–2019)
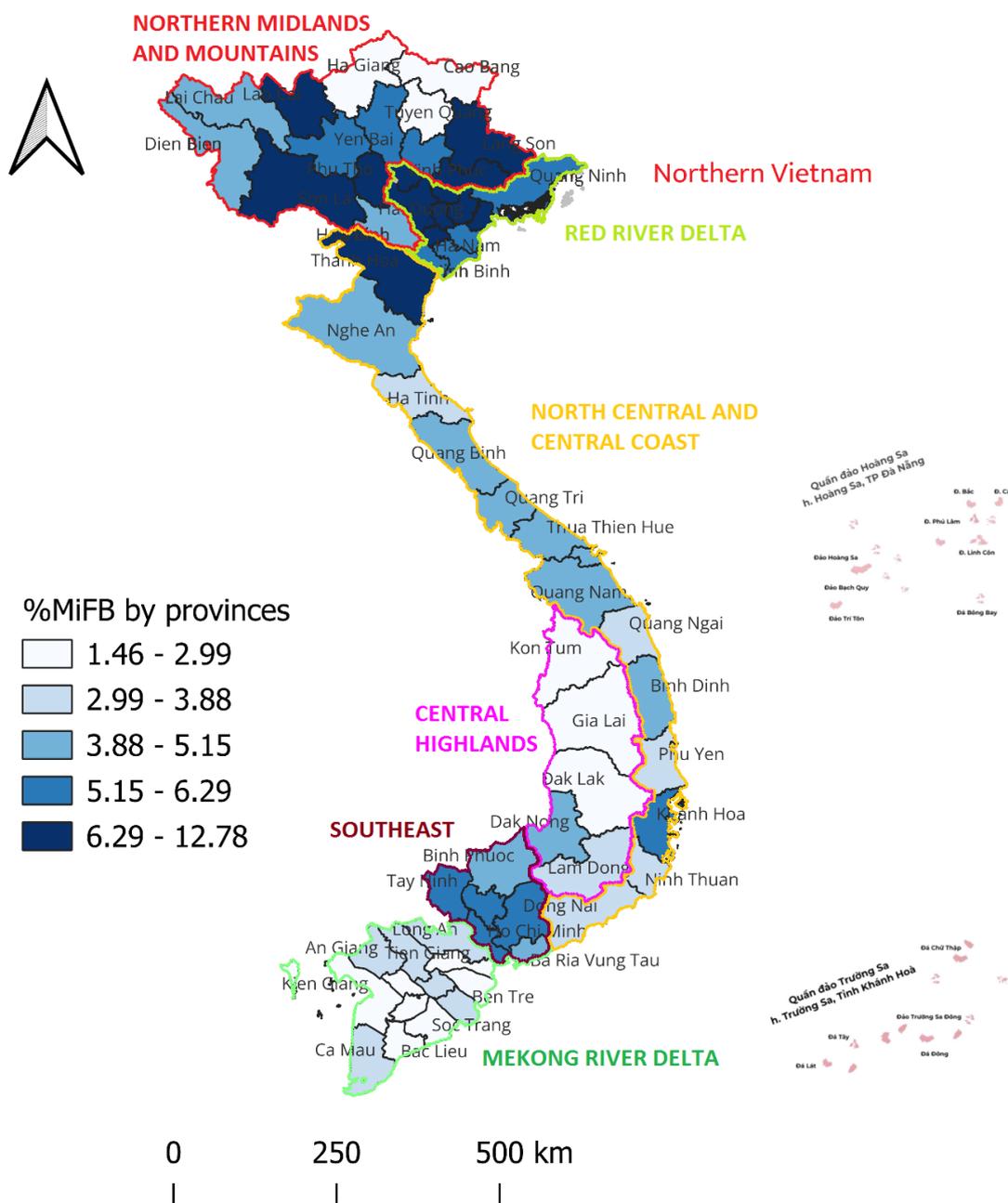
Note: Six regions are noted with different colored boundaries. Quintile classification is used to categorize the percentage of MiFB, represented in various colors, with NSRB equaling 105; Database of GSO, authors' construction.

Trends in single-year MiFB by geographical locations and cultural preferences

This section examines the single-year MiFB estimates using the survival rates for the single-year age group from the GSO abridged life tables. Figure 5 shows the trends of the single-year MiFB in both count and percentage with their 95% CI at the national level. Meanwhile, Figure

6 illustrates only the single-year percentage of MiFB with their 95% CI to compare and eliminate the difference in population sizes between urban and rural areas. The trend analysis was not conducted for provinces due to the unavailability of recorded single-year-age children in the 2019 Census. Note that children aged 0, as enumerated in the 2019 Census, were those born between April 1, 2018, and March 31, 2019. The terminal year of birth is thus indicated as 2019 on the x-axis. This definition was likewise applied to children aged 1–9 years.

Figure 5 shows the nationwide MiFB count fluctuating considerably over time. Specifically, the MiFB count increased gradually from 26,867 (95% CI [26,546–27,189]) in 2010 to 37,546 (95% CI [37,167–37,926]) in 2012. A peak followed this in 2013, the Year of the Water Dragon, or *Nham Thin* in Vietnamese, a good year for boys and a neutral year for girls (Do & Phung, 2010) at 45,349 (95% CI [44,931–45,766]), suggesting couples wanted to have sons in this year. The peak in MiFB count was due mainly to the highest total births estimated this year, as the peak is eliminated when considering the percentage of MiFB. After this year, the MiFB count dropped sharply to 38,347 (95% CI [37,963–38,731]) in 2014, followed by a slight increase over the next two years. After 2016, the MiFB count remained relatively stable until reaching 39,648 (95% CI [39,258–40,039]) at the end of the observed period. In terms of percentage, the percentage of MiFB was relatively stable, with a slight increase over the observed period from 3.42 (95% CI [3,38–3.46%]) in 2010 to 5.65% (95% CI [5.60–5.71]) in 2019.

Figure 5: Trends in Single-Year MiFB Estimates Nationwide, Vietnam (2009–2019)
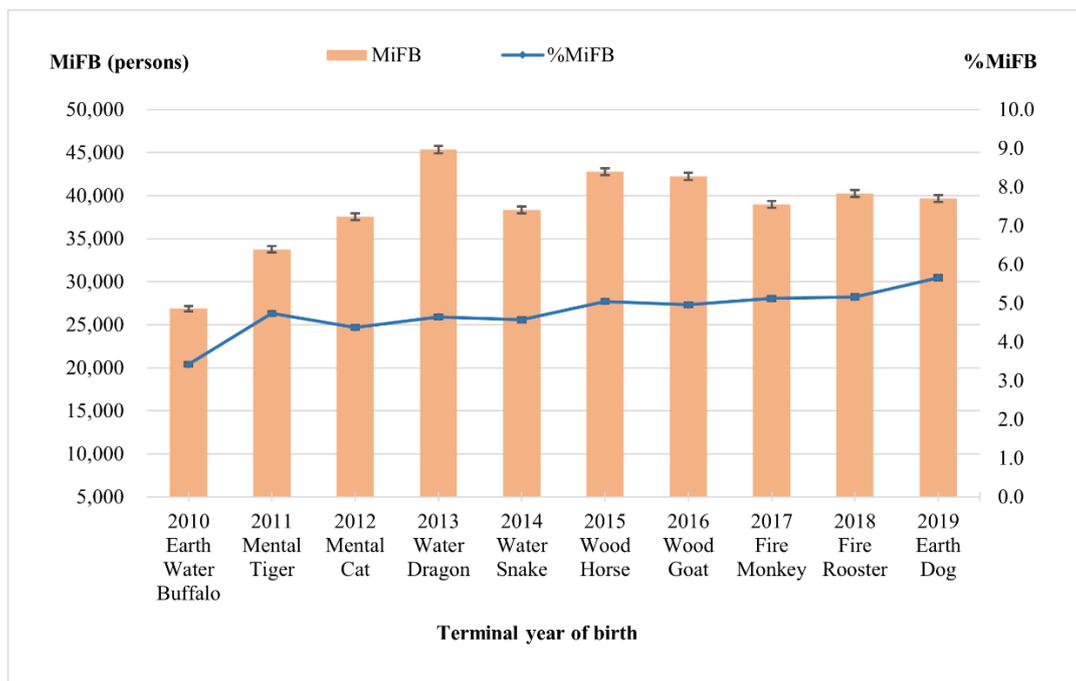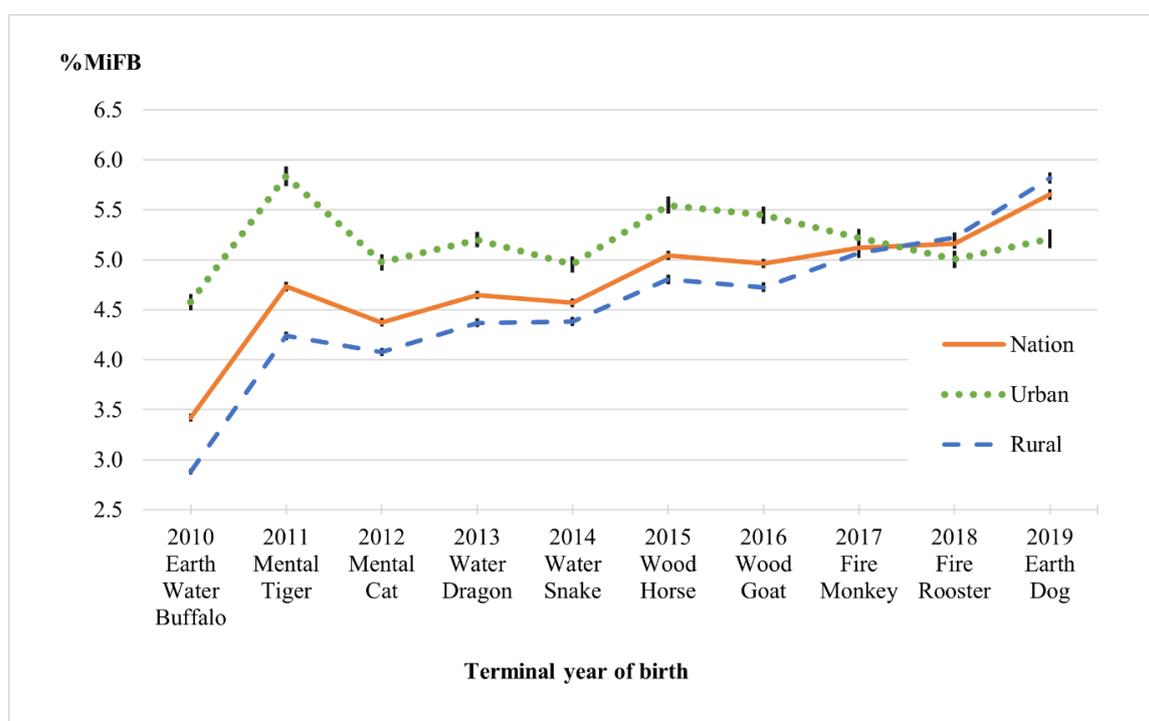

Note: NSRB equals 105, and 95% confidence intervals are presented; Database of GSO, authors' construction.

Figure 6 shows that the percentage of MiFB in urban areas was similar to that in rural areas from 2010 to 2015. In addition, the percentage of MiFB was consistently higher in urban areas than in rural areas. The national percentage of MiFB was similar to the trend in rural areas. However, these trends started to reverse in 2016 until 2018, with the percentage of MiFB in urban areas declining significantly from 5.45% (95% CI [5.36–5.53%]) to 5.01% (95% CI [4.92–5.09%]), whereas the percentage of MiFB in rural areas increased considerably from 4.73% (95% CI [4.67–4.78%]) to 5.22% (95% CI [5.16–5.28%]), resulting in the overall increase

nationwide by 0.04%. At the end of the observed period, another increase in the percentage of MiFB in urban areas was seen, similar to the trend observed in rural areas and the country.

Moreover, several spikes in the percentage of MiFB were observed during the ten years, likely related to the lunar years of birth. These included the Year of the Mental Tiger or *Canh Dan* in Vietnamese (2011), a neutral year for boys and a bad year for girls; the Year of the Water Dragon or *Nham Thin* in Vietnamese (2013), a good year for boys and a neutral year for girls, and the Year of the Wood Horse or *Giap Ngo* in Vietnamese (2015), a good year for boys and neutral year for girls (Yip et al., 2002). These peaks were consistently observed across urban and rural areas of residence, suggesting that this gender-related cultural preference was likely universal in Vietnam.

Figure 6: Trends in Single-Year Percentage of MiFB by areas of residence, Vietnam (2009–2019)

Note: NSRB equals 105, and 95% confidence intervals are presented; Database of GSO, authors' construction

Discussion

Using a well-known method, this study contributes to our understanding of the trend and prevalence of MiFB across different geographical locations in Vietnam between 2009 and 2019. Even though the percentage of MiFB in Vietnam was at the stabilization stage (Figure 5), our findings indicated a sharp increase in the number of MiFB as its prevalence in 2009–2019 was double that of 1999–2009 using the same estimation method (Nguyen, 2021), alarming the enormous shortage of females would be witnessed in adults, marriage, and reproductive ages soon in Vietnam.

Our study, once again, confirmed the essential role of geographical locations in the SRB variation in Vietnam compared to elsewhere in the world (GSO, 2020b). This finding has been indicated in earlier studies in Vietnam (Chao et al., 2021; GSO, 2011c, 2016, 2020b) as well as in other son preference countries such as South Korea, India, and China (Chun, 2019; Guilmoto, 2009; Kulkarni, 2007). Table 1 shows geographical differences in many aspects of Vietnam.

One of our new contributions is identifying urban and rural differences in absolute and relative terms of MiFB, even though the percentage difference was relatively small (Figure 2). From 2010 to 2015, the percentage of MiFB in urban areas increased earlier than that of rural areas (Figure 6). This trend is similar to South Korea (Chun, 2019), India (GSO, 2020b), and China (Jiang & Zhang, 2021). Since urban areas were more developed than rural areas, with higher education, higher income, and low fertility (Table 1), leading to earlier access to ultrasound scans and sex-selective abortions (GSO, 2016, 2020b; Guilmoto, 2012; UNFPA, 2011). Meanwhile, the percentage of MiFB rural areas increased later due to higher TFR and a higher percentage of minorities (Table 1), where couples had more chances to obtain sons naturally and were affected by folk or local culture instead of Confucianism (GSO, 2020b; Hieu, 2015). The pressure of having a son might be similar; rural women are often pressured by their families to produce a male heir, while urban women—particularly professional women—are more likely to be influenced by the societal conventions and symbols that shape women's roles in households and society (Hang, 2018).

After 2015, we witnessed a continuous decline in the percentage of MiFB in urban areas, making conditions for rural areas catch up and cross urban areas in 2018. Weaker son preference due to poverty reduction and improved living standards (GSO, 2020b) or the cumulative effects of the current government's interventions and regulations (Chao et al., 2021), with more strengthening in 2016 (Prime Minister of Vietnam, 2016), was suggested as the reason for urban decline. However, the percentage of MiFB in urban areas increased again in 2018, similar to rural areas at the end of the observed period.

Consequently, there was no signal of a downturn toward NSRB at the national percentage of MiFB over ten years (Figure 6), as opposed to the previous studies (Chao et al., 2021; GSO, 2020b). Even though learning from the experiences of earlier affected countries, the SRB trend includes three stages: first increase, then stabilization, and downward to the NSRB (GSO, 2020b; Guilmoto, 2009). Each country had its speed in this common trend. For example, Vietnam is currently on its stabilization with a high SRB, while China and India are in their downturn process, and South Korea has successfully normalized its SRB (United Nations, 2024). Further investigation to examine MiFB trends in the next period is essential to determine the onset of the downturn in Vietnam.

Moreover, this study found that MiFB estimates were biased towards Northern Vietnam, consistent with previous investigations in Vietnam (Chao et al., 2021; GSO, 2012, 2016, 2020b; Guilmoto, 2012; Guilmoto et al., 2009). To better understand the north-south difference, the Red River Delta and Southeast could be representative of the north and the south, respectively. Table 1 shows that the Red River Delta and Southeast were similar regarding education, income, and life expectancy. However, the percentage of knowing the sex of fetuses under 15 weeks was significantly high in the Red River Delta, implying that searching for the sex of fetuses in the early weeks of gestation was a priority of couples in this region. In addition, Confucianism has more impact on the top social classes and strata, leading to a strong patrilineal kinship system in the north, where those people lived and established the country after wars (Hieu, 2015). This family kinship system is the key reason strong son

preference persists in China, India, and South Korea despite rising incomes, education, and urbanization (Das Gupta et al., 2003). A study conducted in Chi Linh, a peri-urban area in the Red River Delta, still shows a high SRB caused by the intensive son preference culture. Sons had higher values than daughters in carrying the family name and living with older parents after marriage, explaining why over 50% of women believed sex-selective abortion was practiced in this place (Le et al., 2017).

Superstition remains popular in Vietnam (Do & Phung, 2010). Without being reported in the literature, Vietnamese people have traditionally used the lunar calendar in many daily activities, such as marriage, pregnancy, business, ancestor worship, and funerals, to ensure the best outcome for these events. For instance, children born in a good year are thought to have a successful and lucky future (Le et al., 2017). This study found the highest peak percentage of MiFB in the Year of the Mental Tiger due to Vietnamese couples likely avoided giving birth to girls, as women born in this year were believed to be excessively powerful and combative, facing a higher likelihood of failing first marriages or widowhood (Lee & Paik, 2006). Vietnamese parents sometimes consider the combination of their horoscopes and their children's horoscopes to expect a better future for the family. However, the implications of the lunar calendar are diverse and inconsistent, depending on personal cases and the strength of one's beliefs. With the routine of the 60-year lunar cycle (Do & Phung, 2010), a couple's preference toward the specific gender of the child in one particular lunar year is more likely predictable, and the government can prepare for the changes in MiFB estimates and SRB.

Finally, the study results should be interpreted considering its potential limitations. First, the MiFB count is likely overestimated in our study due to the possible higher undercount rate of girls versus boys in the 2019 Census, according to what was observed in the 2009 Census (GSO, 2011a). This violation is difficult to capture in our MiFB estimation because the sex-specific and age-specific undercount rates among children aged 0–9 were unavailable in the 2019 Census report. Still, the nation's undercount rate of all ages was not considered high, at 3.6% (GSO, 2019). This overestimation is expected to be relatively lower than other methods or data sources due to the advantage of the reverse survival method discussed in the introduction (Nguyen & Pothisiri, 2024). Additionally, given the data constraints, this study employs the ratio method, leading to MiFB estimates of the subnational locations changing at the same rate as the nation's, which may not completely match the real-life conditions.

Acknowledgments

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