SPATIAL INEQUALITIES in THE COVERAGE OF UNDER FIVE DEATHS: ASSESSING VITAL REGISTRATION DATA in TÜRKİYE

1. INTRODUCTION

The neonatal, infant and under-5 mortality (U5M) rates are important indicators of child health used by countries to monitor their health policies and compare with other countries (Gonzalez and Gilleskie, 2017; Sharrow et al., 2022). In addition, early age mortality has long been used to measure the level of development of countries; reducing childhood mortality was one of the Millennium Development Goals (MDGs) until 2015, and currently it is one of the Sustainable Development Goal (SDG) targets (United Nations, 2013; WHO, 2019). Coverage and completeness of registration systems is critical for the quality of the indicators, however under registration of deaths is still a major problem today especially where registration systems are still in the process of being established, particularly in low- and middle-income countries.

Although the vital registration (VR) system in Türkiye was established at the beginning of the 20th century, the coverage and completeness of the system have been achieved at sufficient levels in the 2000s. Before 2009, the death registration covered only urban settlement; since then the systematic and nationwide registration of deaths by permanent residence of the deceased has started. Official estimates of mortality below age 5, previously obtained through censuses and surveys—especially from Demographic and Health Surveys (DHSs)—have been calculated directly from the VR data after this date. In the last two decades, Türkiye stands out with its rapidly declining child and infant mortality, as well as its developing VR system. However, the completeness of under-5 deaths in the VR system in Türkiye has not been fully evaluated yet. There are few studies on the completeness of infant mortality, yet these studies are not recent -based on pre-2014 period- and do not examine the completeness of infant mortality according to age in detail but consider the infancy period as a whole. Moreover, the last census in Türkiye was in 2000 therefore quinquennial DHS data with full birth history are the only alternative childhood mortality data source of the VR system. There still may be deficiencies in VR information; these deficiencies may vary regionally within the country. However, assessment methods based on comparison with survey data suffer strong limitations at the subnational level. This situation causes the data quality assessments to remain at the national level, and the regional data quality problems especially for regions with low population remain invisible.

In this study, we improve the assessment of under-5 deaths at the national and regional level by using a recently developed model for estimating under-5 mortality. This model relies on age regularities between ages 0 and 5 observed in high-quality VR data. The model was derived from a newly compiled database, the Under-Five Mortality Database (U5MD), which provides distributions of deaths by detailed age including daily, weekly, and monthly breakdowns. The fine age granularity of the model allows an original procedure to assess the potential omission of early deaths in any source of information (Verhulst et al.,2022). In this article, we apply this procedure at both the national as well as the regional level in order to assess the coverage of under-5 deaths in the VR system of Türkiye from 2009 to 2022. Moreover, we create model estimates for mortality indicators. The method we use enables us to reveal the deficiencies by detailed age in regions including ones with low population and number of deaths, thus enabling us to point out regional differences in the under registration of early deaths.

2. LEVELS AND TREND OF UNDER-5 MORTALITY IN TÜRKİYE

If we examine deaths under the age of five in Türkiye during the period in which data were collected by a vital registration system, we can see that there has been significant improvement over the years. NMR, IMR, and U5MR have decreased over the years except last year, and the IMR and U5MR values have converged. While IMR and U5MR were 13.9 and 17.7, respectively, in 2009, they decreased to 9.2 and 11.2 in 2022. This provides a clue about the mortality rate between 28 days and 5 years (${}_{28}q_5$), that its share in U5MR is gradually increasing, while the share of IMR is gradually decreasing.

When we examine regionally, the regional intervals (max-min) are 4.409, 7.639, and 8.969 for NMR, IMR, and U5MR, respectively. In all regions, all three mortality indicators have decreased from 2009 to 2022. When we look at the highest values among regions by year, we see that the eastern regions stand out. Southeastern Anatolia Region is the region with the highest values (NMR: 8.258, IMR: 13.643, U5MR: 16.208) in all three mortality indicators. Other eastern regions also follow this region. On the other hand, in the western and more developed regions, the indicators are significantly lower than in the eastern regions. For example, the IMR value is 6.004, which is the minimum among all regions in the West Marmara region. Also, one of the most developed regions (also a city) İstanbul has a 6.885 IMR value.

3. DATA AND METHODS

In this study, we estimated death rates from the Türkiye VR data for the period 2009-2022 based on under-5 death counts obtained from TURKSTAT. Death distributions were computed for 12 regions and exact-age cut-off points: 0, 7, 14, 21, and 28 days; 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 15, 18, and 21 months; and 2, 3, 4, and 5 years.

For exposure to the risk of dying, we used populations by single year of age published by the ADNKS for the same years, assuming a uniform distribution of the population across detailed age groups. Then, age-specific death rates (*nMx*) were computed dividing death counts by the corresponding exposure, and cumulative probabilities of dying *q(x)* were obtained under the assumption of constant force of mortality within the age group.

We used a model summarizing the age patterns observed in the U5MD to quantify the relationship *q(28d)* and *q(28d,5y)*. This quantification allowed us to measure potential underestimation of q(28d) and, in this case, propose a correction.

The model is a newly developed log-quadratic model in which the cumulative probability of dying between birth and age x, q, is assumed to be a log-quadratic function that depends on two parameter: i) *q(5y)*, which determines the overall level of mortality, and ii) a parameter *k*, which determines the age pattern of mortality.

$$ln[\ ] = \quad x + \quad x \bullet ln[\ ] + \quad x \bullet \quad 2 + \quad x \bullet k \qquad (1)$$

Based on these two parameters, the model predicts mortality for the 22 age groups defined in the U5MD. The parameter *k* takes a continuous range of values between -1.1 and 1.5. When k is equal to zero, the model predicts a full series of *q(x)* corresponding to the U5MD's average age pattern of mortality. Positive values of k reflect later age patterns of mortality with a higher-than-average concentration of deaths after 28 days of age. Conversely, negative values of k correspond to earlier age patterns, with a higher-than-average concentration of deaths before 28 days. Using the R package associated with the model, the parameter *k* can be estimated by fitting any observed probabilities of dying between 0 and 5 including *q(28d)* and *q(28d,5y)*. The model can then be used to predict *q(28d)* based on the values of *q(28d,5y)* and *k*.

4. RESULTS

Using q(28d) and q(28d, 5y) as inputs, we estimated the value of the parameter *k* in order to quantify the age pattern of under-5 mortality observed in the VR data of Türkiye. At the national level the age pattern has fluctuated over time around the average prediction (k = 0) and within 95% boundaries of the log-quadratic model (k = [-0.65, 0.88]). We attribute the fluctuation of *k* partly to random variations due to low level of mortality in both DHS and VR data. However, the range of value of *k* is consistent with the agreement of the data described above.

At the regional level, there is a spatial variation of *k* at the two ends of the studied period (2009 and 2022). In the 2009 values of *k* is increasing from West to East. This represents the increasing presence of age patterns characterized by higher concentration of mortality after 28 days. When *k* remains within the boundaries of the log-quadratic model, we have no means to determine to what extent the age pattern is true or due to potential omissions of early deaths. However, when the value of *k* exceeds or is close to the boundaries of the model, we can suspect that the data are likely affected by quality issues. Therefore, the values of *k* found in the three regions of Eastern Anatolia (1.7265 for the Northeast, 1.0805 for the Centre, and 0.8495 for the Southeast) confirm the risk of early death omissions in this part of the country. Nonetheless, in 2022 there is a strong reduction of *k*-value in Eastern Anatolia. Such reduction occurred in a couple of years and was not observed in the other regions. This sudden variation of the age pattern is thus an indication that high values of *k* in the early period are most likely spurious and due to the omissions of early deaths. Therefore, the behavior of the parameter of *k* indicates a strong improvement of the coverage of early deaths in the three regions of East Anatolia.

In the three regions of Eastern Anatolia, the predictions of the model constitute a potential correction of observed estimates. The three regions appeared to have experienced a strong increase in coverage from 2009 to 2014 from 50-60% to virtual completeness. Afterward, the potential under-coverage is not anymore significant except in the Northeast region that experienced noticeable fluctuations. Despite these fluctuations and the uncertainty caused by the COVID-19 pandemic, in 2022 all observations are within the boundaries. This confirms that the issue of early death omissions has been strongly reduced in the regions of Eastern Anatolian.

The findings of our study reveal that there is a lack of early death registration, especially in disadvantaged regions where infant mortality is also higher than the national average. The fact that these regions, which have a limited impact on Turkey's average infant mortality rate due to their small population size and therefore the high infant mortality rate of the region is not discussed enough, also has an incomplete record of neonatal deaths, further increases the invisibility of their disadvantaged situation. Our study draws attention to the lagging of infant mortality records of disadvantaged regions, which have a limited impact on national averages due to their small share in the total population and creates more reliable estimates of U5M indicators for these regions.