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PHYSICIANS IN THE CZECH REPUBLIC: A DEMOGRAPHIC PERSPECTIVE

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ABSTRACT

Physicians can be viewed as a relatively homogeneous group, but one that has its own internal specifics that may be affected, for example, by the demographics of physicians. Basic differences in gender and age structure by major medical specialty are covered relatively frequently in the literature. Rarely, however, do we see analyses on the number of physicians in relation to their average workload, which varies according to age, gender and specialty. It is possible to monitor these differences using the database of the main Czech health-insurance company, which has information on almost all the physicians in the Czech Republic. The findings can be used, for example, to better plan territorial access to health care, which generally ignores these aspects.

Keywords: physicians, differences, demographic structure, average post, Czech Republic

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INTRODUCTION

Physicians constitute a relatively homogeneous group and it is possible to identify certain demographic processes that affect them. These reflect traditional demographic processes – a physician enters the system from another cohort, either naturally (equivalent to being born) or artificially (immigration), and then leaves the cohort, either naturally (mortality) or artificially (emigration, i.e. moving into another sphere of work, retirement). Consequently, we can analyse their age and gender distribution according to the health-care segment in which the physicians works. Distribution is also affected by the number of contracted work hours in selected types of care, which may have a significant impact on health-care provision, both spatially and temporally.

This paper simply aims to describe the differences in the gender and age structure of physicians across types of care and selected specialties in the Czech Republic as of the end of 2013. We focus not only on the number of physicians (headcount), but also on the number of FTE physicians[1)], which means according to their number of working hours per week. Understanding these differences is crucial to those working in this field in order to ensure that there is a smooth generational turnover of physicians. As is the case with the population of the Czech Republic as a whole, as a profession physicians are facing demographic ageing issues that are the result of past demographic and political development.

1) FTE (full-time equivalent) is a unit to measure employed persons in a way that makes them comparable although they may work a different number of hours per week. The unit is obtained by comparing an employee's average number of hours worked to the average number of hours of a full-time worker. A full-time person is therefore counted as one FTE, while a part-time worker gets a score in proportion to the hours he or she works or studies. For example, a part-time worker employed for 20 hours a week where full-time work consists of 40 hours, is counted as 0.5 FTE (*Eurostat*, 2013).

DATA AND METHODOLOGY

The issue of ageing among physicians is a frequent research topic in the literature, particularly in the form of basic descriptive analyses (e.g. *AAMC*, 2013; *Pang – Lansang – Haines*, 2002), and studies of regional differences (e.g. *GAO*, 2003; *Léonard – Stordeur – Roberfroid*, 2009) or model forecasts (e.g. *Birch*, 2002; *HRSA*, 2003; *Roberfroid – Léonard – Stordeur*, 2009). The overwhelming majority of these studies, however, deal only with data relating to the number of physicians. The average number of FTE physicians' posts held by physicians in particular specialties is often a simplistic view of the issue. The average number of FTE physicians varies by age, gender and the type of health care and according to the specialty. In predicting health-care provision, we must be aware of these details so that we can predict whether it will be necessary to adopt any measures (policy, stimuli, labour law, and so forth) to at least partially mitigate potential future imbalances.

To obtain this kind of insight, relevant data are required. The data currently available in the Czech Republic that are used to analyse the demographic structure of physicians are drawn from the database of the Institute of Health Information and Statistics of the Czech Republic (IHIS). The results are published in *Physicians, Dentists and Pharmacists* (*Lékaři, zubní lékaři a farmaceuti*) (*ÚZIS ČR*, 2015), available from the website of the IHIS[2]. However, the IHIS data are not appropriate for this type of analysis, because they are classified across two fields: physicians are either included under the specialty their main job position falls within, or under all specialties regardless of the post held (*ÚZIS ČR*, 2015). Therefore, analyses must also draw on data from another database, and that database belongs to the General Health Insurance Company of the Czech Republic (GHIC). This is the biggest insurance company of its kind in the Czech Republic and has contracts with almost all the health-care providers in the country. It therefore has detailed data not only on reported health care, but also on the structure of health-care providers, including physicians. Another advantage of this database is that the data are more up-to-date; this paper was written using data from the end of 2013. Nevertheless, there are also disadvantages to using data from the GHIC database: it is practically impossible to monitor current trends in the number and distribution of physicians over time. It is only in the last two years that contracts with health-care providers have been computerised, and the data currently available in the database are for the last few years only. In addition, some of the data on workloads has been incorrectly entered, so the data had to be corrected. From 2013, all current data were entered as revised values, and it is now possible to make future comparisons. Nevertheless, the current data on the gender and age distribution of physicians and posts are both interesting and useful.

The following analysis uses simple indicators on the number and distribution of physicians in the Czech Republic, such as the proportion of selected age groups of physicians, total number of FTE physicians, ratio (e.g. the 'modified age index', defined as the number of FTE posts held by physicians aged 60 years and over per 100 FTE physicians, under the age of 39) and the average age of physicians, both by total number and by FTE number.

RESULTS AND DISCUSSION

Basic information on the number and distribution of physicians in the Czech Republic

The GHIC database has records on more than 170,000 health-care workers. There are more than 47,000 physicians[3], comprising approximately 27% of the total number of health-care workers (nurses = 65%, paramedical undergraduates = 5%, transport workers = 3%) while the sum of FTE physicians is fewer

2) http://www.uzis.cz/katalog/zdravotnicka-statistika/lekari-zubni-lekari-farmaceuti.

3) Information published by the Institute of Health Information and Statistics of the Czech Republic (*ÚZIS ČR*, 2015) indicates that there were 46,200 actively working physicians and almost 2,000 thousand temporarily inactive physicians (e.g. owing to maternity or parental leave); there were more than 48,000 physicians in the country; the GHIC database purports to have information on almost all physicians in the Czech Republic.

Table 1 Basic data on physicians in the Czech Republic, 31. 12. 2013

Indicator	Total	Men	Women
Number of physicians	47.0 th	20.3 th	26.7 th
Number of FTE physicians	44.0 th	19.7 th	24.3 th
Average FTE number of physicians	0.94	0.97	0.91
Femininity index – related to the number of physicians	1.32	…	…
– related to the number of FTE physicians	1.24	…	…
Average age of physicians – weighted by the number of physicians	49.4	50.3	48.8
– weighted by the number of FTE physicians	49.1	49.8	48.7
'Modified' age index – related to the number of physicians	88.0	102.2	78.4
– related to the number of FTE physicians	83.7	93.3	76.5

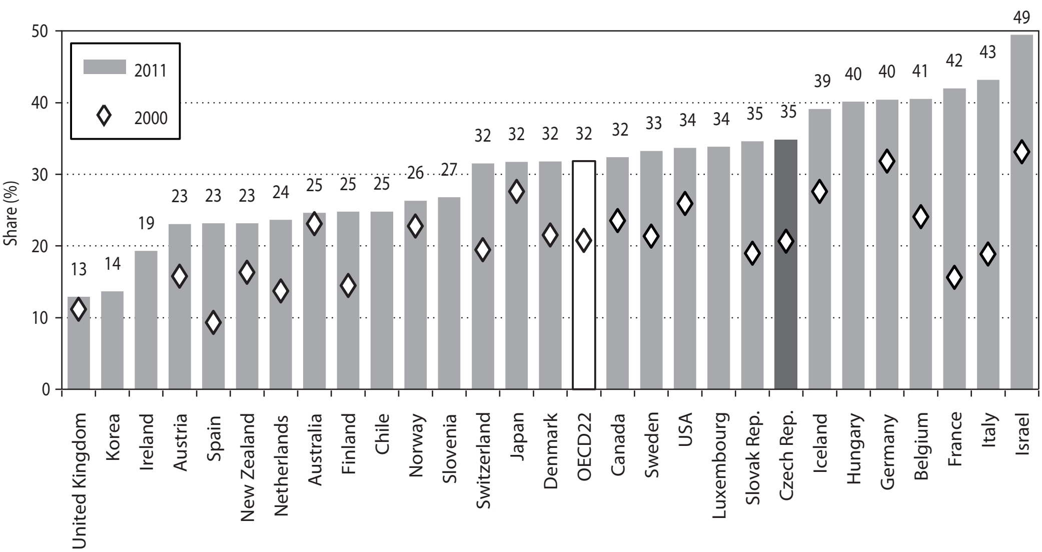
Note: Femininity index = number of FTE physicians' posts held by women per 100 FTE physicians' posts held by men. Modified age index = number of FTE physicians' posts held by physicians aged 60+ per 100 FTE physicians aged 39 and under. FTE = full-time equivalent.

Source: GHIC, 2014.

than 44,000; that is, the average physician's FTE number is 0.94 and men on average have a higher FTE number than women (0.97 vs. 0.91). The average age of physicians is 49.4 years and, there are 88 physicians aged 60 years or more per 100 physicians under the age of 39, i.e. for every 100 FTE physicians aged 39 and less, there are 84 FTE physicians aged 60+ (Table 1).

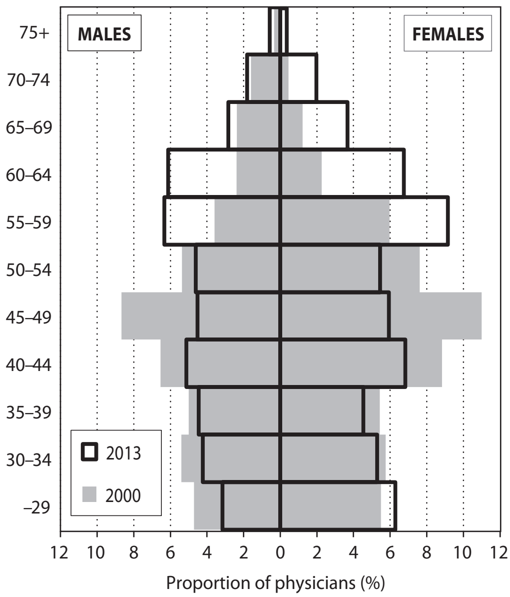
The largest number of physicians is in the 55–59 age group (15.5% of the total number of physicians) and the next largest group is 60–64 years of age (Figures 2 and 3). These shares indicate that most physicians in the Czech Republic fall into relatively older age groups and that the profession may be affected by problems associated with demographic ageing, as almost a quarter of physicians are aged 60 years and over. The large share of older physicians means that the Czech Republic ranks among the OECD countries with the oldest age structure (Figure 1).

Figure 1 The share of physicians aged 55 and over out of the total number of physicians, 2000 and 2011 (or nearest year)



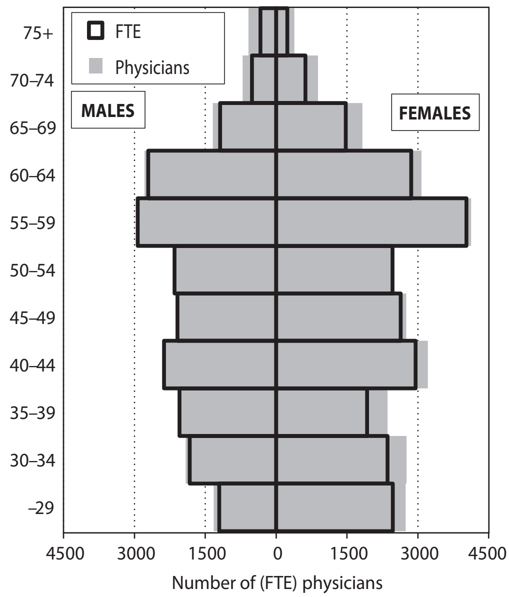
Source: OECD, 2013.

Figure 2 Age structure of physicians, 2000 and 2013



Source: ÚZIS ČR, 2000; 2014.

Figure 3 Differences in the number and FTE number of physicians, 31. 12. 2013



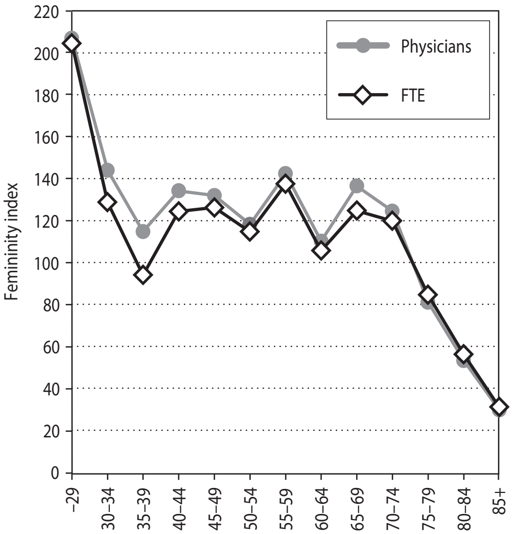
Source: GHIC, 2014.

Demographic ageing can clearly be seen when the current age structure of physicians is compared with that recorded in 2000 in the IHIS database (Figure 2). This comparison reveals a quite marked process of demographic ageing amongst physicians in the middle and old age groups. By contrast, the bottom part of the age distribution indicates a positive change: the number of physicians in the youngest age group is the same in both 2000 and 2013. One of the reasons for this may be the fact that, beginning a few years ago, dentists in the Czech Republic no longer have to undertake postgraduate study in order to be able to practice. Young dentists can now begin practising as soon as they graduate from dentistry school, and this is also reflected in a higher number of students at these schools – for example, while in 2003 there were 885 current students of dentistry and there were 116 new, recently graduated dentists, by 2013 the number of students had risen to 1,246, and there were 262 'new' dentists (*ÚZIS*, 2004; 2014).

Figure 3 presents a comparison of the current structure of both, number of physicians and number of FTE physicians by gender and age. It has a number of interesting features: first, workload, measured as contracted hours, is lighter among older male physicians and younger female physicians, which in the latter case is due to young women having children and taking leave. Similarly, there is a larger share of younger female physicians to male physicians (11.7% of women vs. 6.9% of men under the age of 35). Indeed, there is a larger share of women recorded in every age group right up to 75–79 years of age (Figure 4).

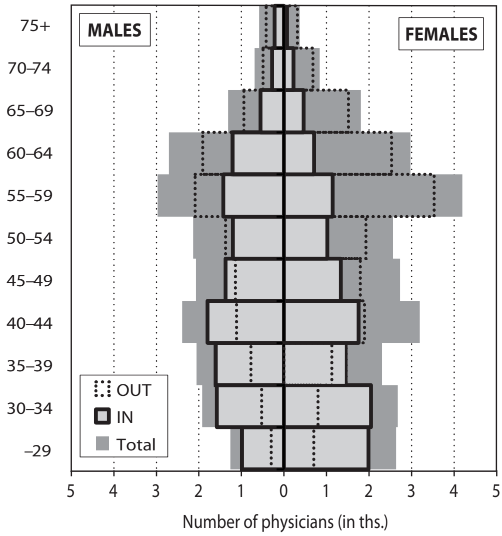
There are also significant differences when we compare the number of physicians according to type of health care in terms of outpatient or inpatient care. While in inpatient care the age structure is relatively progressive, i.e. there is a stationary age distribution amongst physicians; in outpatient care the distribution is significantly regressive (Figure 5). The reason for the differences in distribution is that physicians need to gain experience so that they can practise their profession. Most medical courses require medical graduates to undertake more specialised postgraduate study in their field before they are licensed to practise and this is usually achieved by gaining experience in inpatient care. Once they have earned their license, physicians often work in outpatient care, or even set up their own private outpatient clinics. The majority of outpatient

Figure 4 Femininity index of physicians by age, 31. 12. 2013



Source: GHIC, 2014.

Figure 5 Differences in the age structure of physicians according to type of health-care provider, 31.12.2013

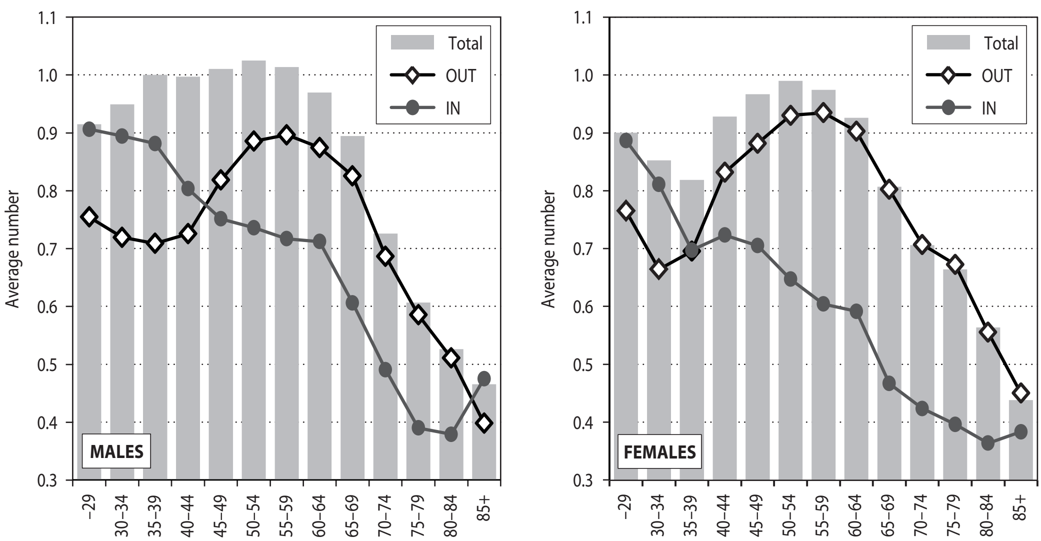


Note: OUT = outpatient care, IN = inpatient care.
Source: GHIC, 2014.

specialists have some medical experience in inpatient care. This means that both types of care overlap during a physician's working life; one kind of care often replaces the other as age increases.

These changes and reciprocal links are also evident when the average number of FTE physicians is compared by age, gender and type of care (Figure 6). Women work part time in outpatient

Figure 6 Differences in the average number of FTE physicians compared by age, gender and type of health-care provider.



Note: OUT = outpatient care, IN = inpatient care.
Source: GHIC, 2014.

health care to a much greater extent, while among men the difference in the average number of contracted hours worked in outpatient care and inpatient care is less significant, but almost throughout the whole year men spend more time in outpatient care. It is clear, however, that men are more likely toattempt to combine both kinds of work than women are.

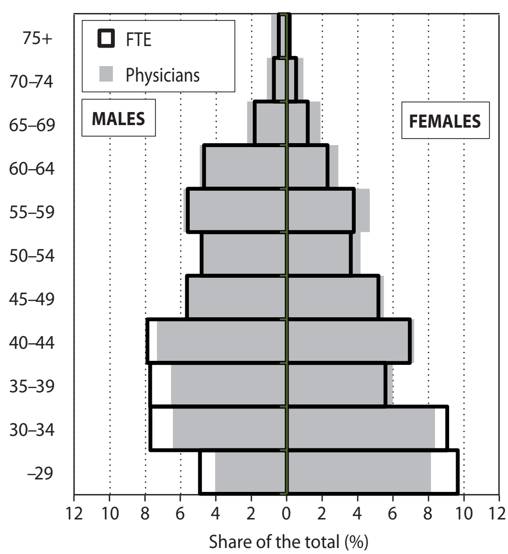
DISTRIBUTION OF THE NUMBER OF PHYSICIANS AND THE NUMBER OF FTE PHYSICIANS BY AGE AND GENDER IN CERTAIN TYPES OF CARE

Differences in the number of physicians by age, gender and the average number of FTE physicians are clearly visible when we come to look at selected types of care. First, if we return to physicians working in inpatient care, we can see in Figure 7 the type of progressive age distribution mentioned earlier: the under 40 age group accounts for 40% of all physicians working in inpatient care, but it accounts for a total of 45% of FTE physicians; by contrast those aged 65 and over account for only 7.5% of physicians and the number of FTE physicians represents only 5% of the total. It is also very easy to see the greater involvement of young physicians in the health-care system in the form of a higher number of simultaneously held positions in multiple locations, where the total number of FTE physicians is higher than the number of physicians. This is again due to the need for physicians to obtain necessary qualifications; on the other hand, GHIC, for instance, allows for only a maximum of 1.2 FTE per 1 physician.

The nature of the data makes it possible for us to observe more closely the structural differences in particular outpatient specialties, which form a specific group consisting of four basic primary health-care specialties. In general practice and general paediatrics, there is a distinctly regressive age pyramid, where the majority of physicians and posts are pre-retirement age – the 55–59 age group alone accounts for at least 25% of all positions (Figure 8). The situation is worse among paediatricians, where the average age of physicians according to the average number of FTE physicians has passed the 56 year-old mark; while 100 FTE posts are held by physicians under the age of 40, it would appear that more than 800 are held by physicians over the age of 60.

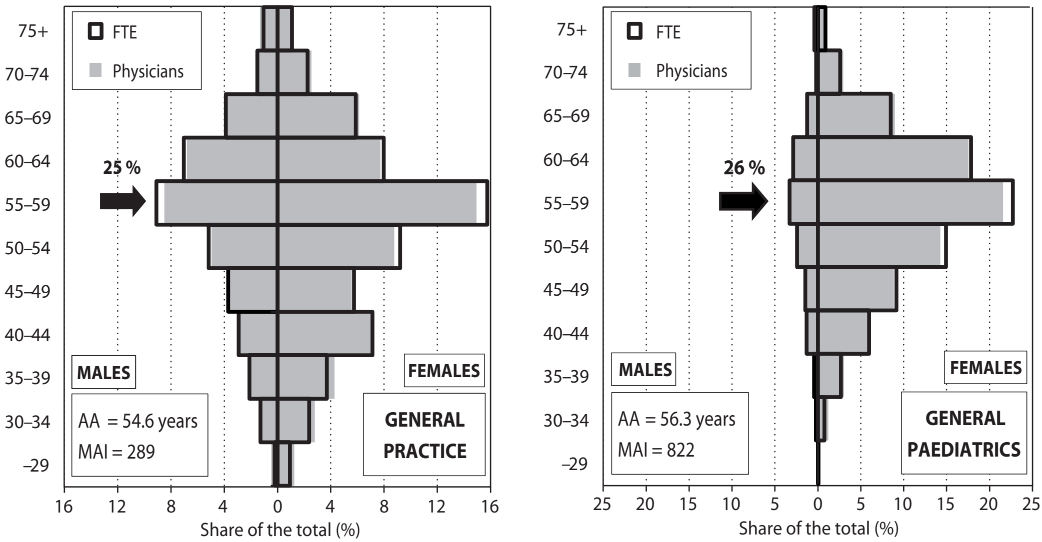
The distribution of the age of dentists is particularly unusual: the majority of dentists fall into the 55–64 age group, which accounts for 29%

Figure 7 Structure of physicians and FTE physicians in inpatient care, 31. 12. 2013.



Source: ÚZIS ČR, 2000; 2014.

Figure 8 Structure of physicians and FTE physicians in general practice and general paediatrics, 31. 12. 2013.

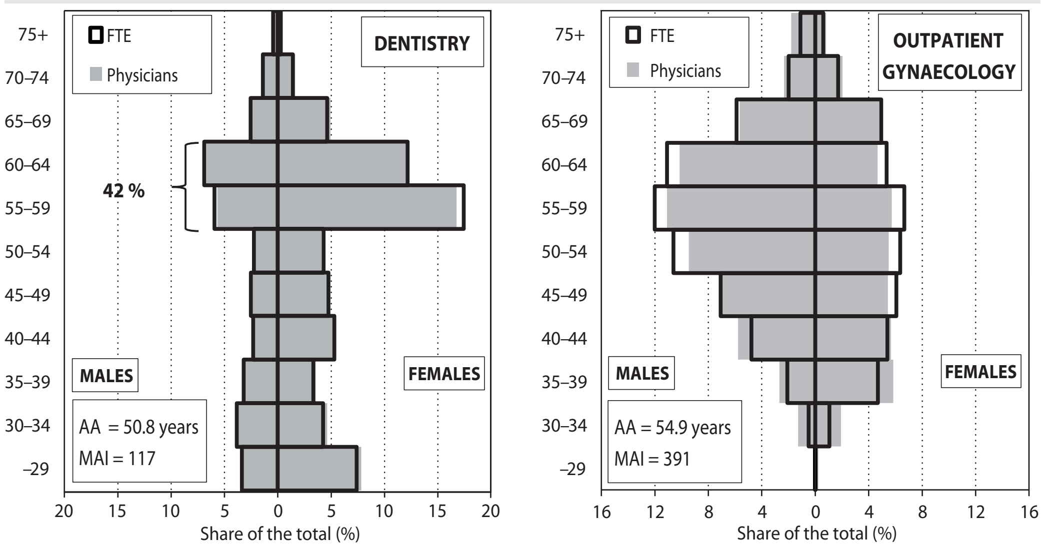


Note: AA = average age according to FTE physicians; MAI = modified age index (number of FTE physicians aged 60+ per 100 FTE physicians aged 39 and less).

Source: GHIC, 2014.

of the total number of FTE dentists (Figure 9). This 'notch' in the age distribution is mainly due to policy decisions taken in the 1970s, whereby once every few years a large number of new students were admitted to dentistry school over fears of a future lack of dentists, but after a few years admittance numbers

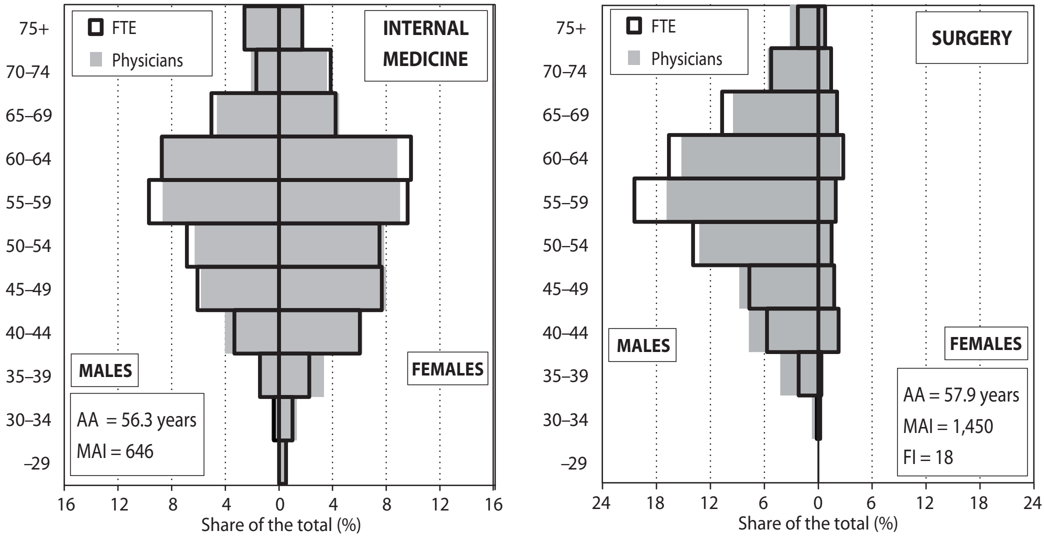
Figure 9 Structure of physicians and FTE physicians in dentistry and outpatient gynaecology, 31. 12. 2013.



Note: AA = average age according to FTE physicians; MAI = modified age index (number of FTE physicians aged 60+ per 100 FTE physicians aged 39 and under).

Source: GHIC, 2014.

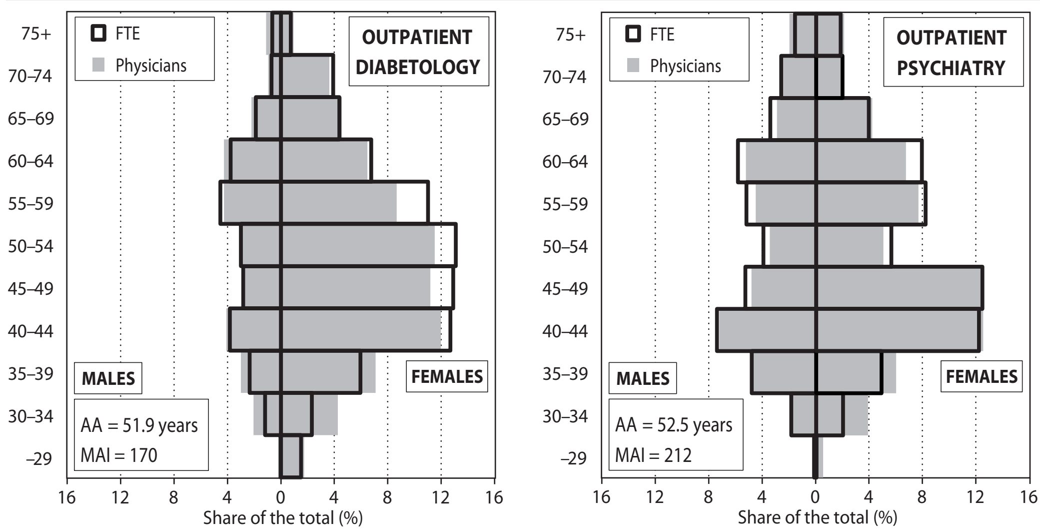
Figure 10 Structure of physicians and FTE physicians in internal medicine and surgery, 31. 12. 2013.



Note: AA = average age according to FTE physicians; MAI = modified age index (number of FTE physicians aged 60+ per 100 FTE physicians aged 39 and less); FI = femininity index.
Source: GHIC, 2014.

returned to normal (*Hnilicová*, 2010). This has created a problematic imbalance in the age distribution which will significantly impact on the future availability of dentists. The situation is, however, different for outpatient gynaecologists, where there has been a shift in the gender of physicians: men dominate amongst older physicians while the opposite is true in the younger age group.

Figure 11 Structure of physicians and FTE physicians in outpatient diabetology and outpatient psychiatry, 31. 12. 2013.



Note: AA = average age according to FTE physicians; MAI = modified age index (number of FTE physicians aged 60+ per 100 FTE physicians aged 39 and under).
Source: GHIC, 2014.

We can illustrate the two different age distributions using the example of physicians specialising in internal medicine and surgery (Figure 10). While in internal medicine the number of physicians and the number of FTE physicians are relatively evenly balanced in terms of gender, in surgery men dominate owing to of the demands associated with this profession. It is also worth noting the relatively high proportion of physicians aged 75 or over working in internal medicine, which is again related to the nature of the specialty, which places no great demands on the health of the physician working in this area.

In the Czech Republic there are also specialties where it is possible to find a relatively balanced age structure – for example, the age structure of outpatient diabetologists and outpatient psychiatrists (Figure 11). In neither of these specialties is a shortage of physicians expected in the near future as a result of population ageing. Nevertheless, in both of these specialties this process should not be underestimated.

CONCLUSION

The above findings highlight major differences in the distribution of physicians by age and gender, both generally and across different types of care, i.e. in different specialties. There are also significant differences in the average number of FTE physicians in relation to age: those in the 50–59 age group have the longest contracted hours, the average number of posts then gradually decreases; the differences can be seen in part as the result of female doctors combining work and motherhood.

The overall current distribution of physicians in the Czech Republic is less than favourable, as other studies have shown (especially in primary health care, see, e.g. *Šídlo*, 2010a; 2010b; 2011). The over-representation of physicians in the 50–59 age group in conjunction with the average number of FTE physicians may lead to difficulties in providing adequate health care in the Czech Republic in the near future. This situation could be solved by encouraging public debate on how some of the issues in providing health care might be mitigated or eliminated. The debate should involve political parties, the Ministry of Health, medical schools and postgraduate medical institutions, medical associations, and experts on demography, geography and economics.

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AN ANALYSIS OF THE BIRTH INTERVALS OF MARRIED WOMEN IN JABLONEC NAD NISOU FROM THE 17TH TO 19TH CENTURY: A CONTRIBUTION TO RESEARCH ON FERTILITY PATTERNS[1)]

Ludmila Fialová – Klára Hulíková Tesárková – Barbora Kuprová

ABSTRACT

Analysis of birth intervals is a traditional part of historical demographic studies. However, these analyses are usually only simple and descriptive because of the high demands on data and labour such analysis requires. This study draws on a relatively large dataset including more than 2,000 families from Jablonec nad Nisou from the 17th to 19th centuries. Records on children were used in the analyses. The application of survival analysis and Cox regression revealed that marriage-birth intervals were significantly influenced by the large share of prenuptial conceptions. All three variables used in the study of birth-birth intervals (birth parity, age of the mother at marriage, and age of the mother at the birth of the child) proved to be significant. Unlike other studies of birth intervals in historical populations, in this paper the average birth-birth intervals were not longer for higher birth parity; however, the analysis did show that the age of the mother at the birth of the child is more significant for increasing birth-birth intervals. Some factors were left aside in this first analysis of birth intervals. These factors should be studied in future planned analyses.

Keywords: Historical demography, birth intervals, birth parity, age at marriage, age at birth of a child, survival analysis, Cox regression, 18th century, Jablonec nad Nisou

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1. INTRODUCTION

The frequency of births in families could be taken as an indicator of the type of reproductive behaviour in families. This indicator is useful, among other things, for monitoring a number of factors such as how quickly a family expanded, its reproductive health, or even its mortality level. Changes in the length of birth intervals also indicate changes in reproductive behaviour. Analysing birth intervals also makes it possible to evaluate retrospectively the completeness of parish

1) This article was written with the support of the Czech Science Foundation as part of work on project no. 15-19601S, 'The Early Stage of Transformation of the Reproductive Behaviour in Bohemia from the Second Half of the 18th Century to the End of the 19th Century'.

registers and the effect of infant mortality on fertility and to track changes in the fertility rates of women by age (*Henry*, 1967). That is why this type of analysis is mentioned as important in all manuals of historical demography (e.g. *Guillaume – Poussou*, 1971; *Maur*, 1979; *Kuklo*, 2009). Because of its importance, this issue is a traditional part of the analysis of fertility in historical demographic studies that use the family reconstitution method. One of the most important studies containing an analysis of birth intervals is, for example, the analysis of fertility in England in the 17th and 18th centuries published by *Wrigley et al.* (1998).

The most important and the most detailed such study of the Czech lands is that by Ladislav Dušek. His findings are based on an analysis of the fertility of women in Budyně nad Ohří at the turn of the 18th and 19th centuries (*Dušek*, 1985). Dušek studied birth intervals from many perspectives: the length of the interval from marriage to birth of the first child, the influence of the length of life of the previous child (death in infancy), or the woman's age at marriage, etc. He confirmed the findings observed in foreign studies, especially the shorter average length of birth intervals in the case of the death of the previous child in infancy and the longer average length of birth intervals with increasing maternal age. Later studies by *Brabcová* (2001) and *Poulová* (2007), which dealt with the same topic, are much more concise. They are limited to an analysis of marriage-birth intervals and the average length of birth intervals at higher birth parity.

The terms 'birth parity' and 'birth order' are often taken to be nearly synonymous, with the former representing the chronological order of a studied child in a family, and the latter representing the total number of children born in a family before the studied child. In this article, we prefer the term 'birth parity', which is in accordance with many classic works in the field of historical demography (e.g. *Wrigley et al*., 1998).

Usually only simple calculations of the length of birth intervals according to birth parity were applied in all the above-cited studies – frequency distributions or arithmetic means. Often also the relation of birth intervals to the age of mother is neglected. The reason for these simplifications is the fact that such calculations are very demanding on time and labour.

This problem of the enormous demand for and relatively complicated processing of data can be at least partly overcome by using modern statistical software, which was not possible in the time when the traditional methods of historical demography were proposed. Modern statistical and demographic methods have recently begun to play an increasing role in historical demography. Survival analysis, Cox regression, or logistic regression are the most common methods used in contemporary historical demographic research (e.g. *Pozzi et al*., 2014 or *Sandström – Reher*, 2014). In Czech demography, these methods are traditionally used to analyse contemporary data, but their application to historical data has been published only recently (*Fialová et al*., 2014; *Hulíková Tesárková – Kuprová*, 2015).

This article presents an analysis of families living in Jablonec nad Nisou during the 18th century (and partly also during the 17th and 19th centuries). The goal of this paper is to enrich the analysis of birth intervals for this locality. The first basic analysis was published in *Demografie* in 1992 (*Wowková – Fialová*, 1992). As only basic data were published in that article, without any detailed analysis, we decided to perform a new, more detailed analysis.[2)]

In this paper, we would like to build on the initial findings and deepen the analysis through the use of modern methods. The aim is to describe birth intervals during the studied period and specify more the connection between the length of the intervals and birth parity, the age of the mother at marriage, and the age of the mother at the time of birth of the child.

The advantage this study has is the availability of an extensive database for the analysis. Originally we had a database of 2,366 marriages (couples and their children), where at least the information about the year of marriage (from 1650 to 1872; 1870 was the latest year of marriage in which information about the children born are known in the data set) was available.

2) The family reconstitution for Jablonec was performed by Walburga Wowkowa in the 1980s and 1990s; the original family lists are deposited in the State District Archives in Jablonec nad Nisou.

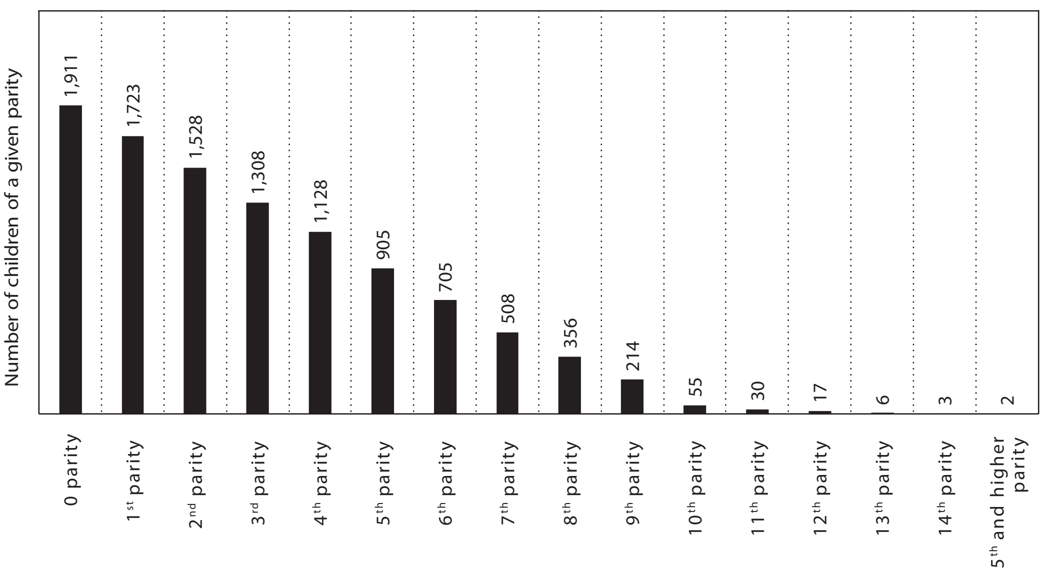
From those marriages only bachelor/spinster marriages (first marriages) were selected for the analysis, which consisted of 2,007 couples and their children. Because the objective was to study birth intervals, we analysed all the children from the marriages, again, using only bachelor/spinster marriages. In the data set there were records on 10,399 children for which at least the date of the birth was known. The analysis was prepared separately for various variables (age of mother at the birth of the child, age of mother at marriage, birth parity). Because the values of all these variables were not known for all the children in the data set, the number of analysed cases was different in various parts of the study. However, the exact number of analysed cases will be specified below separately for all the analyses along with a numerical representation of combinations of values of explanatory variables (where these were used).

The research subject of this paper was the analysis of inter-birth intervals in all first marriages of women; without regard to the duration of their marriages and without regard to the number of births (we consider only live births). This makes our methodology different from the traditional methods used by Louis Henry, which took into account only marriages with six or more children (*Henry*, 1980: 102–112).

In the analysis we distinguished between first birth intervals ('**marriage-birth**', parity 0) and birth intervals for children of higher parity ('**birth-birth**'). Birth intervals were studied for the different ages of mothers at marriage, the age of mother at the time of birth of the child, and birth parity. All three variables were used as categorical variables:

- The birth parities were used as individual categories up to the 5th parity. Birth parities of 6 and higher were classified as a separate category (more than 81% of children in the data set were 5th or lower parity births; see Figure 1).
- We distinguished four categories for the age of mother at marriage: the first includes women who married under the age of 20; the second includes women who married at the age of 20–24; the third includes women who married at the age of 25–29; and the fourth category includes women who married at the age 30 or older.
- The same categories as for the age of the mother at the time of marriage were also used for the age of the mother at the time of the child's birth.

Figure 1 Structure of children in the data set according to their birth parity; Jablonec nad Nisou, 17th–19th centuries



Note: 0 parity represents first-order children born in a family, 1st parity stands for second-order children born in a family, etc.

2. RELATED LITERATURE

The paper by *Wowková and Fialová* (1992) focusing on an analysis of reproductive behaviour in Jablonec before the year 1800 served as the basis for this paper. However, in that study only a small section was devoted to describing birth intervals. Only the occurrence of prenuptially conceived births and the length of birth intervals by parities were analysed in that paper.

A much more detailed analysis of parish monographs (the past development of the population in some parishes using the family reconstitution method) can be found, for example, for Budyně nad Ohří (*Dušek*, 1985), Domažlice (*Mužík*, 1986), Rožmberk (*Poulová*, 2007), Komín (*Brabcová*, 1997), Hostivař (*Laštovková*, 1994). Most of these analyses distinguished between the interval between marriage and the first birth and the intervals of other parities of births. Some of them are very detailed; Ladislav Dušek compared the situation in Budyně with several other places in Western Europe or in Canada and studied the influence of infant mortality on the length of intervals too. However, most of the studies are very simple and do not take into account the mother's age (at marriage or at the birth of the child). Nevertheless, the results are very useful for international comparison.

The share of prenuptial conceptions in most cases ranged between 20 and 30% in various localities in the Czech lands in the late 18^{th} century, which is a much larger share than in France or Poland but is close to the values for England at the same time (*Dušek*, 1985; *Kuklo*, 2009; *Wrigley et al.*, 1998). In all the studied localities a lengthening of the intervals between births was observed: the mean length of the interval between first- and second-parity children was close to 24 months, while the last interval was about 36 months or more. The same results have been found by French, English, and Polish historical demographers (*Bardet*, 1983; *Henry*, 1967; *Houdaille*, 1988; *Kuklo*, 2009; *Wrigley et al.*, 1998).

None of the studies of the Czech lands that have already been published studied the relationship between birth intervals and the age of the mother (at marriage and at the birth of the child). That was the motive for this paper, where we decided to study this relationship using the relatively large database available to us. It must also be mentioned that these issues cannot be studied using contemporary demographic data because this type of data is not usually available for contemporary societies in developed countries and also the number of children in families is significantly lower these days.

3. METHODOLOGY

In accordance with the aim of the paper SAS statistical software (version 9.4) was used for the analysis. We used simple descriptive statistics calculated in a survival analysis (the Lifetest procedure in SAS software) stratified according to birth parity and the age of the mother at marriage or the age of the mother at the birth of the child. We present only the most important results below.

The survival analysis is a simple basic tool used for analysing 'survival times' (failure times, time durations between two defined events). The most common output of the survival analysis is the survival distribution function (survival function). This function could be interpreted as a 'probability that an experimental unit from the population will have a lifetime that exceeds *t*' (SAS Institute Inc. 2015: 5120). Applied to the study of birth intervals, the estimated survival function, *S(t)*, expresses the probability that the birth interval of a randomly selected child of n^{th} birth parity from the studied data set will exceed a value *t*:

$$S(t) = P(T > t)$$

where *T* is the birth interval for the selected child (measured as a time period between its date of birth and date of birth of the child of $(n\text{-}1)^{th}$ birth parity in the same family). We used the non-parametric Kaplan-Meier method to estimate the survival function. More about survival analysis can be found, for example, in *Aalen et al.* (2010) and *Hendl* (2012, in Czech).

The second type of analysis in this paper is the Cox regression (the Phreg procedure in the SAS software), or the Cox proportional hazards model (*Cox*, 1972). This method 'assumes a parametric form for the effects of the explanatory variables, but it allows an unspecified form for the underlying survivor function' (*SAS Institute Inc.*, 2015: 6723). In the Cox regression it is more common to work with the hazard function rather than with the survival function (although both of these functions represent in fact the same thing).

The hazard function (or an age-specific failure rate) can be defined (according to *Cox*, 1972: 187, authors' symbols in the equation) as:

$$h(t) = \lim_{\Delta t \to 0+} \frac{P(t \leq T < t + \Delta t | t \leq T)}{\Delta t}$$

For our study it is important to keep in mind that the higher values of the hazard function mean shorter average birth intervals and vice versa.

In the regression model the aim is to study the relationship between the failure times (in our case the length of the birth intervals) and the set of explanatory variables ($\boldsymbol{Z}$). This relationship can be defined (according to *Cox*, 1972: 189, authors' symbols in the equation) as:

$$h(t, \boldsymbol{Z}) = \exp(\boldsymbol{Z} * \boldsymbol{\beta}) * h_0(t)$$

where $\boldsymbol{\beta}$ is a vector of the parameters and $\boldsymbol{h_0(t)}$ is the baseline hazard function, a standard hazard function related to the reference categories of the explanatory variables $\boldsymbol{Z}$. The hazard ratio, a ratio of two hazard functions defined by different values of $\boldsymbol{Z}$, makes it possible to express the different influence of explanatory variables to the hazard rate, i.e. to the average length of the birth intervals.

As was stated above, for the analysis only the bachelor/spinster marriages were used. Moreover, only children born to women who married between the ages of 15 and 49 or to women between the ages of 15 and 49 at the birth of the child were included in the analyses. Since the analysis of birth intervals was not distorted by missing or incorrect information about children and their births, only cases where the birth interval was shorter than 5 years and was at least 9 months long were included.

4. RESULTS

4.1 Marriage-birth intervals

The first part of the study describes the marriage-birth intervals. Because the aim was to present the differences in reproductive behaviour, we decided to distinguish prenuptial conceptions. This means that in the first part all the first births (0 parity) were analysed, then the analysis was repeated, but only children born 8 and more months after the marriage were included in the analysis. Prenuptial conceptions were defined as children born within 7 full months after a marriage (the marriage-birth interval < 8 months). We could use only those records where both the date of the marriage and the date of birth of the first child were available.

A. All first births (including the prenuptial conceptions)

In order to describe reproductive behaviour after marriage, we studied the marriage-birth intervals separately for four classes of the age of mother at marriage. When prenuptial conceptions are included, there are no significant differences in the length of the intervals for different ages of mothers at marriage. The marriage-birth interval was on average longer for women who got married at the age of 30 or older; 25% of them had their first child within 5.05 months

Table 1 Upper and lower quartile, median, and mean of marriage-birth intervals (in months), prenuptial conceptions included, according to the age of the mother at marriage; Jablonec nad Nisou, 17th–19th centuries

	Age of the mother at marriage (years)			
	–19	20–24	25–29	30+
Upper quartile (Q75)	15.35	14.07	14.53	17.41
Median (Q50)	10.09	9.80	9.57	10.01
Lower quartile (Q25)	4.34	4.60	4.96	5.05
Mean	12.52	11.41	11.52	12.69
Number of cases included in the analysis	183	723	305	84
Percentage of prenuptial conceptions	33.33	36.65	39.67	33.33

Note: According to Log-Rank or Wilcoxon tests of equality over strata, the differences are not statistically significant at a 5% level of significance.

after marriage. In all the other age groups 25% of first children were born by the end of the 5th month after marriage. A difference between the age groups of women was slightly more visible for the upper quartile: 25% of women who married at the age of 30 or older did not have their first child until 17.41 months after the marriage. For other age groups of women the same interval was only around 14 and 15 months (Table 1).

B. First births without prenuptial conceptions

As Table 1 showed, the length of the marriage-birth interval was strongly influenced by the large percentage of prenuptial conceptions in the population. This proportion was between 33%, for women who married under the age of 20 or at the age of 30 and older, and almost 40% for women who married between the ages of 25 and 29 (Table 1).

In this second part of the analysis prenuptial conceptions were excluded from the analysis. This allows us to study reproductive behaviour after marriage. A logical consequence of excluding prenuptial conceptions is that no marriage-birth interval in the studied data set could be shorter than 8 months.

The results of this part of the analysis are presented in Table 2. The average length of the marriage-birth intervals ranged in this case from 16 months (for women who married at the age of 20–24) to more than 17 months (for women who married at the age of 30 and older or under the age of 20). In all ca tegories of women, 25% of them had their first child around 10 months after the marriage. There are almost no differences among women according to their age at marriage.

It can be concluded that there are no significant differences in the length of the marriage-birth interval according to the age of the women at marriage. The next part of the study analyses birth-birth intervals according to the above-described variables (the age of mothers at marriage, the age of mothers at the birth of the child, birth parity). In the next section first births (parity 0) are excluded.

4.2 Birth-birth intervals

In this part of the paper only first- and higher-parity births are included in the analysis. In the case of twins, only one child was included in the analysis (the birth-birth interval equal to 0 was not used in the data set).

In the first part of this analysis, we used descriptive statistics for a basic analysis of birth-birth intervals according to the age of the mother at marriage, the age of the mother at the birth of the child, and birth parity.

The birth-birth intervals were in all the cases calculated as the difference between the date of birth of the child and the date of birth of the previous child. That means that for the analysis only those records could be used in which the date of birth of the studied child and previous child were known. So that the analysis was not influenced by some cases where the birth record was missing or incorrect, we considered only the birth-birth intervals not longer than 5 years and not shorter than 9 months. All the values of the variables were classified as described above.

Table 2 Upper and lower quartile, median, and mean of marriage-birth intervals (in months), prenuptial conceptions not included, according to the age of the mother at marriage; Jablonec nad Nisou, 17th–19th centuries

	Age of the mother at marriage (years)			
	–19	20–24	25–29	30+
Upper quartile (Q75)	20.94	18.58	18.41	21.11
Median (Q50)	13.12	12.48	13.18	15.17
Lower quartile (Q25)	10.09	10.09	10.58	10.01
Mean	17.16	15.93	16.47	17.27
Number of cases included in the analysis	122	458	184	56

Note: According to Log-Rank or Wilcoxon tests of equality over strata, the differences are not statistically significant at a 5% level of significance.

A. Birth-birth intervals according to birth parity and the age of the mother at marriage

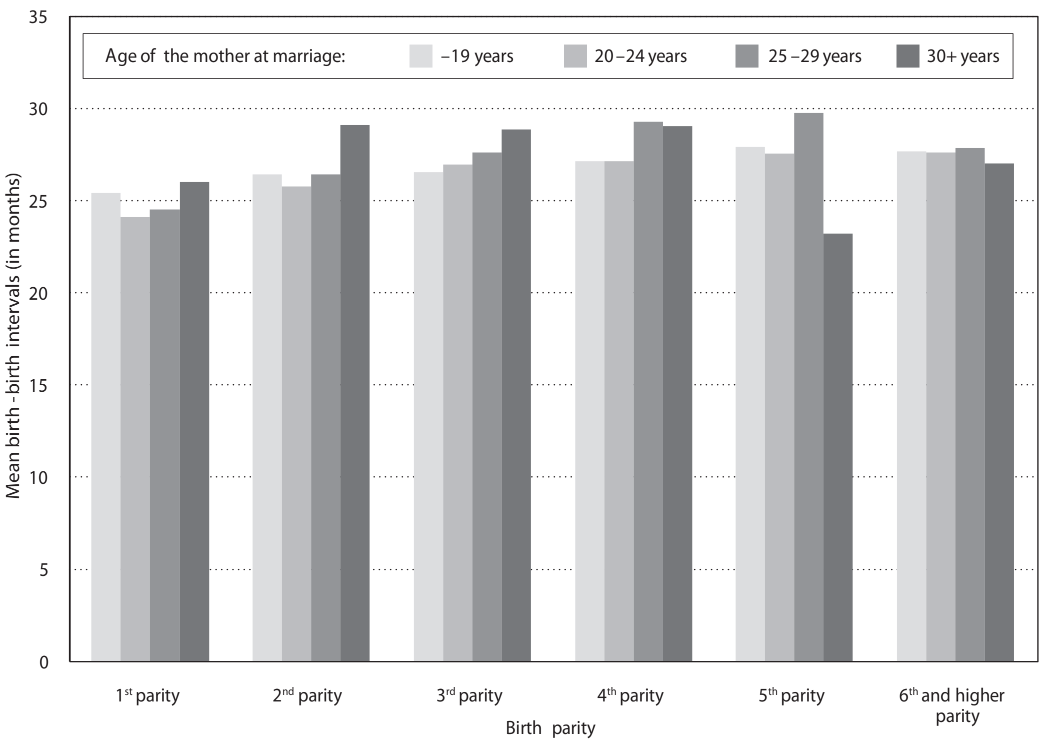
For the analysis of birth-birth intervals it was possible to use 5,588 records on first- and higher-parity births where the age of the mother at marriage was known as well as the date of the birth of the studied child and the date of the birth of the child of previous parity.

When considering the age of the mother at marriage together with the birth parity, the mean lengths of the birth-birth intervals are not very different (see Figure 2). Some differences are observable only for the highest birth parities and the highest ages of women at marriage. However, these categories are rather under-represented (see Appendix 1). The length of the birth-birth intervals are slightly increasing for the 4th and lower birth parity, and seems to be somewhat decreasing for higher parity. This could be explained by the fact that if women could have 6 or more children during the limited reproductive age, the birth intervals had to be somewhat shorter. However, this suggests that there is sense in considering also the influence of the age of the mother at the birth of the child in the analysis. That is the next step presented below.

Within particular birth parities there are visible differences according to the age of women at marriage. The birth interval between the birth of the child of 0 parity and 1st parity child is on average the shortest for women who married at the age of 20–29. For women, who married at a younger or older age, the interval is on average slightly longer (but only by about one month).

The interval between the 2nd, 3rd and 4th child and the birth of the previous child is on average the longest for women who entered into marriage at the highest age (30 and more years). Again, this fact speaks in favour of including the age of the mother at the birth of the child in the analysis. For the highest birth parity the birth-birth intervals are on average shorter for women who entered into marriage at the highest

Figure 2 Mean length of the birth-birth intervals according to birth parity and the age of the mother at marriage, Jablonec nad Nisou, 17th–19th centuries



age. Again, this could be explained by the fact that for those women the period of time between marrying and the end of their reproductive period is the shortest, so if these women had more children (gave birth to children of high parity), their birth-birth intervals had to be on average shorter. We can assume this fact to be likely because most all of the children (of 1st and higher birth parity) were born into marriage.

It can be concluded that increasing age at marriage on average shortens the fertile period of women. That is why the influence of the age of the mother at marriage together with birth parity can be taken as logical.

B. Birth-birth intervals according to birth parity and the age of the mother at the birth of the child

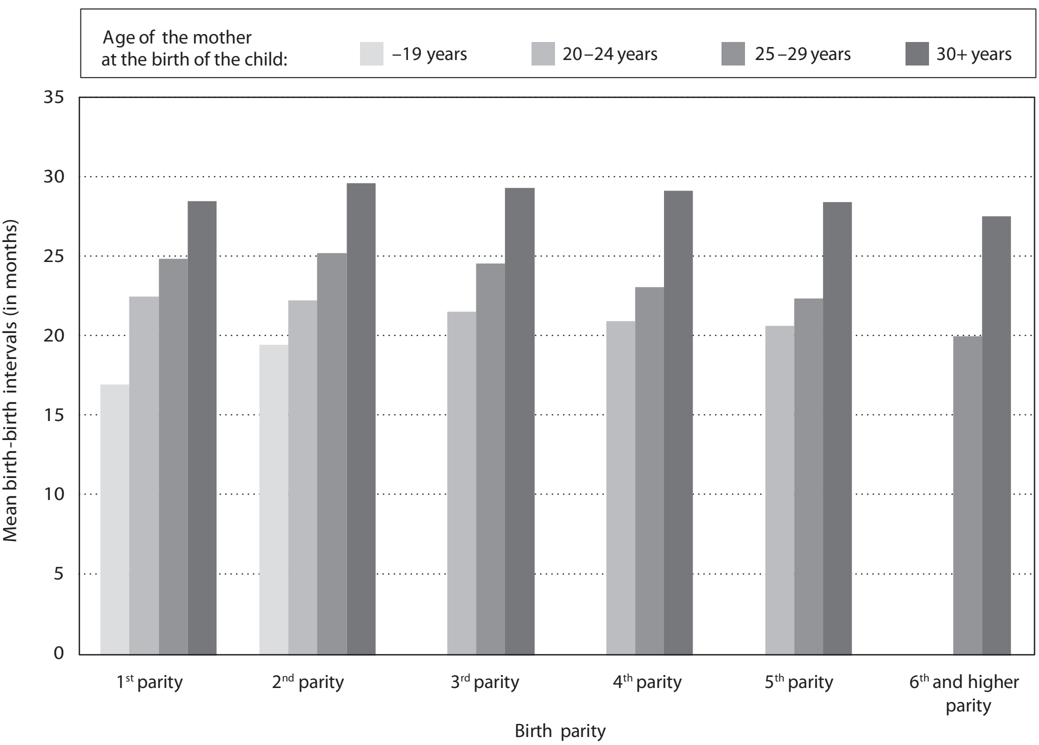
In this part of the analysis the potential influence of the age of the mother at the birth of the child of a particular parity is considered. The previous analysis is repeated using the age of the mother at the birth of the child instead of the age of the mother at marriage. The aim is above all to present the descriptive statistics.

All the characteristics of the data set used in the analysis remained the same as stated above: we worked only with records of children born in first and higher parity into bachelor/spinster marriages, we considered only marriages where the age of the woman at marriage was between the ages of 15 and 49 (incl.), and for the age of the mother at the birth of the child the same age interval was considered. The variable age of the mother at the birth of the child was classified into 4 categories as described above.

In this case we were able to use 6,070 records where the date of birth was known for the studied child and for the child of previous parity, and the age of the mother at the birth of the child and birth parity were also known.

According to the results (Figure 3), the influence of the age of the mother at the birth of the child on

Figure 3 Mean length of the birth-birth intervals according to birth parity and the age of the mother at the birth of the child; Jablonec nad Nisou, 17th–19th centuries



the average length of the birth-birth intervals seems to be much stronger than the age of the mother at marriage. For all birth parities the average length of birth-birth intervals is the longest for the oldest group of mothers. The average birth-birth interval increases with the age of the mother.

However, we should mention two important points here:

1) Not all the categories are represented adequately (see Appendix 2). For example, in the studied data set we have no women in the youngest category (age at birth of the child under 20 years) who had 3rd and higher parity births, and the number of children born in lower birth parities are also not high. For women in the 20–24 age group there are no 6th and higher parity births. In general, most of the children born to women under the age of 20 were first-parity births (we do not consider 0-parity children in the analysis). Most of the children born to women aged 20–24 are 1st or 2nd parity births. Most children born to women aged 25–29 years are 1st to 3rd parity births. In the highest age group of mothers most of the children are 4th and higher parity births (see Appendix 2).
2) Together with the previous point we have to keep in mind that the length of the possible period in which a child of a studied parity could be born is limited by the age of the mother at the birth of the child on one side and her age at marriage on the other side. This means that the age of the mother at the birth of the child is influenced among others by her age at marriage. Alternatively, we could also work with the age of the mother at the birth of the first child instead of the age of the mother at marriage, but the results would in principle be the same.

Both mentioned points lead to one important conclusion: both the descriptive studies (according to the age of the mother at marriage and according to the age of the mother at the birth of the child) are not adjusted for the other variable. Studying the influence of the age of the mother at marriage (Figure 2) we left out the effect of the age of the mother at the birth of the child. Studying the influence of the age of the mother at the birth of the child (Figure 3) we left out the influence of the age of the mother at marriage. Both analyses should be taken only as descriptive; the overall analysis considering all the variables in one model will be presented below.

As noted above, the average length of the birth-birth interval increases with the increasing age of the mother at the birth of the child of a given parity; this could also be understand in that way, that younger women had to have on average shorter birth-birth intervals in order for them even to be able to have higher-parity children. On the other hand, the average length of the birth-birth intervals decreases with increasing birth parity for all the age groups of mother. This is especially visible in the 25–29 age group. The explanation is again the same: for women to be able to give birth to higher-parity children, the birth-birth intervals had to be shorter. The only exception would be for women who married at the lowest ages, which meant they had a longer reproductive period. Again, this is the reason for the overall analysis presented below.

There is one more point which should be kept in mind, which is the influence of infant or child mortality. The length of the birth-birth intervals is without any doubt influenced by the survival of the child of previous parity. However, in this study we decided to discuss only the variables introduced above and the connection to child mortality could be explored in some future study on this issue. In future work consideration could also be given to the effect of the total family size, the total number of children born in a family, the age of the mother at the birth of her last child, and other variables.

C. Cox regression: evaluation of the relationship between the length of birth-birth intervals and birth parity, the age of the mother at marriage and the age of the mother at the birth of the child

In the model, the length of the birth-birth intervals was considered as the explained variable and birth parity, the age of the mother at marriage, and the age of the mother at the birth of the child were explanatory variables. All these explanatory variables were considered as categories; the classification was described above. In the model the reference parametric schema was used, where the reference category was the first one (the first-parity child, the age of the mother at the birth of the child, and marriage under the age of 20).

Table 3 Hazard ratios for the categories of the age of mother at marriage; Jablonec nad Nisou, 17th–19th centuries

Age of the mother at marriage	Point estimate of the hazard ratio	95% Wald Confidence Limits	
Age under 20 vs. 20–24 years	0.735	0.678	0.796
Age under 20 vs. 25–29 years	0.605	0.544	0.672
Age under 20 vs. 30 and more years	0.558	0.469	0.664
Age 20–24 vs. 25–29 years	0.823	0.763	0.887
Age 20–24 vs. 30 and more years	0.759	0.650	0.886
Age 25–29 vs. 30 and more years	0.922	0.789	1.079

It was possible to analyse 5,588 records in which the values of all the variables were known. According the Wald Chi-Square test all three explanatory variables are significant in the model at a 1% level of significance. Also the parameter estimates for all the considered categories of explanatory variables are significant at least a 5% level of significance. The influence of particular categories of explanatory variables can be evaluated using the hazard ratios.[3)]

Considering the effect of the age of the mother at marriage (adjusted for the effect of the birth parity and of the age of the mother at the birth of the child), then the first category of women (who married under the age of 20) has a hazard ratio below 1, which means that this category of women have on average lower hazard functions (= longer birth-birth intervals) compared to all the following age categories (Table 3). The same could be said also for the second category of women (who married at ages 20–24 years) compared to women who married at an older age. The differences between the 3rd and 4th categories are not significant at a 5% level of significance.

In other words, considering the pure effect (adjusted for the values of other variables) of the age of the mother at marriage, then a younger age at marriage leads on average to longer birth-birth intervals. This is above all true for the first two age categories (age at marriage under 25). These results are fully consistent with the fact that the average reproductive period of women who entered into marriage at a lower age is longer, so they are able to have children of higher birth parity with longer average birth-birth intervals.

For the variable age of the mother at the birth of the child the results are contrary to the results for the previous variable. This means that for lower categories of ages at the birth of the child the hazard function is higher (= shorter birth-birth intervals) than it is in higher age groups (Table 4). In other words, the pure effect of age at the birth of the child shows that a lower age at the birth of the child means shorter average birth-birth intervals. And a higher age at the birth of the child means longer average birth-birth intervals (when adjusted for various values of birth order or the age of the mother at marriage). This result probably has to do with the ideal biological age for conception and the relatively rapid onset of childbirth at a lower age.

According to the pure effect of birth parity, as Table 5 shows, lower birth parity leads on average to lower

3) The hazard ratios represent the ratios of hazard functions. Higher hazard function values mean a higher intensity of births in shorter intervals. When we assume the hazard ratio for two categories of a studied variable, say Z1 and Z2, the higher the values of the ratio, the higher the hazard function of category Z1 compared to category Z2. In other words, if the hazard ratio has a positive value, the hazard function of category Z1 is higher than of Z2, which means that the birth-birth intervals are on average shorter for the Z1 category than for Z2. The most important fact when evaluating the influence of one explanatory variable from this complex model is that the results are adjusted for the values of the other variables (which means that we can evaluate the pure effect of the explanatory variables, free from the effect of other variables).

Table 4 Hazard ratios for the categories of the age of the mother at the birth of the child; Jablonec nad Nisou, 17th–19th centuries

Age of the mother at the birth of the child	Point estimate of the hazard ratio	95% Wald Confidence Limits	
Age under 20 vs. 20–24 years	2.333	1.377	3.622
Age under 20 vs. 25–29 years	3.776	2.322	6.141
Age under 20 vs. 30 and more years	7.811	4.764	12.806
Age 20–24 vs. 25–29 years	1.691	1.523	1.878
Age 20–24 vs. 30 and more years	3.498	3.065	3.993
Age 25–29 vs. 30 and more years	2.069	1.900	2.252

values of the hazard function (= longer birth-birth intervals) than in higher birth parities. This result is significant at a 5% level of significance for all the categories of birth parities, with just one exception – the difference is not statistically significant for 4th parity compared to 5th birth parity (Table 5).

The presented results differ from the results of studies working with traditional historical demographic methods (Henry's family reconstitution method). In those studies, the usual conclusions indicate that the higher the birth parity, the longer the average birth-birth interval. These were the results for Jablonec

Table 5 Hazard ratios for the categories of birth parity; Jablonec nad Nisou, 17th–19th centuries

Birth parity	Point estimate of the hazard ratio	95% Wald Confidence Limits	
1st parity vs. 2nd parity	0.913	0.835	0.999
1st parity vs. 3rd parity	0.822	0.744	0.909
1st parity vs. 4th parity	0.721	0.644	0.807
1st parity vs. 5th parity	0.688	0.608	0.779
1st parity vs. 6th and higher parity	0.616	0.548	0.692
2nd parity vs. 3rd parity	0.901	0.821	0.989
2nd parity vs. 4th parity	0.790	0.712	0.876
2nd parity vs. 5th parity	0.753	0.672	0.845
2nd parity vs. 6th and higher parity	0.675	0.607	0.750
3rd parity vs. 4th parity	0.876	0.793	0.969
3rd parity vs. 5th parity	0.836	0.750	0.934
3rd parity vs. 6th and higher parity	0.749	0.679	0.826
4th parity vs. 5th parity	0.954	0.856	1.064
4th parity vs. 6th and higher parity	0.855	0.777	0.940
5th parity vs. 6th and higher parity	0.896	0.812	0.988

Note: 1st parity = 2nd child in a family. The width of the confidence limits is influenced by the under-representation of some categories already mentioned above.

published by *Wowková and Fialová* (1992: 231): the mean interval between second and third births was 24 months, while that between the next-to-last and the last (without regard to parity) was more than 36 months.

The reason for this difference could probably be found in the method of calculating birth-birth intervals; i.e. the sets of families entered into the calculation are defined differently. Henry recommends estimating birth-birth intervals using data only for families with more than six children and moreover only for families where the woman survived married until the age of 50 (*Henry*, 1980: 102–112). According to that methodology, many women (families) are not included in the calculation of birth-birth intervals. Using data from the dataset analysed in this paper, 81% of children would not be included (Figure 1). Unlike Henry's methodology, our study also uses data for families in which women married at a higher age and had fewer than 6 children (because of their short reproductive period in marriage). It can be assumed that these women probably had longer birth-birth intervals between children (because of their age) than women who got married at a lower age. This could be the reason for the increasing birth-birth intervals among lower birth parities. At the same time, women who died or were widowed under the age of 50 (regardless of the number of children) would also be excluded from the analysis according to Henry's methodology. However, data for those women were included in the dataset analysed above in this paper. It is likely that women who married at a lower age and who had children of higher parity could be among them. These women could have their children with relatively short birth-birth intervals (because they did not terminate their reproductive period), which reduce the average length of birth-birth intervals for higher birth parity. According to Henry´s recommendations mentioned above, only women who gave birth to children across their reproductive period are included in the database for calculating the birth-birth intervals. The length of the birth-birth intervals of these women grew with increasing age and the increasing birth parity of their children. However, it has to be mentioned that the purpose of the Henry's methodology was completely different from the aims of the present study. Henry focused purely on the study of natural fertility (*Henry*, 1961). That was the reason for the many restrictions defining the records to be used for analysis. The aim of the study presented in this paper was not to evaluate the database, nor to study the natural fertility, but just to study the birth intervals in more detail using various explanatory variables.

The results of our study fully correspond to the assumption that children of higher birth parity had to be born on average with shorter birth-birth intervals during a limited reproductive period (when standardised for the different ages of the mother at marriage and at the birth of the child). Moreover, when a woman gets married at higher ages, her reproductive period is on average shorter (assuming that most of the children are born in marriage), which is also a factor behind the shorter mean length of the birth-birth intervals. If the age of the mother at the birth of the child is lower, then also the birth-birth intervals tend to be shorter. This is illustrated for example by the estimated survival curves for various values of explanatory variables using the Cox model (see Appendix 3 to 5). One can see there that the survival curves are steeper (i.e. the birth intervals are on average shorter) for all the birth parities when the ages of the mother at marriage and at the birth of the child are both low (Appendix 3). When the age of the mother at marriage is high and the age at the birth of the child is also relatively high then the slope of the survival curves is milder (Appendix 5). The combination of a young marriage age and a relatively high age at the birth of the child leads on average to the longest birth-birth intervals (Appendix 4).

5. CONCLUSION

The aim of this paper was to apply survival analysis and Cox regression to historical data about the population (births). More specifically, we sought to illustrate the possibilities for using these methods to analyse birth intervals of married women in Jablonec nad Nisou from the 17th to 19th centuries. In that time, we can talk about natural fertility. The main goal of the analysis was to study the frequency of births and the possible influence of the age of the mother at marriage and at the birth of the child and how this influence changes in relation to birth parity.

In the analysis we did not consider the possible influence of mortality level (child or infant mortality), we did not studied the relation between the length of the birth intervals and the life trajectory of the previous child. The analysis concentrated solely on the relationship between the birth intervals and birth parity and other explanatory variables represented by the age of the mother at marriage or at the birth of the child. What we also left aside in the study was the fact of whether the studied families were families with completed reproduction (the woman survived married up to the age of 50). The time period was studied as a whole; we did not distinguish particular time intervals so that the changes in time could be described. The reason was to ensure the adequate representation of various categories. On the other hand, it can be assumed that the situation was not stable in time (e.g. this was described for prenuptial conceptions in *Hulíková Tesárková – Kuprová*, 2015).

The results presented above confirmed some expected facts about the character of the reproductive behaviour of the historical populations. The analysis of birth intervals was divided into two main parts: the first one dealt with the 0-parity children (the first child born in the family) and the other studied births of children of higher birth parity.

The average length of the marriage-birth intervals was significantly influenced by the percentage of prenuptial conceptions. This percentage was relatively high in the studied population – more than one third; and it was higher for women who married at the age of 20–29 years compared to women who married younger or older. On average, more than every third woman got married when she was already pregnant. This was a relatively common situation in the Czech lands in the past, and similar differences have been found by Ladislav Dušek for Budyně nad Ohří (*Dušek*, 1985) and by Petra Brabcová for the Brno region (*Brabcová*, 2001). When considering only children conceived after marriage, they were born on average 10 months after the wedding, and the length of this interval was independent of maternal age at marriage.

The analysis of births of children of higher parity showed how significantly the length of the birth-birth intervals influenced the total number of children in a family. In families where children were born at shorter intervals, the total number of children born was on average higher. This simple relation also demonstrates the nature of the reproductive regime, where there were no deliberate limits placed on the number of children in a family. This was also the reason why not only the length of the birth intervals was important for the overall number of children born into a family, but also the age of the mother at marriage. The average length of the birth-birth intervals decreased slightly with the increasing parity of the child. It can be assumed that the increasing average length of the birth-birth intervals with increasing birth parity observed in some studies (as cited above) is not really the effect of birth parity but rather the effect of the increasing age of the mother.

An important advantage of the present study is the size of the dataset used in the analyses. Also thanks to this the results are statistically significant at least at a 5% level of significance. In the Cox regression we studied the pure effects of the birth parity, the age of the mother at marriage and at the birth of the child. When women married younger, their reproductive period was on average longer as well as the average birth-birth intervals. On the other hand, if the age of the mother at the birth of the child was younger, the birth-birth intervals were on average shorter. That means that all the results presented above are consistent. However, there are differences from studies that strictly followed Henry's original methodology: in our study the average birth-birth intervals shorten with increasing birth parity. The reason can be found in the methodology, more specifically in the restrictions on the records that can be used in the analysis. For Henry's purposes (*Henry*, 1980), only a selected (and relatively small) group of women (and their children) could be included into the analysis. For our purpose, those restrictions are not necessary and women with incomplete fertility or a lower number of children were also included in the studied dataset. Moreover, in studies based on Henry's methodology the influence of birth parity is not adjusted for the age of the mother at the birth of the child; it can be assumed that children of higher birth parity are more often born to older women.

The analysis proved above all the importance of the age of the mother at marriage and at the birth of the child and the importance of the birth parity for the average length of the birth intervals. However, the results also raised questions for future analyses: a more detailed study of families with more children, total family size and its influence on the birth intervals, the effect of infant and child mortality, etc. These issues will be the aim of upcoming studies based on the introduced dataset.

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Appendix 1 Upper and lower quartile, median and mean of the lengths of birth-birth intervals (in months) for 1st and higher birth parities, according to the age of the mother at marriage; Jablonec nad Nisou, 17th–19th centuries

		Age of the mother at marriage (years)			
		–19	20–24	25–29	30+
1st parity	Q75	29.62	28.44	29.23	31.33
	Q50	24.10	22.96	22.49	24.30
	Q25	19.18	17.52	17.19	18.51
	Mean	25.42	24.12	24.52	25.97
	N	164	642	261	71
2nd parity	Q75	31.43	29.62	30.90	35.97
	Q50	25.07	24.35	24.72	27.62
	Q25	20.60	20.38	20.58	21.04
	Mean	26.39	25.77	26.39	29.11
	N	152	590	215	49
3rd parity	Q75	30.51	31.23	33.11	34.06
	Q50	25.25	25.32	25.87	28.67
	Q25	21.24	21.21	22.22	23.34
	Mean	26.54	26.93	27.61	28.86
	N	135	510	193	33
4th parity	Q75	31.53	31.53	35.16	34.65
	Q50	26.20	25.87	28.11	27.35
	Q25	22.03	21.63	23.39	22.26
	Mean	27.13	27.15	29.28	29.05
	N	115	441	156	17
5th parity	Q75	32.25	33.11	35.38	25.51
	Q50	25.84	26.53	29.03	23.00
	Q25	21.96	21.14	22.39	19.50
	Mean	27.91	27.56	29.77	23.21
	N	101	377	109	10
6th and higher parity	Q75	33.40	32.58	32.86	31.70
	Q50	26.86	26.50	26.05	24.62
	Q25	21.40	20.38	21.16	22.22
	Mean	27.67	27.60	27.82	27.20
	N	259	847	132	9
Total number of cases	N	926	3,407	1,066	189

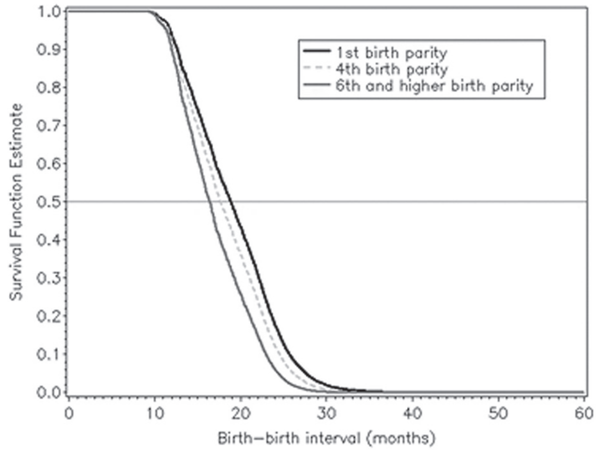
Note: Q75 = Upper quartile, Q50 = Median, Q25 = Lower quartile, N = Number of cases in the category used in the analysis.

Appendix 2 Upper and lower quartile, median and mean of the lengths of birth-birth intervals (in months) for 1st and higher birth parities, according to the age of the mother at the birth of the child; Jablonec nad Nisou, 17th–19th centuries

		Age of the mother at the birth of the child (years)			
		–19	20–24	25–29	30+
1st parity	Q75	18.97	26.20	29.59	33.73
	Q50	14.15	21.96	23.47	26.89
	Q25	12.59	16.93	18.05	20.68
	Mean	17.06	22.59	24.99	28.64
	N	18	457	546	197
2nd parity	Q75	24.46	25.84	28.87	36.10
	Q50	21.21	22.62	23.97	27.81
	Q25	13.05	18.51	20.45	22.75
	Mean	19.57	22.38	25.36	29.74
	N	3	167	595	321
3rd parity	Q75		26.50	28.24	34.69
	Q50		22.26	24.16	27.58
	Q25		14.27	19.92	22.88
	Mean		21.66	24.67	29.47
	N		43	417	479
4th parity	Q75		23.64	27.06	34.65
	Q50		19.46	23.39	27.58
	Q25		18.64	18.16	23.57
	Mean		21.05	23.19	29.29
	N		7	208	575
5th parity	Q75		25.05	26.50	34.49
	Q50		20.75	22.87	26.99
	Q25		16.44	19.04	21.88
	Mean		20.75	22.47	28.55
	N		2	74	576
6th and higher parity	Q75			23.74	32.66
	Q50			17.85	26.45
	Q25			16.60	20.89
	Mean			20.08	27.67
	N			25	1360
Total number of cases	N	21	676	1,865	3,508

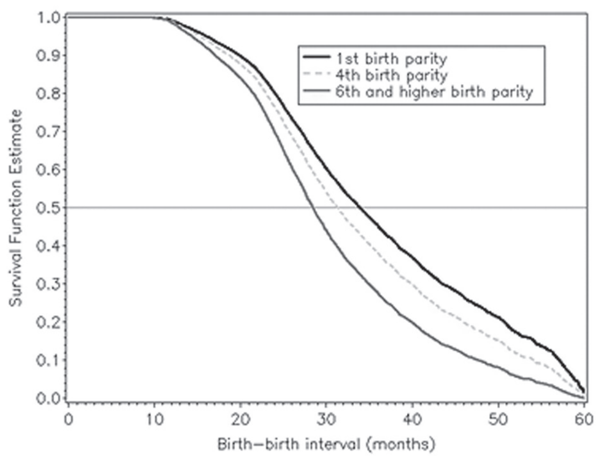
Note: Q75 = Upper quartile, Q50 = Median, Q25 = Lower quartile, N = Number of cases in the category used in the analysis.

Appendix 3 Survival function estimate for 1st, 4th, and 6th and higher birth parities, age at marriage under 20, age at birth under 20; Jablonec nad Nisou, 17th–19th centuries



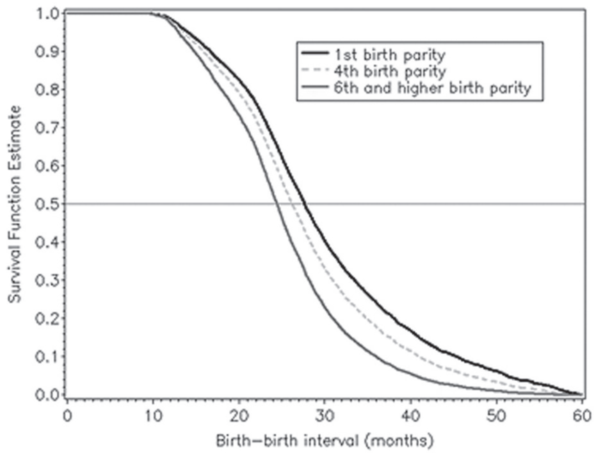
Note: Estimation based on a Cox regression model.

Appendix 4 Survival function estimate for 1st, 4th, and 6th and higher birth parities, age at marriage under 20, age at birth 30 and more years; Jablonec nad Nisou, 17th–19th centuries



Note: Estimation based on a Cox regression model.

Appendix 5 Survival function estimate for 1st, 4th, and 6th and higher birth parities, age at marriage 30 and more years, age at birth 30 and more years; Jablonec nad Nisou, 17th–19th centuries



Note: Estimation based on a Cox regression model.

THE IMPORTANCE OF BENJAMIN GOMPERTZ FOR THE ANALYSIS OF MORTALITY PATTERNS

Tomáš Fiala – Jitka Langhamrová

ABSTRACT

This year marks 150 years since the death of Benjamin Gompertz, a famous mathematician and actuary. This article offers a short biography and then focuses on Gompertz's analysis of human mortality pattern. It also mentions later modifications to Gompertz's mortality law and other possible models of old-age human mortality.

Keywords: Benjamin Gompertz, human mortality, ageing rate, growths curve **Demografie,** 2015, **57: 338–344**

INTRODUCTION

The date of 14 July 2015 marked 150 years since the death of Benjamin Gompertz, famous mathematician and actuary.

Source:
http://www-history.mcs.st-andrews.ac.uk/PictDisplay/Gompertz.html.

SHORT BIOGRAPHY (KIRKWOOD, 2015; O'CONNOR AND ROBERTSON, 2005; TROPP, 2008)

Benjamin Gompertz was born on 5 March 1779 in London. He was one of three sons of a merchant family that emigrated from Holland in the eighteenth century. He was Jew and therefore he was denied admission to universities. He was privately and self-educated, and fed his interest in mathematics by reading Newton and Maclaurin.

His very good knowledge of mathematics resulted in his being elected, at the mere age of 18, to Spitalfields Mathematical Society (later the London Mathematical Society). In a letter to De Morgan (1865) he wrote:

As to the Mathematical Society, of which I was a member when only 18 years of age, having been, contrary to the rules, elected under the age of 21. How I came to be a member of that Society - and continued so until it joined the Royal Astronomical Society, and then was the President - was: I happened to pass a bookseller's small shop of second hand books, kept by a poor taylor, but a good mathematician, John Griffiths. I was very pleased to meet a mathematician, and I asked him if he would give me some lessons; and his reply was that I was more capable to teach him, but he belonged *to a society of mathematicians, and he would introduce me. I accepted the offer, and I was elected, and had many scholars then to teach, as one of the rules was, if a member asked for information, and applied to one who could give it, he was obliged to give it, or be fined one penny.*

In 1810 he married Abigail Montefiore. They had a son, Joseph (who died at the age of 10), and two daughters, Justina Lydia and Juliana (who survived until the age of 72 and 58 years, respectively).

In 1810, Gompertz began working at the stock exchange. Nine years later he became a Fellow of the Royal Society. The following year he presented a paper on calculations of life expectancy applying the differential calculus.

In 1821 he applied for the position of actuary in the just established Guardian Insurance Office, but without success. The reason for his rejection is said to have been because he was a Jew. Nevertheless, three years later he was appointed as actuary and head clerk of the Alliance British and Foreign Life Assurance Company founded by his brother-in-law, Sir Moses Montefiore, and Nathan Rothschild. He was also chief manager of the related Alliance Marine Insurance.

Gompertz is most famous for his law of mortality. In 1825 he showed that the mortality rate at adult age increases in a geometric progression (*Gompertz*, 1825). When age-dependent death rates are plotted on a logarithmic scale, a straight line is obtained. Owing to his expertise in this area he served the government as an adviser, and he also did computations for the army medical board.

Gompertz was also interested in astronomy. He was an early member of the Royal Astronomical Society and wrote a number of papers about astronomical instruments: 'The Theory of Astronomical Instruments' (1822), 'A New Instrument Called the Differential Sextant' (1825), and 'On the Converted Pendulum' (1829). He also assisted Francis Bally in calculating of tables of the mean places of stars to help him to produce a catalogue of 3000 fixed stars. Gompertz was also a founding member of the Statistical Society of London in 1834.

In 1848 Gompertz retired from active work but he continued his studies in the fields of mathematics and science, as he had much more time and energy to do so. He published a mathematical work titled 'Hints on Porisms' in 1850 as a sequel to earlier papers on imaginary quantities. At the International Statistical Congress in 1860 he contributed a paper concerning human mortality. He also continued his astronomical investigations of comets and meteors (but this work was not published).

When in 1865 the London Mathematical Society was founded, Gompertz (though by then 86 years old) began work on a paper that he intended to submit to the new journal *Proceedings of the London Mathematical Society*. However, he died on 14 July 1865 before finishing the paper.

GOMPERTZ'S MORTALITY LAW

At a meeting of the Royal Society of London on 16 June 1825, Benjamin Gompertz presented his famous paper 'On the nature of the function expressive of the law of human mortality, and on a new mode of determining the value of life contingencies' (*Gompertz*, 1825), which was subsequently published in *Philosophical Transactions*. It was a continuation of his previous mortality analysis work published in a previous paper (*Gompertz*, 1820).

Gompertz sought to improve how survival probabilities through the human life were calculated and tried to discover the law behind the age mortality pattern and thereby develop a more reliable method of calculating the rates for selling and purchasing life insurance and annuities.

In his previous work (*Gompertz*, 1820), Gompertz '*observed the near agreement with a geometrical series for a short period of time, which must pervade the series which expresses the number living at ages in arithmetical progression, proceeding by small intervals of time, whatever the law may be, provided the intervals be not greater than certain limits*'. The differences of the logarithms of the equidistant numbers of living persons were almost constant, which means that the force of mortality (and hence the probability of dying) would be almost constant in these intervals.

The purpose of the paper from 1825 was to observe the law of mortality *for equal intervals of long periods* (p. 514). Gompertz shows that for large portions of different tables of mortality the law of geometrical progression is valid, presenting, as an example, the interval between the age of 25 and 45 from the Deparcieux life tables (*Gompertz*, 1825: 515).

More interesting and surprising are other examples of mortality tables (Milnes, Carlisle) where in the age interval of very old age – from 92 to 99 years – the annual probabilities of mortality were almost constant at the level of 0.25 and almost did not increase further with age. Based on this finding he remarked that '*if the law of mortality were accurately such that after a certain age the number of living corresponding to ages increasing in arithmetical progression, decreased in geometrical progression, it would follow that life annuities for all ages beyond that period were of equal value*' (*Gompertz*, 1825: 515).

Moreover he reasoned that this '*would indeed make it appear that there was no positive limit to a person's age; but it would be easy, even in the case of the hypothesis, to show that a very limited age might be assumed to which it would be extremely improbable that any one should have been known to attain … the limit to the possible duration of life is a subject not likely ever to be determined, even should it exist*' (*Gompertz*, 1825: 516).

Gompertz formulated an important hypothesis concerning the nature of mortality: '*It is possible that death may be the consequence of two generally co-existing causes; the one, chance, without previous disposition to death or deterioration; the other, a deterioration, or an increased inability to withstand destruction.*' (*Gompertz*, 1825: 517)

If all diseases were equally destructive regardless of the age of the patient, the intensity of mortality would then be almost constant (p. 517). But in human life susceptibility to death at an older age increases with age, so the force of mortality must also increase with age, and the number of survivors decreases in a greater ratio than geometrical progression.

Gompertz proved that '*if the average exhaustions of a man's power to avoid deaths were such that at the end of equal infinitely small intervals of time, he lost equal portions of his remaining power to oppose destruction which he had at the commencement of those intervals, than at the age x his power to avoid deaths, or the intensity of his mortality, may be denoted by* aq^x, *a and q being constant quantities*':

Because the intensity of mortality at higher ages increases with age, $a>0$ and $q>1$.

The number of persons living at age x then equals

$$d \cdot g^{(q^x)},$$

where d is a positive constant and

$$g = e^c$$

(*Gompertz*, 1825: 518).

This law can be also expressed in the form of the following equation (with other parameters than in Gompertz's original work)

$$\mu(x) = \alpha \cdot e^{\beta x} \qquad \alpha>0, \beta>0, \qquad (1)$$

and in logarithmic form we have a linear equation

$$\ln \mu(x) = \ln \alpha + \beta x, \qquad (2)$$

and which is known as the Gompertz equation, the Gompertz function or Gompertz's mortality law.

The value of parameter β determines how fast the force of mortality increases with age; in a sense it indicates the ageing rate of the population.

The equation (1) includes only the second type of causes of deaths (with the probability of death growing with age) and 'omitted' the first type of causes (independent of age). Only several decades later, two years after Gompertz deaths, William Matthew Makeham (*Makeham*, 1867) proposed a modification of the Gompertz equation incorporating 'age-independent' causes of deaths

$$\mu(x) = \alpha \cdot e^{\beta x} + \gamma \qquad \alpha>0, \beta>0. \qquad (3)$$

The 'Gompertz-Makeham function' is frequently used for smoothing and extrapolating mortality at higher ages. Later on, in the literature on biodemography, the concepts of 'extrinsic' mortality (caused by hazards that have no relation to biological age) and 'intrinsic' mortality (the risk of which increases with age) were used.

Gompertz's law of mortality has attracted the attention of many scientists. It was the first empirical tool for providing a relatively simple description of the dying-out process over the life span.

For example, *Sacher* (1977) used it to analyse and compare the patterns of mortality rates among different species. He termed the quantity $\ln(2)/\beta$ the *mortality rate 'doubling time'*, i.e. the length of an age interval at the end of which the mortality ratio is twice what it was at the beginning. While the mortality doubling time for the house mouse (Mus musculus) was about 7 months (220 days), for humans (US white females, 1969) the value was almost 8 ½ years (3,100 days).

The Gompertz model would of course underestimate neonatal mortality, because the death characteristic of newborns is different than that of adults. The intercept ln α was thus described as a '*vulnerability* *parameter, the initial vulnerability to disease, before the onset of ageing*' (*Sacher*, 1977).

It was early recognised that the age mortality pattern of some species in not in accordance with the Gompertz rule. Within some species there is observable even a decline in mortality rates with increasing age (*Vaupel et. al.*, 2004).

The Gompertz model has also been used to analyse the trends in human longevity in various countries and different years. *Jones* (1956), for example, made a comparison of mortality in India in 1900, Mexico in 1940, Sweden in 1949, and the USA in 1900, 1940 and 1950.

The curves showing the dependence of the log mortality rate against age formed almost parallel lines in the age after 40 in particular populations, which means that the ageing ratio (the value of β) would be almost the same for all these different populations (corresponding to a mortality doubling time of about 8 years). Even the comparison of mortality between Australian prisoners in Japan war camps in 1945 (where the conditions were terrible) with the mortality profile of citizens in Australia brought the same result, i.e. the value of parameter β was almost equal for both populations despite a substantial difference in mortality (Finch, Pike, Witten, 1990). On the other hand, the values of the mortality rate doubling time for various species were quite different: it is just 1.2 years for the White-footed mouse, but 15 years for a Rhesus monkey. *Vaupel* (2010) offered the hypothesis that the ageing ratio (slope parameter β in equation (2)) is practically the same for all human populations today and in the past, and only the value of parameter α differs.

The question arose as to whether Gompertz's law, expressed as a relatively simple equation, could be a fundamental law of mortality in nature, one in some sense similar to the laws of physics. Several attempts were made to 'explain' the nature of this law, but they failed (*Olshansky – Carnes*, 1997). An interesting attempt was based on the reliability theory. The biological organism is modelled as a set of irreplaceable 'blocks' and each block consists of substitutable 'elements'. When all the elements of a block failed, the failure of a block occurs. The failure of any arbitrary block means the death of the organism (*Gavrilov – Gavrilova*, 2001). It can be shown that in this type of model the failure rate grows exponentially according to Gompertz's law.

MORTALITY IN VERY OLD AGE

Gompertz's model (with Makeham's improvement of it) was for a long time the main tool for modelling mortality at higher ages. But Gompertz was also interested in the question of whether a limit to the human lifespan exists and in the pattern of mortality at very high ages. In his day the number of people who survived to a very high age was relatively small and so it was very difficult to obtain reliable empirical data with which to answer this question. Recently, as human longevity has increased, it has become possible to investigate more precisely mortality at high and very high ages. One such investigation has shown that not only in human but also in some animal populations mortality rates are constant (or even declining) at the very high ages (*Carey et. al.*, 1992).

Thatcher (1999) analysed data on advanced human ages in the Archive on Population Data on Aging (*Thatcher – Kannisto – Vaupel*, 1998). He found that during a major part of adult life mortality increases according to the Gompertz exponential law. But at a very high age, which can be considered in some sense as 'extremely' high, other mathematical models are of the same quality or even better. He compared the Gompertz model with the following models:
the three-parameter logistic model

$$\mu(x) = \frac{\alpha \, . \, e^{\beta x}}{1 + \alpha \cdot e^{\beta x}} + \gamma, \qquad \alpha>0, \beta>0, \qquad (4)$$

the Weibull (1951) model

$$\mu(x) = \alpha \cdot e^{\beta x}, \qquad \alpha>0, \beta>0, \qquad (5)$$

and a model by Heligman and Pollard (1980) for high ages, expressed as

$$\mathrm{logit}(q(x)) = \alpha + \beta, \qquad \alpha>0, \beta>0, \qquad (6)$$

where $q(x)$ is the probability of deaths in the exact age x.

According to *Thatcher* (1999) the best fit of the observed pattern of mortality at the highest attained ages was observed with the logistic model (4)[1)].

1) A brief overview of these and some other models can be found, for example, in *Thatcher – Kannisto – Vaupel* (1998) or in *Burcin – Tesárková – Šídlo* (2010).

Numerous studies have confirmed the existence of a 'mortality plateau' at higher ages, i.e. the force of mortality is constant or even slightly decreasing with age. One possible explanation is population heterogeneity (*Vaupel, et al.* 1998). If robustness against death is various between individuals, the 'weakest' will die earliest, while the most robust will increasingly predominate among the oldest ages, which may be why the force of mortality stabilises (or even declines slightly) at high ages.

A MODIFICATION OF THE GOMPERTZ-MAKEHAM FUNCTION FOR HIGH AGES

Analyses of mortality in many European countries in the 1990s showed that somewhere between the age of 85 and 90 years the values of the Gompertz-Makeham function begin to be systematically higher than the empirical age-specific death rates (*Koschin et al.*, 1998, chap. 6b). There are two possible reasons for this: either errors in data on deaths and survivors at this age, or the Gompertz hypothesis is not valid for very old ages.

It is known that there may be errors in data on populations at higher ages for some countries. But the phenomenon described has been observed in many populations (e.g. *Horiuchi – Coale*, 1990). Moreover, if very old age mortality were as high as the Gompertz-Makeham function indicates it to be, there could not be as many people who are 100 years old and over as there are in many countries.

Koschin proposed that the Gompertz hypothesis should be corrected in the sense that at higher ages the relative decrease of resistance to death is not constant but diminishing. (Let's remember Gompertz's observation about constant mortality rates in the age interval from 92 to 99; *Gompertz*, 1825: 516.) The decrease cannot be too rapid because the force of mortality is expected to continue to increase, but not exponentially.

Gompertz's assumption should, according to Koschin, be rewritten in the form of a differential equation (*Koschin et al.*, 1998, chap. 6b)

$$\frac{-\mathrm{d}\,1/\mu(x)}{\mathrm{d}\,x} = h \cdot 1/\,\mu(x) \quad , h > 0 \ . \qquad (7)$$

The hypothesis that the relative decrease of resistance to deaths slows down (in very old age) means that in the equation (7) the constant value of h should at higher ages be replaced by a slowly decreasing function, $h(x)$. If the force of mortality $\mu(x)$ is supposed to rise above all limits, product $x{\cdot}h(x)$ must not converge (with increasing x) to zero, so $h(x)$ must not converge to zero faster than $1/x$. A function that may adhere to this condition is a power of a hyperbole, i.e. $1/(k{\cdot}x+q)^{\alpha}$, where α is equal to 1 or higher. The simplest choice is $\alpha=1$.

A possible choice for the $h(x)$ function could thus be

$$h(x) = \frac{h}{\delta\cdot(x-x_0)+1} \quad , h > 0, \quad \delta > 0 \ . \qquad (8)$$

The Gompertz-Makeham function is thus modified for higher ages as

$$\mu(x) = \alpha \cdot e^{\beta\left(x_0+\frac{1}{\delta}\cdot\ln\left[\delta\cdot(x-x_0)+1\right]\right)} + \gamma, \qquad (\alpha>0,\ \beta>0) \ \text{for } x>x_0, \quad (9)$$

while for lower age the standard function

$$\mu(x) = \alpha \cdot e^{\beta x} + \gamma \qquad (\alpha>0,\ \beta>0) \qquad (10)$$

is used (*Koschin et al.*, 1998, chap. 6b).

Data investigated in *Koschin et al.* (1998, chap. 6b) show that in the age interval from 60 to 80 years the standard Gompertz-Makeham function fits age-specific mortality rates well. While it differs significantly for ages over 85, so the age of around 83, is a suitable value of x_0 (in equation (9)).

CONCLUSION

The Gompertz equation formed the basis for the development of growth curves representing not just human and biological but also economic phenomena. The significance of Gompertz's work for studying patterns of mortality is well known. The Gompertz function, especially after Makeham's and Koschin's modifications, is even today still one of the functions that is often used to model human mortality at higher ages.

Numerous studies have drawn on Gompertz's work on growth curves (*Winsor*, 1932) and they include not just demographic studies of human mortality but also, for example, studies in medicine, hygiene and epidemiology, or biological studies on the mortality patterns of some species. *Kirkwood* (2015).

Augustus De Morgan called Gompertz 'the link between the old and new' when he mourned '*the passing of the last of the learned Newtonians*'.

Kirkwood (2015) summed up Gompertz's contribution to science in the following words. '*Although Gompertz's paper was not alone in forming the basis for actuarial science, it has played a pivotal role in doing so and is very well known to practising actuaries today. Within the biology of ageing, Gompertz's work has had an even more distinctive impact, notably through the early recognition of its significance by George Sacher. The subsequent field of the biodemography of ageing has grown largely through exploring its implications and through 'proving the rule' by exploring cases where it does not so well describe the patterns of mortality. As one leading proponent put it 'The more the Gompertz equation is studied, the more interesting it becomes' (J. W. Vaupel 2014, personal communication). Today, as actuaries and biogerontologists converge in addressing the challenges of understanding the continual increase in human longevity and the underpinning science of ageing, the twin legacies of Benjamin Gompertz are beginning to converge. It is about time.*'

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THE VIENNA YEARBOOK OF POPULATION RESEARCH 2013[1)]

Martina Miskolczi

The yearbook of the Vienna Institute of Demography for the year 2013 is dedicated to the ageing process and longevity. The fourteen contributions in the yearbook focus on the continually increasing life expectancy in the Western world and on longevity and the major decrease in mortality among seniors. This revolutionary development of mortality is ascribed to a combination of various determinants, such as programmed genetic ageing, age-associated changes, primary damage, evolutionary theories or biological determinants of the ageing process, and the immunological status of centenarians (what are called 'biogenetic theories'). Demographers study the underlying models of mortality curves, where frailty models play an important role, and they discuss issues such as the age limit of the human lifespan, the compression or shift of the modal age, and deceleration in the force of mortality.

The most recent studies strongly support the view that genetic effects are important for survival at older ages. On the other side, both lifestyle and the environment may also be involved and genetics can only partially account for survival and probably for no more than 25–30%.

Despite the continuous rise of life expectancy there are still large differences between populations and subpopulations that are not fully understood. This issue of the Vienna Yearbook of Population Research aims to find and present as many of the factors that influence longevity as possible. The articles are grouped into four sections:

- methodological issues for studying longevity and mortality
- longevity islands
- longevity and mortality of specific risk groups
- survival to old and oldest-old age: familial and socio-demographic determinants.

The first article, by *Elizabeth Wrigley-Field*, is entitled '**Mortality deceleration is not informative of unobserved heterogeneity in open groups**' and provides an in-depth exploration of the dynamics of mortality deceleration in the context of population sub-groups that are defined by their health status and can be entered as well as exited. For this purpose the author develops a theoretically simple dynamic frailty model in order to highlight the complexity of the deceleration patterns resulting from movement between groups. She shows that the order of deceleration between the healthy and the not-healthy subpopulations is in a dynamic context almost unpredictable.

In a contribution titled '**Modal age at death: lifespan indicator in the era of longevity extension**', *Shiro Horiuchi* and his colleagues provide an extensive summary of their lengthy research on the characteristics of the modal age at death as an indicator of human longevity. Their paper includes examples with empirical data and derivations of statistical properties. The overview is supplemented with an analysis of differences in mortality by sex and country based on the modal age. The authors also demonstrate how the modal age can be estimated from empirical data

1) Luy, M. – Caselli, G. – Butz, P. (ed.). 2014. *Vienna Yearbook of Population Research 2013*. Volume 11. Vienna: Vienna Institute of Demography, Austrian Academy of Science. Avalable at: http://www.oeaw.ac.at/vid/publications/VYPR2013/VYPR2013.shtml. ISBN-13: 978-3-7001-7625-1 ISBN-13 Online: 978-3-7001-7645-9.

and they provide a new R routine to implement this estimation procedure.

The third methodological contribution, by *Jon Anson*, '**Surviving to be oldest-old: destiny or chance?**', shows that the probability of reaching old age seems unrelated to the survival conditions in younger ages. Moreover, the author uses simulations to show that the emergence of extraordinarily high centenarian rates in specific populations could occur by chance rather than being the consequence of causal mechanisms related to longevity. The author concludes that in order to broaden our knowledge about the keys of extreme longevity a conceptual framework is needed that identifies the conditions conducive to both extraordinary long and short lives.

A promising strategy in mortality research is the identification of populations with exceptional longevity, as it is interesting to study the reasons for their low mortality levels. Some studies try to determine geographical areas where an exceptional proportion of people reach the highest ages, and these are called 'longevity islands', 'hot spots', or 'Blue Zones'. In an article titled '**The Blue Zones: areas of exceptional longevity around the world**', *Michel Poulain* and his colleagues describe the concept of blue zones and discuss different indexes for measuring exceptional longevity. They summarise existing validations of four specific blue zones: Ogliastra in Sardinia, Okinawa in Japan, the Nicoya peninsula in Costa Rica, and the island of Ikaria in Greece. The authors provide a comparative examination of specific characteristics in order to find commonalities. The extreme longevity of these blue-zone populations could be the result of a balance between the benefits of a traditional lifestyle and those of modernity.

Luis Rosero-Bixby and his colleagues, in the article '**The Nicoya region of Costa Rica: a high longevity island for elderly males**', provide further evidence that Nicoya is in fact a blue zone, though only for men. The paper extends existing knowledge by quantifying the longevity advantage of Nicoyan males and by investigating biomarkers, diet consumption patterns, and other health indicators as possible explanations. The study indicates that the exceptional longevity of Nicoyan men is primarily due to their low cardiovascular mortality, and the authors offer several possible explanations for this specific survival advantage.

Sebastian Klusener and *Rembrandt D. Scholz* present for the first time a study on longevity islands in Germany ('**Regional hot spots of exceptional longevity in Germany**'). Moreover, this is the first study that looks at the distances between place of birth and place at death of long-lived individuals (semi-supercentenarians). The authors identify some German longevity islands, including Berlin, some areas in north-western Germany, and Munich, and find that these hot spots are almost identical for place of birth and place at death. The dominance of northern Germany is surprising since nowadays the regions of southern Germany show the highest life expectancy levels. The authors hypothesise that early- and late-life contextual conditions are the main explanations for the emergence of these blue zones and consider also the possibility of genetic influences.

Richard G. Rogers and his colleagues, in a study titled '**Lifetime abstainers and mortality risk in the United States**', investigate the variability in mortality among non-drinkers, who are distinguished by their decision to abstain from alcohol consumption. They find that the risk of dying is low for light drinkers and for those non-drinkers who abstain from drinking for religious and moral reasons, have a responsibility to their family, were brought up not to drink, and are not social. Conversely, mortality is higher among former, infrequent, and moderate drinkers and some other groups of abstainers. Thus, the authors challenge the common picture of the J-shape relation between alcohol consumption and mortality and offer some explanations for this new perspective.

The study by *Maria Winkler-Dworak* and **Heiner Kaden**, called '**The longevity of academicians: evidence from the Saxonian Academy of Sciences and Humanities in Leipzig**', focuses on an interesting vanguard group in achieving longevity: the members of a learned society, namely, the Saxonian Academy of Sciences and Humanities in Leipzig. They find that Saxonian academicians have a higher life expectancy than the total German male population and that the gap has widened since the 1950s. The results for the Saxonian academicians are similar to those for members of various other European learned societies. The authors conclude, therefore, that the survival of academicians is less determined by national mortality conditions and that they instead share a common health advantage that operates independently of economic conditions and societal environments.

Morgan E. Levine and *Eileen M. Crimmins* investigate the population subgroup of smokers aged 80 and older with a special focus on the effect of innate frailty. In '**Evidence of resiliency among longlived smokers**' they find that smoking did not significantly contribute to the risk of mortality among individuals 80+, compared to smokers below the age of 80, who had higher mortality than non-smokers. Hence, long-lived smokers present an interesting paradox. They appear to present a distinct and biologically advantaged group, who are less susceptible to the negative effects of smoking and perhaps other environmental harms. Thus, the results of this study point to the practical importance of selection effects when differences in mortality are studied.

The study by *Ethan J. Sharygin* and *Michel Guillot* titled '**Ethnicity, russification and excess mortality in Kazakhstan**' investigates mortality differences between Russians and Kazakhs in Kazakhstan with the particular aim of testing the 'Russian mortality paradox', which is that Russians in Central Asian countries are wealthier and better educated than the indigenous population but have poorer health and higher mortality. The authors compare their results to those of a similar study for Kyrgyzstan, hypothesising that the ethnic differences are smaller in Kazakhstan and that overall adult mortality in Kazakhstan should lie between the levels apparent in Russia and Kyrgyzstan. The hypotheses are confirmed and the authors conclude that these results suggest the existence of a continuum between 'non-Russian' and 'Russian' mortality patterns, predominantly related to the level of alcohol consumption.

Kirkwood and Rose (1991) suggested there exists a trade-off between longevity and fertility and the relationship between these two phenomena has been tackled in various articles. The main results showed that women who live longer seem, on average, to have had fewer children and gave birth to them, and particularly to their last children, at an older age. The paper by *Graziella Caselli* and colleagues titled '**Exploring Sardinian longevity: women fertility and parental transmission of longevity**' refers to a sample from the Sardinian centenarian study. This article sets out to analyse the two-way association between women's fertility and longevity and the parental transmission of longevity. For the association between longevity and fertility, the authors find evidence that long-lived individuals benefit from factors related to the timing of fertility. The parental transmission of longevity seems to be significant for women, but not for men. The authors also find that a higher birth order decreases the probability of becoming a centenarian. Finally, they find that a higher father age at birth has a negative effect on the longevity of a female child. The authors conclude that long-lived women seem to have been favoured both by their late fertility and by a young paternal age at the time of their own conception.

The paper by *Valerie Jarry et al.*, '**Maternal age, birth order and other early life factors: a family-level approach to exploring exceptional survival**', investigates very specific factors of early-life conditions and their effects on extreme longevity in Quebec. The core questions are why siblings are different from one another in terms of achieving exceptional longevity and if differences in parental age and in birth order and other unshared variables could be associated with reaching old age. The most important findings are that having a younger mother is associated with a higher probability of becoming a centenarian and that third and fourth-born individuals show a significant survival advantage. The authors conclude that the biological advantage of having a young mother is likely to be masked by a social disadvantage.

'**Determinants of exceptional human longevity: new ideas and findings**' is the title of the paper by *Leonid Gavrilov* and *Natalia Gavrilova*, which summarises the results of the authors' studies on centenarians using several different approaches to specify control groups of centenarians. In these studies, the authors identified several mechanisms that increase the probability of becoming a centenarian, including region of childhood residence, household property, genetics (parents' and siblings' longevity), lifestyle, maternal age at birth, and month of birth.

The last paper, by *Luisa Salaris* and her colleagues, entitled '**Familial transmission of human longevity: a population-based study in an inland village of Sardinia (Italy), 1850–2010**', is based on data collected by the authors on the population of a specific village in Sardinia covering a period of more than

150 years, which they use to examine the relationship between individuals' survival with that of their parents and siblings. They restrict the analysis to people aged 50+ in order to exclude infant and child mortality and externally caused deaths (e.g. accidents). The authors identify a familial transmission of longevity effect primarily along the mother–daughter line and, even more significantly, between siblings, in this case mainly male siblings.

The studies presented in this volume are very diverse in content and provide many new insights into the mechanisms behind extreme and unusual longevity. However, it is important to note that an issue very different from the length of human life is its quality in terms of health and well-being and the additional life years spent in good health. The progress that has been made in recent years in the fight against disease has been remarkable and even more intense than advances in life expectancy. A follow-up volume is planned that extends the presented findings about human life in quantitative terms with a look at its qualitative characteristics focusing on an analysis of the trends and determinants of healthy life expectancy.

Terminology: centenarians (100+), 'semi-super-centenarians' (105–109), 'super-centenarians' (110+), the oldest-old individuals, extremely long-lived individuals

WILLIAM P. O'HARA: THE UNDERCOUNT OF YOUNG CHILDREN IN THE U.S. DECENNIAL CENSUS

Jaroslav Kraus

This publication is part of a series of demographic analyses published by Springer in its Population Studies imprint.[1] Its focus, as the title indicates, is a traditional issue in population censuses: census undercounts and specifically the undercounts of persons in the youngest age groups, namely, children. The publication is divided into eight chapters, each of which opens with an abstract, concludes with a summary, and has a rich list of references at its close.

In the introductory chapter O'Hara opens with a section in which he describes the census in the United States in 1940, when the census assessment was already highlighting the problem of the undercount of children aged 5 and under and specifically up to one year of age. As well as in the United States, undercounts were identified as a problem in England and Wales[2] and in countries in continental Europe. O'Hara believes that undercounts continue to be a problem today, though the United States and Europe use entirely different census methodologies. The undercount of children does not just affect population censuses but also occurs in other surveys of the population,

1) http://www.springer.com/gp/book/9783319189161; the code for the electronic version of the publication is ISBN 978-3-319-18917-8, and the price is 41.64 EUR.

2) In Scotland and Northern Ireland, which were and are part of the United Kingdom, censuses were and still are organised by local statistics bureaus.

such as the American Community Survey and the Survey of Income and Program Participation, which is a sign that this is a deeper, more general problem and one to which not enough attention has been paid in the literature. When O'Hara is quantifying the size of the census undercount, it is important to note what he is contrasting it with, namely, the results of the Census Bureau's Demographic Analysis (DA). The DA uses a different methodology to estimate the size of the population and the number of births and deaths. O'Hara then proceeds to describe the DA methodology and concludes the chapter by explaining the effect the undercount has on federal programmes.

The second chapter focuses on the methodologies used to measure the coverage results of the census. As well as the methodology used in the DA, O'Hara describes the method used in the Dual System Estimates (DAS), which are essentially Post Enumeration Surveys (something that this reviewer envies his American colleagues as he was unable to assert the same for the census programme in the Czech Republic in 2011). While O'Hara presents a detailed analysis of the history of the two methods, including their data sources, the reader does not learn much from this in terms of methodology (except for a basic outline). The results the two methods produce are, however, included in the chapter, including their limitations (i.e. the results for sub-populations). Unlike O'Hara, this reviewer believes that the results of these two methods differ considerably from the census results and in truth are not much alike. This is equally true of the comparisons made to the last three censuses. The author's reliance on the results of the DA is more a matter of faith (p. 20). The ensuing sections of this chapter focus on differences in relation to ethnicity, which is understandably a more complicated situation.

The third chapter moves more towards the main theme of the monograph, undercounts of the youngest age groups, and an innovation are the estimates (based on the DA method) of the Hispanic and African-American populations for the 30 and under age group. What is important is the variability of the phenomenon: while the total undercount equals 0.1%, for the youngest age group it is 1.7%, and this difference, when the age groups are broken down further, actually grows. This is very apparent in figure 3.1, but the explanation provided for this phenomenon is somewhat vague (it is generally believed that it could be due to/caused by...). The age gradient of the undercount between ages 1 and 17 is, however, indisputable and it appears in both of the last censuses.

Also of interest is to analyse the undercount by sex and subpopulations, and the fourth chapter does this on all the post-war censuses from 1950 to 2010, and in this reveals an interesting trend. The total undercount rate has been decreasing in the long term (except in the year 1990) and is now 0.1%, but starting in 1990 the trends in the undercount rates for the child and adult segments of the population have grown visibly different. These trends are described in depth and accurately, but there is not much explanation for them. The undercount phenomenon is then also broken down regionally based on the census results for individual states and counties, and this too is interesting. Undercount rates range from 10.2% (in Arizona) to 2.1% (in North Dakota) and for the youngest age groups they can be studied in comparison to the DA results. The greater the territorial close-up/or the lower the territorial unit level (i.e. counties) the greater the variation in undercounts. The author has the advantage that the US Census Bureau publishes a great range of auxiliary and related materials that can be used for this type of analysis. There are also differences between states by racial groups, and the author tests this with a correlation coefficient and its statistical significance. Here however he commits a statistical error: it is not possible to calculate a correlation coefficient for such phenomena (states) that are autocorrelated and instead it is necessary to choose some other form of correlation, such as Moran's I. The Hard-to-Count score, mentioned on p. 62, which reports on the difficulty of surveying in individual counties, is also interesting. It is based on twelve characteristics, and there is no question that this score is connected to the size of the undercounts in different counties, which is the subject of analysis in this chapter.

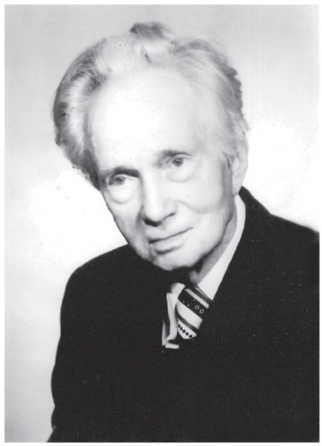
The sixth chapter focuses on undercounts in an international comparison. In the introductory chapter O'Hara put forth three working hypotheses that he wanted to examine in other states. The first problem with this, however, is the lack of information on this subject, and somewhat surprising is the author's choice of other states. Except for the Soviet Union (*sic*) they are all English-speaking world; that something like the European Union exists, where Member States work with the same recommendations, seems to have escaped the author. It must be added, however, that there are comparisons with undercounts in selected Asian countries. This reveals that undercounts of children in census results are a common phenomenon even in other countries, but degree to which the phenomenon is observed varies. Undercount are usually larger in the youngest age group, ages 0–4, than in older age groups, but vary from one country to another depending on its survey methodology.

The seventh chapter finally focuses on the causes of undercounts. The opening of this chapter is not very encouraging. According to O'Hara, there are many factors that could potentially cause undercounts, but either they are not consistent or they act in contradictory ways. He outlines several probable reasons for undercounts of children, such as the absence of an entire housing unit or a member of that unit or of the person selected for the sample. The process by which information is gathered may be the reason. While these may be formal reasons, they are not the real reasons why some persons are not counted. The real reasons are partially described in the second part of the chapter, though on the whole it is understandable that they are hard to quantify, for example, in relation to household income. The results, however, are not in the opinion of this reviewer very convincing. Sometime O'Hara seems to move in a circle: he explains undercounts by age and ethnicity by cross-referencing one characteristic with the other and concludes by declaring that the statistical data are insufficient to produce an explanation. Better is the explanation about the (un)willingness to take part in surveys, in relation to age or ethnicity, and a role may also be played by the interest of public authorities in child welfare. Another more acceptable explanation is the changing structure of households, the emergence of non-traditional households, and the census errors that this can give rise to, though it is not clear why this is something that would primarily affect the youngest age groups. One asset of this chapter is that it is accompanied by calculations based on alternative sources of data (DA, DEA).

The eighth and final chapter sums up the findings of the preceding chapters. Overall it can be said that this is a compact work that takes a systematic approach to its subject and also offers a great list of references on it. To this reviewer it seemed that O'Hara is somewhat at a loss when he attempts to explain why things are the way they are. Nevertheless, this should inspire us to think about undercounts in our censuses, which in all likelihood will continue to grow in the future. But that's another story.

120 Years since the Birth of Jaromír Korčák

If there was ever a figure in the field of social geography whose students still looked up to him decades later it was prof. RNDr. **Jaromír Korčák**, Dr.Sc. This year marks 120 years since his birth, but his direct impact on his field endures. Even today terms like 'Korcak's law' and 'Korcak's exponent' are still encountered as part of the terminology not just of geography but also, for instance, of statistics and ecology.



Source: Archives of Geographical library of Faculty of Science

Korčák was born on 12 July 1895 in Vrážné u Jevíčka to the headmaster at the local school. He attended secondary school (Realschule) in Jevíčko and after graduating went on to study at the Faculty of Arts in Prague; like many of his generational peers (e.g. Jan Hromádka) his studies were interrupted by a three-year spell on the front lines during the First World War. It was 1922 before he was able to defend his dissertation, supervised by Viktor Dvorský. He then spent a year at the University of Belgrade where he met famous geographer and politician Jovan Cvijić. His immediate career path, however, took him not into university but to the State Statistical Office, where he worked first as population statistics analyst, then as a ministerský komisař (1928), chief komisař (1931), and odborový rada (from 1935), and where he helped organise the population census that was conducted in 1930. Among his colleagues and superiors there Antonín Boháč had the biggest influence on him. He described himself as working in the department of mesology (anthropogeography) and population science; he worked less in the field of geography, though he did participate in numerous national conventions and international conferences in the field, including the famous convention of Slavic geographers and ethnographers held in Poland in 1927.

It was only after the Second World War that Jaromír Korčák first began teaching at the university level, first at the University of Business, and then, starting in 1951, at the Faculty of Science of Charles University; that same year he was appointed professor and assumed the post of head of the Department of Geography (which in 1953 became the Department of Economic and Regional Geography). Martin Hampl and Zdeněk Pavlík are two prominent examples of his students, but the names of many more could also be mentioned. He retired in 1966, but he continued to devote himself assiduously to geography. For many years he was also the head of the National Geographical Committee and in 1961/62–69 he was the head of the Czechoslovak Geographical Society. He died on 6 October 1989 in Prague at the age of 94 and as the doyen of his field.

Korčák already began devoting himself to demographic geography and statistics in the 1920s, and it was in this this period that he wrote, for instance, his now classic works 'The Depopulation of Southern Bohemia' (*Vylidňování jižních Čech*, 1929) and 'A Study on the Theory of Nationality' (*Studie o teorii národností*, 1931); regionally he focused, among other areas, on Subcarpathian Ruthenia. The threat posed by Nazi Germany to Czechoslovakia caused Korčák to turn his attention to geopolitics, and evidence of this interest is provided by the study 'The Geopolitical Foundations of Czechoslovakia and Its Root Regions' (*Geopolitické základy Československa, jeho kmenové oblasti*, 1938). He also applied himself to theoretical questions in the field, and it was his concept of geographical regularities that gave rise to the entire Albertov School of Geography (Albertov is the site of the Faculty of Science of Charles University), which was probably his biggest contribution to Czech social geography; the key study on this subject, 'Two Fundamental Types of Statistical Distribution' (*Přírodní dualita statistického rozložení*) was published in the journal Statistical Horizons (*Statistický obzor*; volume 22, 1941, pp. 171–222). Out of his many other writings, mention can be made of his study of mathematical methods in geography (the use of variational methods, the introduction of the term 'median' into use in Czech; e.g. *Deux types fondamentaux de distribution statistique*, 1938), and he was worked on the preparation of the university textbook 'The Geography of Czechoslovakia' (*Zeměpis Československa,* 1960). Approaching the age of 80, he set out to write a synthetic study of the field, which was published in 1973 under the title 'A Statistical Synthesis of Population Geography' (*Geografie obyvatelstva ve statistické syntéze*). Most of his studies are still cited today. In recognition of his work a street on the grounds of the university complex at Albertov in Prague was named after him and since 2009 bears the name Korčákova.

Jiří Martínek

Persons in Germany with a migrant background[1)]

In light of the current migration flows in Europe, there is a much growing need for available up-to-date, plausible and comprehensive statistics on migrants. Germany, one of the countries most affected by the mass wave of refugees, has been collecting statistics on people with a migrant background living in Germany via regular microcensus surveys since 2005. In 2011 the Federal Statistical Office of Germany used the population census as an opportunity to gather robust and significant information on persons, distinguishing between persons with or without a migrant background. According to the census methodology, persons with a migrant background were defined as all foreigners – people with the citizenship of another state regardless of whether they were born abroad or in Germany – and all Germans who has immigrated to the present-day territory of the Federal Republic of Germany after 1955 or who had at least one parent who had immigrated after 1955.[2)] Corresponding census data was gained using a household survey based on a random sample of around 10% of the population. The topic was surveyed in more detail than required by EU regulation.[3)] In total, up to nine questions inquiring into respondents' migration background were included in the questionnaire.

1) Most of the figures and facts presented in this contribution were drawn from the article '15.3 million people have a migrant background', published on the official 2011 census website:
https://www.zensus2011.de/SharedDocs/AktuellesEN/Press_release_of_the_federal_statistical_office_20140603.html?nn=3068736. The other facts come from the article '19,2 % der Bevölkerung haben einen Migrationshintegrund', published on the official website of the Federal Statistical Office of Germany:
https://www.destatis.de/DE/Methoden/Zensus_/AktuellMigrationshintergrund.html.

2) This definition slightly differs from how persons with a migrant background are defined in the regular microcensus surveys. For a comparison, see:
https://www.destatis.de/EN/FactsFigures/SocietyState/Population/MigrationIntegration/PersonsMigrationBackground/MigrationBackgroundMethods.html.

3) Regulation (EC) No 763/2008 of the European Parliament and of the Council of 9 July 2008 on population and housing censuses.

As of the census reference date, 9 May 2011, there were approximately 15.3 million inhabitants with a migrant background living in Germany, which is equal to **19.2% of the total enumerated population**. Three out of five persons (60.2%) with a migrant background had German citizenship; the remaining 39.8% were foreign nationals – irrespective of whether they were born in Germany or abroad. In total, 63.0% of persons with a migrant background had immigrated to Germany from abroad (first-generation migrants), while 37.0% were born in Germany (second-generation migrants).

The population of migrant background was **distributed very unevenly across Germany**. The overwhelming majority of migrants (96.7%) resided in the former West German states and in the capital city of Berlin, whereas only every thirtieth one (3.3%) resided in the newly-formed federal states of former East Germany. People of migrant background also tended to reside in bigger cities, with 43.4% of them living in cities with at least 100 000 inhabitants. Conversely, municipalities with fewer than 10 000 inhabitants were home to only 14.4%.

The population with a migrant background was about ten years younger (the average age was 35 years) than the non-migrant majority population (the average age was 45 years). However, this **more favourable age structure** was only due to second-generation migrants (the average age was 19 years), as the population of immigrants from abroad had the same average age as the majority. The younger age structure of people with a migrant background also confirmed a higher percentage of young population (19.3% were under 15 years of age) and in particular a significantly smaller share of elderly population (9.4% were aged 65 and over), when compared to their counterparts without a migrant background (12.1% and 23.2%, respectively).

Another interesting finding is that people with a migrant background showed a **lower employment rate** on the one hand and a **higher unemployment rate** on the other. Two-thirds (66.6%) of working-age migrants (aged 15 to 64 years) were in employment, compared to three-fourths of people without a migrant background (75.9%). Women with a migrant background in particular were more often without employment (unemployed or economically inactive) compared to their counterparts in the non-migrant majority (40.2% and 27.9%, respectively). The unemployment rate among persons with a migrant background was 8.0%, while it was just 4.5% among the population without a migrant background.

People with a migrant background had on average a much **worse educational structure** than the non-migrant majority. The share of persons aged 15 years and over who had not completed school education was 15.5% for the population with a migrant background, but only 2.3% for the majority population. However, a considerable difference was observed between the first and the second generations of migrants. Among the subpopulation with a migration background born in Germany 5.3% had not completed school education, while the percentage for persons who had immigrated to Germany from abroad was 18.8%. Similarly, the share of persons aged 25 years and over with no professional qualification was more than twice as high among people with a migrant background (37.0%) as among those without it (16.5%).

The 2011 census data also revealed that the population with a migrant background tended to **live in larger households** than the non-migrant majority. The average household size of people with a migrant background was 3.4 people, while people without a migrant background lived in households with 2.7 members on average. Migrant households were most often made up of four persons (24.1%), while persons without a migrant background primarily lived in two-person households (34.1%).

Persons with a migrant background also **more often lived in traditional family arrangements**, with a higher share of married couples with children (54.0%) and a lower percentage of persons living alone (11.6%) than in the non-migrant majority (37.2% and 18.0%, respectively).

According to the census results on the average size of dwellings, people with a migrant background had a **lower standard of housing**. They lived in dwellings with an average of 33.5 square metres compared to 46.8 square metres for people without a migrant background. The structure of dwellings by tenure status was also more favourable among the non-migrant majority, 56.6% of whom lived in owner-occupied dwellings, which was substantially more than within the subpopulation of migrants (35.5%).

The data on the population with a migrant background that was surveyed in the 2011 German census serve as a relatively broad and robust source of information on which to base a stronger integration policy and as a supporting source of data for solving the society-wide challenges arising from the ongoing immigration of thousands of foreign nationals from abroad. The German practice of collecting statistics on migrants could thus be a good example for other countries facing similar issues to follow.

Štěpán Moravec

Demographers from around the World Met in Prague for a Meeting Focusing on the Analysis of Mortality and Morbidity

From the 16th to 18th of September 2015, close to 50 demographers from all over the world dealing with mortality, morbidity and health issues attended the workshop of the EAPS Heath, Morbidity and Mortality Working Group in Prague. The Heath, Morbidity and Mortality Working Group is the most active Working Group in the European Association for Population Studies (EAPS) and holds an event approximately every two years in various places in Europe. It is an honour that after universities in Tallin, Vienna and – the previous organiser – the London School of Economics, the Department of Demography and Geodemography of the Faculty of Science of the Charles University in Prague and the Faculty of Informatics and Statistics at the University of Economics in Prague were chosen to organise this event. The University of Economics in Prague also provided the meeting room and logistic support for the event.

Welcoming speeches of the representatives of both the organizing institutions opened the workshop. Subsequently, *Jon Anson*, the convener of the Working Group, *Klára Hulíková* from the Charles University and *Petr Mazouch* from the University of Economics presented their opening speeches. Jon Anson concisely summarized the current state of knowledge concerning mortality and morbidity, and defined the focus of the workshop through his discussion of the major questions facing mortality and morbidity research today. *Klára Hulíková* and *Petr Mazouch* followed up with a look at the current state of mortality research in the Czech Republic. This comprised mainly of a presentation of the GAČR P404/12/0883 project "Cohort life tables for the Czech Republic: data, biometric functions, and trends". The workshop was organized as a part of this project.

The following session of three presentations focused on the complex study of mortality development. *Jacques Vallin* and *France Meslé* presented estimations of how long Japan is likely to remain the country with the longest life expectancy in the world. They also raised several crucial questions which reoccurred in many of the following presentations during the whole workshop, namely the quality and reliability of the data, the appropriateness of various indicators for different purposes, and the practical possibilities of an analysis of the level, trends and timing of development. *Patrick Deboosere* focused on the development and changes of mortality developments in Belgium during the last decades, and *Dan Kašpar* and *Klára*

Hulíková presented their research assessing the convergent tendencies of mortality in the world today.

Two final presentations of the initial day focused on specific questions of mortality and health status analysis. *Dorly Deeg* presented her and her colleagues' work devoted to, among other things, the paradox of life expectancy extension at older ages despite increasing disease prevalence at such age. Mortality at higher age also constituted the subject of *Victoria Semyonova* and *Tamara Sabgayda's* comparison of the situation in Russia to that of other states in Europe.

The second day of the workshop was the day with the richest scientific programme. The first session looked at the link between mortality and the socio-economic circumstances of a population. There was a lively discussion following the first presentation, showing the context and impact of unemployment on the level of mortality in South Korea (by the authors *Chulhee Lee* and *K. Kim*). This was followed by a presentation by *Vladimir Isupov*, *Vladimir Lamin* and *Denis Ananyev*, who studied the structure of causes of death in Russia during the mortality crisis in 1933. *Edviges Coelho* and *Luis C. Nunes's* presentation focused mainly on methodology, studying the effect of cohort changes on mortality development and the impact of structural changes.

The second session was of a predominantly methodological nature, opened by *Tim Riffe* with a illustrative introduction of a novel concept of time, not as duration since birth, but as an expected duration until death (the death cohort). He applied this approach in the next presentation with *John MacInnes* to estimate expected future developments in morbidity and mortality. *Kateřina Podolská* presented her work focusing on the mathematical analysis of the relation between mortality and solar activity, a topic rarely discussed among social demographers. *Dmitri Jdanov* closed this session with a presentation of the work prepared with his co-author *M. Shkolnikov* introducing a new approach to the decomposition of mortality and its developmental trends.

The afternoon began with a session devoted to current issues and new possibilities for the analysis and forecasting of mortality. *Maria Ines Azambuja* illustrated the usefulness of graphic approaches and their advantages, e.g. for a study of the impact of flu epidemics on mortality. *Adrien Remund* and *Carlo Giovanni Camarda* proposed an alternative approach to mortality modelling, focused mainly on young adult excess mortality. Their non-parametric approach was inspired by some older, classical, methods but gave them a new dimension thanks to the use of modern information technology and sophisticated statistical approaches. *Lenny Stoeldraijer* introduced her and her colleagues' research on mortality forecasting, looking at evaluations of its short-term accuracy and long-term robustness.

The two final presentations of the second day of the workshop concentrated on selected factors influencing the level of mortality. *Giorgia Gregoraci* mentioned the impact of cigarette smoking and the prevalence of smoking on differences in mortality according to socio-economic status in Europe. *Jan Saarela* represented a group of authors dealing with an analysis of the effects of migration in childhood on the long-term health status of migrating individuals.

The first session of the last day of the workshop turned its attention to specific case studies from different countries. *Juris Krumins* and *Denize Ponomarjova* focused on an analysis of ethnic differences in Latvia and pointed out the importance of this type of research as well as the problem of relevant data availability. Subsequently, *Ameed Saabneh* presented the issue of mortality difference between Jews and Arabs in Israel.

The final session of the scientific part of the event once again dealt with methodological issues in the area of mortality, especially the extrapolation to higher ages or to the future. *Klára Hulíková* introduced the research taking place at the Department of Demography and Geodemography of the Faculty of Science at Charles University in Prague. This research aims to evaluate different parametric models of mortality smoothing and extrapolation. *Heather Booth* discussed the advantages of the so-called coherent approach to mortality forecasting, and introduced a practical demonstration of the approach.

The whole workshop was concluded by *Jon Anson*, who summarized the main merits of the workshop and the diversity of the presented topics as well as their quality. He also outlined potential directions for further meetings of the Working Group, mainly with regard to the upcoming conference of the European Association for Population Studies. From the scientific point of view, the workshop fully fulfilled what participants probably expected most – exchange of experience, opening of some new issues in the field of morbidity and mortality, lively discussions and an overview of crucial developments in the field. Beside plenty of interesting oral presentations, the workshop also featured close to 20 posters related to substantive and methodological issues, which nicely complemented the oral presentations. The workshop also offered an array of social events – joint dinners, lunches, a walk through Prague and a Vltava riverboat cruise. With all these activities, the ties among all participants strengthened, various current professional topics were discussed and new international cooperation was created.

The event also helped to raise awareness of Czech demography in Europe and in the world and became an excellent opportunity for discussing relevant topics of demographic research, as well as enabling many representatives of Czech demographic institutions to present their work. The website of the workshop (http://hmmwg2015.vse.cz/) offers electronic versions of the presentations and posters and links to photos. However, these can only partly show the pleasant, friendly, informal and creative atmosphere of the event. Hopefully, this successful workshop will trigger the organisation of some future events of similar importance which will expose an even larger group of Czech demographers to international research.

In conclusion, we would like to thank, on behalf of the organizing institutions, the Department of Demography and Geodemography of the Faculty of Science of Charles University in Prague, and the Faculty of Informatics and Statistics at the University of Economics in Prague, and all participants for their contribution to the success of the whole workshop. We would also like to thank the University of Economics in Prague for providing the space and logistic support for the workshop; the students of both institutions for their practical help with the organisation; the heads of the organizing institutions and the European Association for Population Studies for moral and financial support in organizing and running the workshop.

Klára Hulíková – Petr Mazouch – Jon Anson

The 7th Conference of 'Young Demographers' Will Take Place in February 2016

Traditionally the Conference of Young Demographers offers an exceptional opportunity to spend two days discussing current demographic issues and above all an opportunity for students and young scientists to learn and get opinions and advice from their more experienced counterparts, colleagues, and teachers from all over the world or at least Europe. The 7th annual Conference of Young Demographers will take place on **11 and 12 February 2016** in Prague at the Faculty of Science (Albertov 6, Prague 2). The traditional topic of the conference, 'Actual Demographic Research of Young Demographers (not only) in Europe', is as wide as possible so that the conference can be open to demographers and scientists with various research interests and specialisations.

Alongside the Young Demographers, the event is supported by the Department of Demography and Geodemography, the Geographical Institute (Faculty of Science of Charles University in Prague), the Czech Statistical Office, and the 'Young Demography' research group of the German Association for Demography (DGD).

All the participants will have an opportunity to present their current research at the conference and discuss it with colleagues from other countries or fields of study. Although the conference is primarily intended for doctoral students in the field of demography, all young (or slightly older) researchers (not just demographers) are welcome. The working language of the conference is English and except for a few posters all the presentations are expected to be in oral form.

At the end of the conference, the SAS Institute of the Czech Republic and the Institute of Sociology of the Czech Academy of Sciences, the partners of the conference, will hand out an award for the best presentation using SAS software and the best presentation with a social context.

A session for non-demographers is planned this year. For this session, topics on which demographers may share common scientific ground with researchers from other fields are planned and perhaps new areas of cooperation may be developed.

If you are interested in participating, please sign up through the registration form (the link can be found on our website http://www.demografove.estranky.cz/en/) before 30 January 2016. The conference programme (will be released in January 2016) and more information about the conference can be found online (http://www.demografove.estranky.cz/en) or you can follow us on Facebook (http://www.facebook.com/young.demographers) or Google+ (http://plus.google.com/u/0/102665514822224781605/posts). In case of any questions please feel free to contact us at: yd.demographers@gmail.com.

We are looking forward to seeing you in Prague!
On behalf of the Organising Committee

Klára Hulíková – Olga Kurtinová – Dan Kašpar – Barbora Kuprová – Tereza Pachlová

Dear Readers,

The reputation of our journal in professional circles abroad and in the Czech Republic continues to grow and a sure sign of this is that effective 15 December 2014 *Demografie* is included on the list of journals in the Scopus database. We are pleased to be able to officially share this news with you. It is our hope that this will lead to an increase in the number of submissions our journal receives and the number of citations of the articles and studies we publish. The publisher of *Demografie* is the Czech Statistical Office, which also publishes the quarterly *Statistika* (journal of *Statistics and Economy*) in English. This partner journal of ours was also included in the Scopus database effective the same date.

All issues of all 57 volumes of *Demografie* that have been published to date (since 1959) are available on the website of the Czech Statistical Office (at https://www.czso.cz/csu/czso/demografie) and are accessible free of charge. The newest issue of the journal is published in electronic format on the same day as the print version. *Demografie* is a quarterly publication. It produces three issues in Czech (with the option of some articles being published in English) while the contents of the fourth issue are entirely in English. The price of a single print issue of the journal is 58 CZK and an annual subscription costs 327 CZK. You can obtain more information by writing to our Editorial Office at: redakce@czso.cz.

We hope that our journal is able to provide you, our readers, with more and more articles of interest and value. Comments and suggestions are welcome and should be sent by email to the address of the Editorial Office listed above.

The Editorial Board

Population and vital statistics of the Czech Republic 2014: towns with more than 50,000 inhabitants

Town	Population 1 July	Population 31 December	Marriages	Divorces	Live births	Abortions	Deaths	Increase (decrease)			Marriages	Divorces	Live births	Deaths	Total increase
								Natural	Net migration	Total	per 1,000 inhabitants				
Praha	1,251,075	1,259,079	5,862	2,828	14,624	4,074	12,118	2,506	13,372	15,878	4.7	2.3	11.7	9.7	12.7
Brno	376,822	377,440	1,760	994	4,427	1,295	3,777	650	−718	−68	4.7	2.6	11.7	10.0	−0.2
Ostrava	294,955	294,200	1,277	882	2,957	1,023	3,313	−356	−1,097	−1,453	4.3	3.0	10.0	11.2	−4.9
Plzeň	168,377	169,033	775	389	1,775	704	1,714	61	938	999	4.6	2.3	10.5	10.2	5.9
Liberec	102,405	102,562	415	299	1,096	493	971	125	136	261	4.1	2.9	10.7	9.5	2.5
Olomouc	99,555	99,809	451	295	1,211	391	941	270	50	320	4.5	3.0	12.2	9.5	3.2
Ústí nad Labem	93,536	93,409	391	254	1,044	297	921	123	−237	−114	4.2	2.7	11.2	9.8	−1.2
České Budějovice	93,175	93,285	476	278	1,009	393	930	79	−47	32	5.1	3.0	10.8	10.0	0.3
Hradec Králové	92,871	92,808	450	228	989	396	995	−6	−90	−96	4.8	2.5	10.6	10.7	−1.0
Pardubice	89,530	89,693	417	274	973	274	941	32	229	261	4.7	3.1	10.9	10.5	2.9
Zlín	75,176	75,112	336	193	717	289	757	−40	−126	−166	4.5	2.6	9.5	10.1	−2.2
Havířov	75,524	75,049	336	222	692	291	825	−133	−927	−1,060	4.4	2.9	9.2	10.9	−14.0
Kladno	68,553	68,552	270	223	737	343	796	−59	92	33	3.9	3.3	10.8	11.6	0.5
Most	67,312	67,089	260	186	628	334	731	−103	−140	−243	3.9	2.8	9.3	10.9	−3.6
Opava	57,891	57,772	265	145	548	227	645	−97	−62	−159	4.6	2.5	9.5	11.1	−2.7
Frýdek-Místek	57,006	56,945	265	156	591	216	553	38	−228	−190	4.6	2.7	10.4	9.7	−3.3
Karviná	56,415	55,985	227	152	506	223	736	−230	−633	−863	4.0	2.7	9.0	13.0	−15.3
Jihlava	50,543	50,521	216	134	600	152	478	122	−111	11	4.3	2.7	11.9	9.5	0.2
Teplice	50,073	50,079	222	169	557	273	565	−8	63	55	4.4	3.4	11.1	11.3	1.1

Radek Havel

Population and vital statistics of the Czech Republic 2014: cohesion regions and regions

Cohesion region (NUTS 2), region (NUTS 3)	Population 1 July	Population 31 December	Marriages	Divorces	Live births	Abortions	Deaths			Increase (decrease)			Marriages	Divorces	Live births	Deaths	Total increase
							Total	Within 1 year	Within 28 days	Natural	Net migration	Total	per 1,000 inhabitants				
Czech Republic	10,524,783	10,538,275	45,575	26,764	109,860	36,956	105,665	263	172	4,195	21,661	25,856	4.3	2.5	10.4	10.0	2.5
Praha	1,251,075	1,259,079	5,862	2,828	14,624	4,074	12,118	16	9	2,506	13,372	15,878	4.7	2.3	11.7	9.7	12.7
Střední Čechy	1,309,139	1,315,299	5,376	3,938	14,572	4,839	12,301	30	19	2,271	10,692	12,963	4.1	3.0	11.1	9.4	9.9
Jihozápad	1,210,904	1,212,423	5,325	2,942	12,111	4,625	12,189	25	18	–78	2,325	2,247	4.4	2.4	10.0	10.1	1.9
Severozápad	1,124,669	1,123,265	4,574	3,129	11,056	4,768	11,997	43	26	–941	–1,223	–2,164	4.1	2.8	9.8	10.7	–1.9
Severovýchod	1,506,652	1,506,813	6,589	3,945	15,363	5,334	15,083	36	24	280	30	310	4.4	2.6	10.2	10.0	0.2
Jihovýchod	1,680,684	1,682,748	7,341	4,031	18,136	5,288	16,279	56	39	1,857	604	2,461	4.4	2.4	10.8	9.7	1.5
Střední Morava	1,221,938	1,220,972	5,219	2,798	11,999	4,065	12,581	35	24	–582	–1,101	–1,683	4.3	2.3	9.8	10.3	–1.4
Moravskoslezsko	1,219,722	1,217,676	5,289	3,153	11,999	3,963	13,117	22	13	–1,118	–3,038	–4,156	4.3	2.6	9.8	10.8	–3.4
Hlavní město Praha	1,251,075	1,259,079	5,862	2,828	14,624	4,074	12,118	16	9	2,506	13,372	15,878	4.7	2.3	11.7	9.7	12.7
Středočeský kraj	1,309,139	1,315,299	5,376	3,938	14,572	4,839	12,301	30	19	2,271	10,692	12,963	4.1	3.0	11.1	9.4	9.9
Jihočeský kraj	636,911	637,300	2,806	1,568	6,437	2,313	6,428	14	10	9	584	593	4.4	2.5	10.1	10.1	0.9
Plzeňský kraj	573,993	575,123	2,519	1,374	5,674	2,312	5,761	11	8	–87	1,741	1,654	4.4	2.4	9.9	10.0	2.9
Karlovarský kraj	299,880	299,293	1,249	777	2,764	1,022	3,151	11	8	–387	–629	–1,016	4.2	2.6	9.2	10.5	–3.4
Ústecký kraj	824,789	823,972	3,325	2,352	8,292	3,746	8,846	32	18	–554	–594	–1,148	4.0	2.9	10.1	10.7	–1.4
Liberecký kraj	438,813	438,851	1,849	1,236	4,435	1,928	4,346	11	7	89	153	242	4.2	2.8	10.1	9.9	0.6
Královéhradecký kraj	551,730	551,590	2,508	1,379	5,518	1,946	5,614	13	10	–96	–223	–319	4.5	2.5	10.0	10.2	–0.6
Pardubický kraj	516,109	516,372	2,232	1,330	5,410	1,460	5,123	12	7	287	100	387	4.3	2.6	10.5	9.9	0.7
Kraj Vysočina	510,006	509,895	2,188	1,107	5,334	1,421	4,880	13	9	454	–768	–314	4.3	2.2	10.5	9.6	–0.6
Jihomoravský kraj	1,170,678	1,172,853	5,153	2,924	12,802	3,867	11,399	43	30	1,403	1,372	2,775	4.4	2.5	10.9	9.7	2.4
Olomoucký kraj	636,109	635,711	2,737	1,521	6,400	2,146	6,461	14	7	–61	–584	–645	4.3	2.4	10.1	10.2	–1.0
Zlínský kraj	585,829	585,261	2,482	1,277	5,599	1,919	6,120	21	17	–521	–517	–1,038	4.2	2.2	9.6	10.4	–1.8
Moravskoslezský kraj	1,219,722	1,217,676	5,289	3,153	11,999	3,963	13,117	22	13	–1,118	–3,038	–4,156	4.3	2.6	9.8	10.8	–3.4

Radek Havel

Abstracts of Articles Published in the Journal Demografie in 2015 (Nos. 1–3)

Olga Kurtinová

A BRIEF INSIGHT INTO GENDER INEQUALITIES IN THE CZECH LABOUR MARKET

This article looks at women in the Czech labour market. Labour market participation is considered a fundamental factor influencing childbearing decisions and one that may contribute to low fertility. Since 1989 the Czech economy has undergone profound changes. Therefore, the article examines how the position of women in paid work has changed. It studies gender inequality in the labour market in the Czech Republic in 1993–2013 based on publicly available data from the Labour Force Survey (LFS). It also uses data from the EU Statistics on Income and Living Conditions (EU-SILC) for the Czech Republic in 2012 and employs a multinomial logistic regression to illustrate the factors that influence gender inequalities, which in the article are approximated by type of employment contract. The basic results show that there are persistent gender inequalities in the Czech Republic and that, depending on age, education, and having at least one dependent child, women are less likely than men to have a full-time job.

Keywords: labour market, Czech Republic, gender inequality **Demografie,** 2015, **57: 05–20**

Jindra Reissigová – Jitka Rychtaříková

THE BASIC CONCEPTS AND PRINCIPLES OF CONSTRUCTION OF AGE-PERIOD-COHORT MODELS

The aim of the article is to examine the age-period-cohort models that are used to evaluate the trends of various population indicators (e.g. mortality, fertility). This approach is mainly used when we have no available data on the potential risk or protective factors (e.g. lifestyle) affecting population indicators. The advantages and disadvantages of age-period-cohort modelling are described and their use is illustrated on the basis of examples of Czech male mortality.

Keywords: Lexis diagram, age-period-cohort, identification problem, generalised linear model, prediction, male mortality, Czech Republic **Demografie,** 2015, **57: 21–39**

Zdeněk Pavlík

SIGNIFICANT TURNING POINTS IN THE DEVELOPMENT OF MANKIND WITH A SPECIAL REGARD TO DEMOGRAPHY

Human populations have inherited sociability from their animal progenitors. Danger lurked everywhere in nature and it was almost impossible to survive individually. This situation gave rise to the herd-instinct, which we can see in some other populations of mammals. Human herds had tens or hundreds of individuals and communication was important among them. Maternal language evolved gradually and became a basis for further development, although it is possible to recognise certain rudimentary features of communication in some other animal populations. Many languages emerged (many of them have already vanished), but the biological unity of the sub-species homo sapiens sapiens was preserved in spite of the fact that people spread all over the Earth. The invention of numbers and consequently measures (the first quantitative revolution) was an important turning point in the development of science immediately after language. The level of development differed among various populations, some were out front and others lived in isolation for a long time. The invention of agriculture was another turning point, which enabled populations to growth to the hundreds of thousands or even millions of people. This occurred in the period after the last glacial epoch. A few civilisations emerged; we will look at the Western one because of its relative success. Two social structures arose in society with the advancement of rationality and human knowledge and due to the more complicated division of labour, which was originally based only on sex and age. The former is vertical and could be labelled political or a power structure, the latter is horizontal and we can refer to it as humanistic or a social structure. The two only rarely overlap. The former is represented by the chieftain, a leader, head, premier or president, with advisers, consultants, and ministers; the latter by shamans, magicians, priests, teachers, physicians, etc. Members of both structures are supposed to serve the people and to coordinate their activities, which is not always what happens, since they often forget to serve and exercise their power instead. The division of antique knowledge into two parts (first- and second-order philosophy) by Aristotle was another important turning point. And finally we are coming to the global revolution of modern era (often called modernisation) with several significant turning points, which could be called partial revolutions. We can mention only some of them: Francis Bacon rejected mediaeval scholasticism and formulated natural philosophy. His follower John Graunt founded demography and had a hand in the invention of statistics (the second quantitative revolution). Revolutionary changes occurred in all of science and in all technologies, as well as in important parts of real-world processes such as industry, the settlement system, agriculture, in cultural processes such as schooling, secularisation, the emancipation of women, medical care, and democratisation, and, last but not least, in the reproductive behaviour of populations (its natural renewal). Some of these processes have already ended, but the majority of them continue, and in some cases are even more dynamic. Nothing will be stable in the future.

Keywords: development of mankind, turning points in this development, quantification, statistics, statistical structures, order of reality, global revolution of modern era, demographic revolution, second demographic transition

Demografie, 2015, **57: 95–112**

Robert Šanda

USUAL AND REGISTERED RESIDENCE IN THE POPULATION CENSUS 2011

The Czech population census in 2011 was the first to count the usually resident population. Previous censuses and other official data sources on population have been based on a person's permanent (registered) residence. The results of the 2011 census were obtained by linking completed census questionnaires to records from the central population register. Thanks to this linkage, information on both usual and registered residence is available. It is therefore possible to evaluate the reliability of statistical and administrative data on population based on registered residence. On the micro-regional and municipality levels the differences between usual resident and permanent resident (registered) population were sometimes very substantial. The level of overlap of registered and usual residence significantly varied depending on age and other socio-demographic characteristics. The biggest discrepancies were in the suburbs of large cities and in particular among the younger, productive-age population.

Keywords: population, Czech Republic, population and housing census, usual residence, administrative data

Demografie, 2015, **57: 113–126**

Branislav Šprocha

NONMARITAL BIRTHS AND NONMARITAL FERTILITY AMONG WOMEN IN SLOVAKIA

The sharp increase in the share of nonmarital births in Slovakia is one of the most significant changes in the character of reproductive behaviour in the country since 1989. However, it appears that this phenomenon cannot simply be explained as solely the result of changing values and social norms in Slovak society. This article takes a deeper look at the natality and fertility of unmarried women, identifies the main developments in these two areas and analyses their possible causes. It also describes some of the characteristics of women in Slovakia who give birth out of wedlock.

Keywords: fertility, nonmarital fertility, unmarried women, Slovakia

Demografie, 2015, **57: 127–143**

Pavel Koudelka

FERTILITY IN RELATION TO THE PARTICIPATION OF MEN IN THE HOUSEHOLD: DOES GENDER EQUALITY HELP?

Profound changes in relations between men and women or what is called the 'gender revolution' are occurring in European families and societies. Considering the unprecedented drop in fertility, do these changes have consequences for the number of children people have? Is the number of children (in a family) influenced by how much men participate in housework and childcare? According to the findings in this article both of these factors have a significant impact on the probability of a man having another child. The strength of the effect of these two factors depends on the man's education and age.

Keywords: fertility, man, gender revolution, gender equality, gender attitudes, housework, childcare

Demografie, 2015, **57: 144–171**

Roman Kurkin – Michaela Němečková

POPULATION DEVELOPMENT IN THE CZECH REPUBLIC IN 2014

The article analyses the demographic situation in the Czech Republic in 2014. It also focuses on trends in the past decade. The study evaluates changes in sex-age and marital status structure, nuptiality, the divorce rate, fertility, the abortion rate, mortality (including cause-of-death mortality) and international migration.

Keywords: demographic development, population, age structure, nuptiality, divorce, fertility, abortion, mortality, migration, Czech Republic

Demografie, 2015, **57: 213–230**

Ladislav Průša

THE IMPACT OF POPULATION AGEING ON THE NEED FOR SOCIAL CARE SERVICES TO 2030

Population Projection for the Czech Republic to the Year 2100 was published in 2013. The release of these projections provides an opportunity to formulate an idea of the impact population ageing will have on social services. This outlook is influenced by many factors, and all the factors that may have an impact on social policy need to be taken into account. Many of these factors are however very difficult to quantify; for instance, it is hard to predict how legislation on and concepts of social services may change in the future.

Keywords: Population Projection for the Czech Republic, social services, care benefit, projections on the need for social care services

Demografie, 2015, **57: 231–244**

Kristýna Peychlová – Petr Holpuch

POSSIBLE APPLICATIONS OF DOMESTIC AND INTERNATIONAL EXPERIENCES IN CREATING A NATIONAL HOMELESS CENSUS IN THE CZECH REPUBLIC

Homeless censuses are an indispensable part of homelessness prevention and management. To this end, some states use integrated social services client databases, while others rely on field counts. This article presents a proposal for a national point-in-time homeless count for the Czech Republic. It sets out from an analysis of examples of best practices in other countries and counts that have been carried out in several Czech towns.

Keywords: homeless census, methodology, point-in-time counts, administrative data, Czech Republic, Europe, ETHOS

Demografie, 2015, **57: 245–269**

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- Roubíček, V. 1997. *Úvod do demografie.* Prgue: Codex Bohemia.)
- Hantrais, L. (ed.). 2000. *Gendered Policies in Europe. Reconciling Employment and Family Life*. London: Macmillan Press.
- *Potraty.* 2005. Prague: Ústav zdravotnických informací a statistiky.

Articles in periodicals

- Bakalář, E. and Kovařík, J. 2000. 'Fathers, Fatherhood in the Czech Republic.' *Demografie*, 42, pp. 266–272.

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Daly, M. 2004. 'Family Policy in European Countries.' In *Perspectives on Family Policy in the Czech Republic*, pp. 62–71. Prague: MPSV ČR.

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Conference papers

Maur, E. '*Problems with the Study of Migration in the Czech Lands in Early Modern History.*' Paper presented at the conference 'The History of Migration in the Czech Lands during the Early Modern Period. Prague, 14. 10. 2005.

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Syrovátka, A. 1962a. 'Injuries in the Household.' *Czech Paediatrics*, 17, pp. 750–753.

Syrovátka, A. 1962b. 'Child Mortality from Automobile Accidents in the Czech Lands.' *Czech Medical Journal*, 101, pp. 1513–1517.

In-text references

(*Srb*, 2004); (*Srb*, 2004: pp. 36–37); (*Syrovátka et al.*, 1984).

Table and figure headings

Table 1: Population and vital statistics, 1990–2010

Figure 1: Relative age distribution of foreigners and total population of CR, 31 Dec 2009

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