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Mortality and morbidity in the city of Bern, Switzerland, 1805–1815 with special emphasis on infant, child and maternal deaths

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ABSTRACT

This article contributes to the research on demographics and public health of urban populations of preindustrial Europe. The key source is a burial register that contains information on the deceased, such as age and sex, residence and cause of death. This register is one of the earliest compilations of data sets of individuals with this high degree of completeness and consistency. Critical assessment of the register's origin, formation and upkeep promises high validity and reliability.

Between 1805 and 1815, 4,390 deceased inhabitants were registered. Information concerning these individuals provides the basis for this study. Life tables of Bern's population were created using different models. The causes of death were classified and their frequency calculated. Furthermore, the susceptibility of age groups to certain causes of death was established. Special attention was given to causes of death and mortality of newborns, infants and birth-giving women.

In comparison to other cities and regions in Central Europe, Bern's mortality structure shows low rates for infants ($q_0 = 0.144$) and children ($q_{1-4} = 0.068$). This could have simply indicated better living conditions. Life expectancy at birth was 43 years. Mortality was high in winter and spring, and decreased in summer to a low level with a short rise in August.

The study of the causes of death was inhibited by difficulties in translating early 19th century nomenclature into the modern medical system. Nonetheless, death from metabolic disorders, illnesses

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of the respiratory system, and debilitation were the most prominent causes in Bern. Apparently, the worst killer of infants up to 12 months was the "gichteren", an obsolete German term for lethal spasmodic convulsions. The exact modern identification of this disease remains unclear. Possibilities such as infant tetanus or infant epilepsy are discussed.
The maternal death rate of 0.72% is comparable with values calculated from contemporaneous sources. Relevance of childbed fever in the early 1800s was low. Bern's data indicate that the extent of deaths related to childbirth in this period is overrated.
This research has an explicit interdisciplinary value for various fields including both the humanities and natural sciences, since information reported here represents the complete age and sex structure of a deceased population. Physical anthropologists can use these data as a true reference group for their palaeodemographic studies of preindustrial Central Europe of the late 18th and early 19th century. It is a call to both historians and anthropologists to use our resources to a better effect through combination of methods and exchange of knowledge.
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Introduction

The City of Bern lies within a landscape typical for the Swiss Midlands, with its numerous moraine hills, relatively few flat farmlands and patches of forests. In the early 19th century, agriculture was the mainstay of the economic system. Bern was the fourth largest city of Switzerland with over 17,000 inhabitants. In 1798, France occupied the territory of Bern and brought the old feudal regime to an end. The new authorities endeavoured to maintain efficient government by implementing various policies. Amongst these, the registration of the deceased was modernized. In 1805, the Bernese burial register was created, and this register has been the main source of the present study. Unlike older records, this register comprises, without exception, all the deceased of a well-defined population, regardless of the status, religion and illegitimacy, including the complete number of stillborn and infant deaths. This completeness allows a cross check between different methods of demography and will help to assess problems concerning the reconstruction of mortality in earlier populations (Acsádi and Nemeskéri, 1970; Bocquet-Appel and Masset, 1982, 1996; Henry and Fleury, 1976).

The main purpose of this study is to reconstruct and discuss the mortality of Bern's population between 1805 and 1815 and to bring it into the Central European context. The frequencies of the causes of death are assessed and compared to two other Swiss cities. Emphasis is placed on the mortality of infants and birth-giving mothers. Modern identification of the most prominent infant cause of death, namely cramps, has been proposed. The topic of death rates of delivering mothers and childbed fever has been vigorously discussed in anthropological and historic literature (Herrmann and Grupe, 1986; Labouvie, 2000). We attempt to investigate the Bernese data on this matter.

Similar studies were carried out in the fields of humanities and physical anthropology and are used here as reference (Budnik et al., 2004; François, 1978; Imhof, 1990; Molleson et al., 1993; Perrenoud, 1979; Pfister, 1995; Schelbert, 1989).

Materials

The information derives from our main source, the Bernese burial register (Municipal Archive of Bern, Sig. E.2.2.1.9), which started in 1805 and carried on until 1876. Each entry includes name, age (given in years, days, and in case of a newborn, in hours), home parish or home country, address, profession, day of death and burial place. Details regarding the cause of death, illegitimacy of birth, stillbirth, and infants who died before baptism, are given consistently. This broad spectrum of information enables research on various demographical, socio-economical and socio-topographical subjects.

This study focuses on the mortality of inhabitants of the City of Bern alone, between 1805 and 1815. Therefore, we leave out results on illegitimacy of birth and funeral practices. We will only briefly touch upon some topics concerning society and economy, which have been discussed in a greater detail by Rüttimann (2008).

The Bernese burial register was the responsibility of a new municipal police formed in 1804 (Markwalder, 1927; Municipal Archive of Bern, Sig. I 66, Conventionenbuch, Verordnung wegen Ausübung der Polizey, 8.2.1804). The residents' registration office collected the data of each inhabitant from several different sources. Name, age, marital status, home parish, and indication of illegitimacy of birth were drawn from baptismal and marriage certificates issued and archived by the priest of one's home parish. Since the later 17th century, each citizen of Swiss cantons was allocated to such a home parish (= "Heimatort"), passed from father to children, and from husband to wife. Baptism, marriage and death of an individual who lived abroad were reported back to the home parish. The parish priest was responsible for updating the registry accordingly. This accurate bookkeeping was important for the economy of the state. The home parish was obliged to support its citizens should they sink into poverty, even if these citizens lived abroad. In case of foreigners, reliability of information was probably lower than for citizens. The indication of profession and the address were provided by the local residents' registration officers, day and time of death by the Bernese priests, burial place by the coroner, and the indication of stillbirth and the cause of death were provided by medical professionals of the Insel Hospital in Bern (Rüttimann, 2008).

A cross-check of the number of recorded burials and the burial registers of an older tradition (= "Totenrödel") – which were continued parallel to our main source – shows only minor deviations, proving that the source is valid and reliable for demographic studies. Studies of municipal records show that the Bernese burial register had a different administrative formation than these older registers (Rüttimann, 2008). The older registers were kept only by the priests, and there were one register for each social group of a different legal status, such as for the population from the home parish of Bern (= "Burger") and for immigrants (= "Hintersassen"), for minor religious communities such as the French Protestant immigrants (= "Colonies française") and Catholics. With the creation of the new Bernese burial register, these older registers grew obsolete and were abandoned in 1815.

Unbaptised dead and stillborn infants were excluded from most calculations in this study, because studies on preindustrial demographics are based on the number of baptisms alone. Registry, up until the first half of the 19th century, recorded baptisms as opposed to births. Hence, in this article, the terms "baptised" and "baptism" have been replaced by the terms "born" and "birth" for convenience, unless logic requires otherwise. The term "infants" exclusively designates children less than one year of age.

The size of the living population is taken from the census conducted in the spring of 1818 (State Archive of Bern, Sig. B XIII 629). The census is not influenced by major mortality crises and therefore is a reliable source to assess mortality. The great subsistence crisis in 1817 did not affect the city of Bern as severely as the rest of the Canton and eastern Switzerland (Pfister, 1995). Besides, it is outside the time period studied here.

The number of annual baptisms comes from BERNHIST, an online database initiated by Pfister (1996). Its data are gathered from historical birth registers.

Methods

Mortality is reconstructed by life tables (Table 1) and its seasonality (Figs. 1 and 2).

The life tables were calculated according to the stationary population model (Acsádi and Nemeskéri, 1970) and the stable population model (Pressat, 1961; Budnik et al., 2004). In order to choose the most representative model, mortality rates from both life tables were compared to the mortality rates calculated with the method "calculation by period" by Henry and Fleury (1976). Unlike the stationary and stable population models, this method takes into account the actual number of births in the period of 1805–1810. It tracks the survival of this cohort for five years until the period of 1810–1815 and thus produces highly reliable mortality rates for children up to 5 years old. The stable population model works with nonzero natural increase. Natural increase is defined as the difference between crude birth rates (CBR) and crude death rates (CDR). In relation to the 17,552 inhabitants, crude death rate in Bern

Table 1
Abridged life tables according to the stationary and stable population model stating number of deceased (D_x), percentages of deceased (d_x) survivorship (l_x), mortality rates (q_x) and life expectancy (e_x). Unbaptised dead and stillborn are excluded.

Age in years	Deceased $n = 4390$	Stationary population model				Stable population model, rate of natural increase $r = 0.006$ per year			
	D_x	d_x (%)	l_x (%)	q_x	e_x	d'_x (%)	l'_x (%)	q'_x	e'_x
0	823	18.7	100	0.187	38.4	14.4	100	0.144	43.4
1–4	324	7.4	81.3	0.091	46.1	5.9	85.6	0.068	49.7
5–9	173	3.9	73.9	0.053	46.5	3.2	79.7	0.040	49.2
10–14	87	2.0	69.9	0.028	44.0	1.7	76.5	0.022	46.2
15–19	97	2.2	67.9	0.033	40.2	1.9	74.8	0.026	42.1
20–24	142	3.2	65.7	0.049	36.5	2.9	72.9	0.040	38.2
25–29	138	3.1	62.5	0.050	33.2	2.9	70.0	0.042	34.6
30–34	136	3.1	59.4	0.052	29.9	3.0	67.1	0.044	31.0
35–39	183	4.2	56.3	0.074	26.4	4.1	64.1	0.064	27.4
40–44	160	3.6	52.1	0.070	23.3	3.7	60.0	0.061	24.0
45–49	219	5.0	48.5	0.103	19.9	5.2	56.3	0.092	20.5
50–54	244	5.6	43.5	0.128	16.8	6.0	51.1	0.117	17.3
55–59	282	6.4	37.9	0.169	13.9	7.1	45.2	0.158	14.2
60–64	316	7.2	31.5	0.229	11.3	8.2	38.0	0.216	11.4
65–69	333	7.6	24.3	0.312	8.9	8.9	29.8	0.300	8.9
70–74	355	8.1	16.7	0.484	6.8	9.8	20.9	0.471	6.7
75–79	217	4.9	8.6	0.574	5.8	6.2	11.1	0.560	5.4
80–84	116	2.6	3.7	0.720	5.3	3.4	4.9	0.702	4.0
85–100	45	1.0	1.0	1.000	7.5	1.4	1.4	1.000	2.5

was CDR = 0.0227. Between years 1805 and 1815, there were 5,567 children born at an annual average of 506 births, resulting in a crude birth rate CBR = 0.0288. Hence the natural increase rate was $r = 0.006$. Thus, the distribution of the deceased was reconstructed according to the following formula:

$$D'_x = D_x(1 + r)^x$$

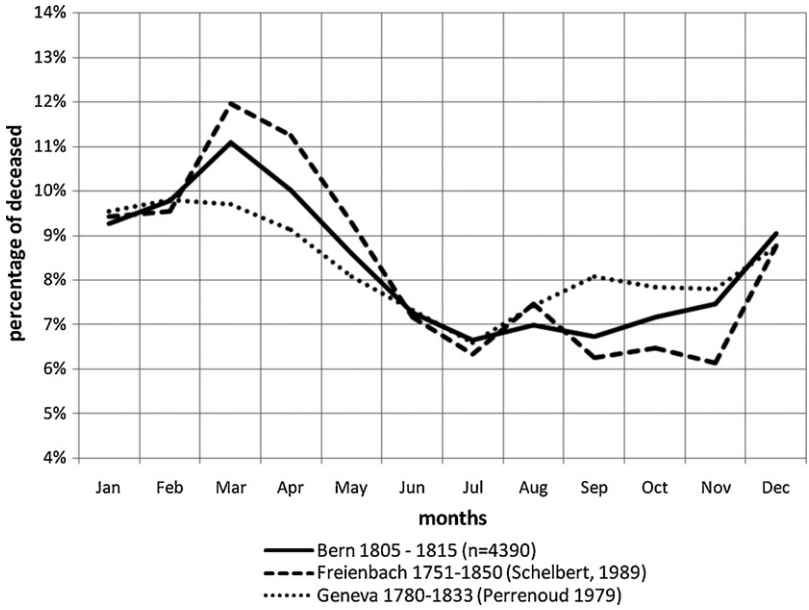

Fig. 1. Seasonal mortality in Bern, Freienbach (Schelbert, 1989) and Geneva (Perrenoud, 1979).

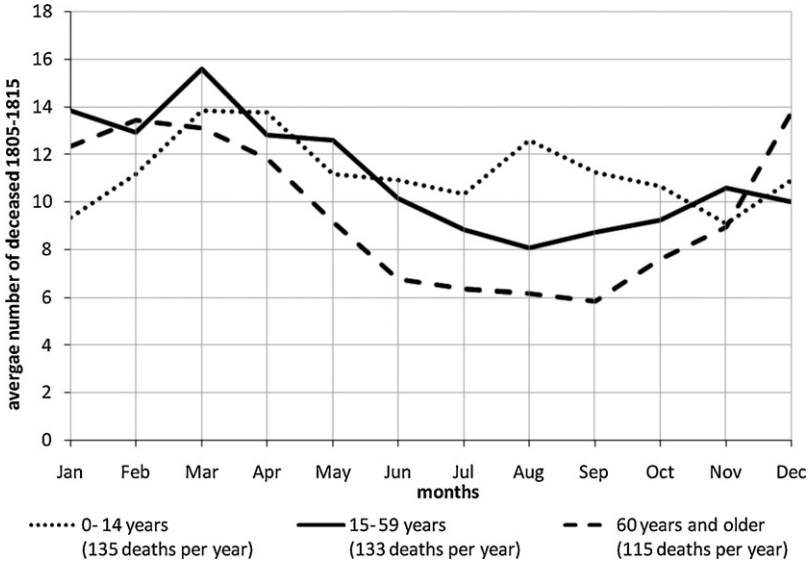

Fig. 2. Seasonal age distribution of deceased in Bern.

where D_x is the number of deceased at a given age for the stationary population, and x is the number of years from birth until death (Henneberg and Steyn, 1994).

The comparison to the calculation by period (Henry and Fleury, 1976) shows that the stable population model generally produces closer, and – in the case of 1–4 year old children – equivalent mortality rates (Table 2). Thus, the stable population model has high reliability for reconstructing Bernese mortality.

The abridged life tables (Table 1) show values and rates for infants (= children under one year old) and children aged between 1 and 4 years. The subsequent age classes advance in 5-year steps. The life tables show the age distribution of deceased in absolute numbers (D_x), the age distribution of deceased in percentages (d_x), the survivorship (l_x) and the mortality rate (q_x) as the quotient of deceased and survivors in each age group, and the life expectancy in years (e_x) for each age group.

The BERNHIST database does not hold separate birth counts for males and females, preventing the determination of birth rates for males and females. Thus for sex-related analyses of mortality rates and life expectancies the stationary population model has to be used.

Seasonal mortality is possible to assess with the exact date of death given in the register (Figs. 1 and 2). Thus, the change of the average number of deceased between 1805 and 1815 in each month was determined along with seasonal age distribution of the dead. This was carried out for

Table 2
Comparison of mortality rates of infants and children up to five years old generated by the "calculation by period" – method, the stationary population model and the stable population model. Unbaptised infants and stillborn excluded.

Age	Calculation by period q_x	Stationary population model q_x	Stable population model q'_x
0	0.151	0.187	0.144
1	0.027	0.041	0.030
2	0.021	0.023	0.017
3	0.011	0.016	0.012
4	0.011	0.013	0.010
5	0.016	0.013	0.010
1–4	0.068	0.091	0.068

three age classes: children younger than 15 years, juveniles and adults between 15 and 59 years, and individuals aged 60 years or older.

Registration of the causes of death did not start until 1815, and hence only 497 causes are discussed here. They are assigned to fifteen categories (Table 3) according to Perrenoud (1979). The original German nomenclature is provided for convenience. The denomination of diseases substantially differs from today's medical system. Therefore for categorisation, German reference works from the 19th century were used (Andral, 1848; Krünitz, 1858; Virchow, 1855) alongside current works (Pschyrembel, 2010; Roche Lexikon Medizin, 2003; Zetkin and Schaldach, 2005). We analysed the categories' frequencies of occurrence in age groups to find the major age-dependent threats. Five age groups were defined: infants up to twelve months ($n = 97$), children and juveniles between 1 and 19 years ($n = 86$), adults between 20 and 39 ($n = 84$), adults between 40 and 59 ($n = 103$) and individuals of 60 years and older ($n = 127$).

The maternal death rate is the quotient of all live births of 1815 (BERNHIST) and the number of women who died in childbed in 1815. The exact cause of the maternal deaths is not stated in the register, nor is the time of death after delivery.

Results

Mortality, infant and child mortality

A total of 4,390 inhabitants died between 1805 and 1815 with a yearly average of 399 deaths. The life tables for the stationary and the stable population models are shown in Table 1.

The mortality rate (q_x) for infants lies at $q_0 = 0.144$, and for children between 1 and 4 years at $q_{1-4} = 0.068$. Up to the age of 34, mortality remained under 0.050 with a minimum between 10 and 14 years at $q_{10-14} = 0.022$. Mortality increased beween 35 and 39 years to $q_{35-39} = 0.064$ and rose steadily after the age of 45 years.

Age distribution of deceased (d_x) is as follows: approximately 15% of the dead are infants and approximately 25% are children under 10 years of age. The lowest percentage appears at the age of 10 years at 1.7%. This percentage increases to approximately 3% at age 20. It rises to approximately 4% at age 40 and again to 6% at age 50. The number of deceased adults peaks at 9.8% at age 70.

Newborn life expectancy (e_0) was 43 years. Life expectancy of the one-year-old child was approximately 50 years.

Sex-related mortality (Fig. 3) of 2,026 males and 2,364 females shows higher rates for male children up to 10 years of age: Infant boys reach $q_0 = 0.224$, infant girls reach $q_0 = 0.156$; boys between one and four years of age reach $q_{1-4} = 0.112$. Girls at the same age reach $q_{1-4} = 0.074$.

The sex-related age distribution of the deceased reveals differences in childhood and in old age (Fig. 3). Approximately 40% of the deceased males and approximately 30% of the females died in the first 20 years. In old age, approximately 39% of the deceased females and approximately 29% of the deceased men died between 55 and 79 years. The male percentages remain on a level of 6% to 7% between 55 and 74 years of age. The number of deceased females and males both peak between 70 and 74 years.

Approximately 9% of the annually deceased died in each month between December and May with an absolute maximum of 11% in March (Fig. 1). Approximately 7% of the annual deaths occurred in each month between June and November, minima of approximately 6.5% appearing in July and September. The three age groups show different behaviours (Fig. 2). On a yearly average, 115 persons older than 59 died, showing the average seasonal distribution as follows: 12–14 deaths each month from December to April, 9 deaths in the months of May and November, and around 6 deaths each month between June and September. On a yearly average, 133 persons between 15 and 59 years of age died: on average, 12–16 deaths in each month between January and May, around 10 deaths in the months of May, November and December, and around 8 deaths in each month between July and October. On a yearly average, 135 children between birth and 14 years died: on average, there were 14 deaths in March and April; 11 deaths in May, June and July; and between 9 and 11 deaths in each month between September and January. In August, the number of deceased children peaked for a second time at 12–13 deaths.

Table 3
Categorisation and frequency of the causes of death in Bern 1815.

	Category	Frequency	Interpretation	Denomination in the register (German)
1	Cramps	17.7%	Epilepsy? tetanus?	Convulsion, Gichteren, Epilepsie
2	Debilitation and emaciation	12.3%	Tuberculosis (excl. pulmonary tuberculosis)	Abzehrung, Auszehrung, Leberschwindsucht, auszehrendes Fieber
			Miscellaneous	Atrophie, Gliedersucht, Hektik, hektisches Fieber, Schwäche (younger then 60 years)
3	Dropsy	11.5%	Metabolic disorder	Brustwassersucht, Wassersucht
4	Frailty in old age	4.4%		Altersschwäche, Marasmus, Entkräftung, Schwäche (older then 60 years)
5	Respiratory diseases	17.7%	Diphteria	Bräune, Croup
			Influenza	Brustkatarrh, Katarrhfieber
			Breathing difficulty	Schleimichte Asthma, Steckfluss, Brustsuffocation
			Pulmonary tuberculosis	Lungenschwindsucht, Schwindsucht, Lungensucht, Brustauszehrung
			Pneumonia	Brustfieber, Lungenentzündung, Brustentzündung
			Miscellaneous	Lungenvereiterung, Engbrüstigkeit, Brustkrankheit
6	Gastrointestinal diseases	5.4%	Dysentery	Gallenruhr, Ruhr, Dysenterie, Gallensteck, Durchfall
			Stomach cramps	Colic, Darmgichteren, Verhärtung des Magens
			Enteritis	Darmentzündung
7	Typhus and typhoid fever	5.6%	Typhus & abdominal typhus	Faulfieber, Gallenfieber, inflammatorisches, faulichtes Gallen-, Nervenfieber, Schleimfieber
8	Fever with exanthems	1.4%	Measels, rubella, smallpox	Masern, Röthlen, Ausschlagfieber, Pocken
9	Undetermined fevers	1.4%	Undetermined	Flussfieber, Wurmfieber, Zahnfieber, schleimichtes Fieber
10	Cancer and ulcers	1.4%		Fuss-, Hals-, Krebs-, innerliche Geschwüre, Mutterkrebs, auszehrende weibliche Krankheit
11	Genital diseases	1.8%	Various, e.g. urinary retention, inguinal hernia with incarceration	Unterleibsbeschwerden, Geschwüren im Unterleib, Harnbeschwerden, Hernie incacserata, Retentio urinae, Lendenabszess, Entzündung der Urinblase
12	Strokes	5.4%	Apoplexiae	Apoplexie, Lähmung, Schlagfluss
13	Childbed	0.8%		Im Wochenbett und Kindbett
14	Accidents and violence	4.8%	Bone fractures, injuries, drowning, burns, smoke poisoning, suicide, homicide	Sturz, Knochenbruch, Verwundung, Ertrinken, Verbrennung, am Kohlendampf ersticken, Selbstmord 1×, Mord 1×
15	Miscellaneous	8.2%	Various, e.g. diseases of the central nervous system, meningitis, cariovascular diseases, hydrocephalus, surgery, gangrene, rabies	Folgen einer Amputation 5× und Operation 2× im Spital, Melancholie, Wasserkopf, Hirnwassersucht, Gehirnentzündung, Lähmung, Wundfieber, Hundswuth, Blutung, fallenden Weh

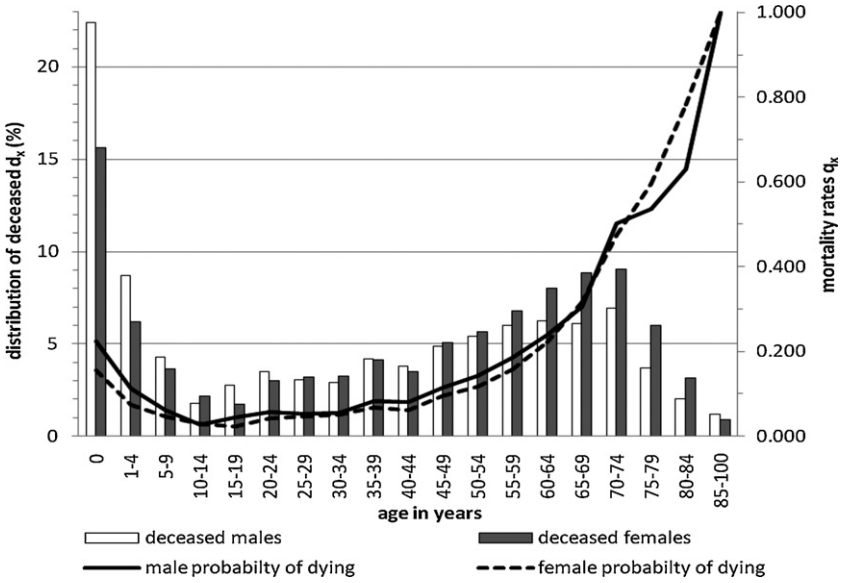

Fig. 3. Bern, males and females: mortality rates (q_x) and age distribution of deceased (d_x).

Between the years 1805 and 1815, 214 liveborn but unbaptised dead infants and 323 stillborn were recorded at a yearly average of 19 unbaptised and 30 stillborn. Of all born infants 5.3% were stillborn. Within two weeks of birth, the death count rose to 10.3%. The register shows that in most cases unbaptised children died within a few hours of birth.

Morbidity

Table 3 shows the categorisation and frequency of the causes of death. The most prominent causes of death were cramps and respiratory diseases (both approximately 18%), followed by debilitation/emaciation and dropsy, both reaching approximately 12%. Frailty in old age, gastrointestinal diseases, typhus and typhoid fevers, strokes, accidents and violence are accountable each for 4% to 6% of the death toll. The remaining categories are less frequent than 4%, amongst them fevers with exanthems (1.4%). Table 4 distinguishes the ages by the causes of death and their frequency of occurrence. Seventy-five percent of the deceased infants died of cramps. Approximately 12% of these infants died within 2 days of birth, approximately 50% of these infants died within 4 weeks. In the following ages up to 59 years, the most prominent causes remained debilitation and emaciation – with percentages between approximately 16% and 21% – and respiratory diseases between approximately 21% and 30%. Dropsy accounted for approximately 30% of all deaths at ages over 59 years.

Maternal death

Of all registered causes, childbed death accounts for 0.8%. It occurs only to women aged between 20 and 39 years at a frequency of 4.8% in this age class. Of 552 livebirths in 1815, four mothers died in childbed, resulting in a maternal mortality rate of 0.72%.

Discussion

To give a socio-economic background we continue with a brief summary of the results presented by Rüttimann (2008). The burial register portrays Bern as a city dominated by the lower class: 77% of the deceased were labourers – men working primarily as unskilled day labourers, menials, ordinary

Table 4
Frequency of the causes of death in age groups.

	Cause of death	Distribution in age (%)					
		0*n* = 97	1–19*n* = 86	20–39*n* = 84	40–59*n* = 103	>60	*n* = 127
1	Cramps	75.3	15.1	0	0	1.6	
2	Debilitation and emaciation	3.1	21	17.9	15.5	7.1	
3	Dropsy	0	3.5	3.6	13.6	29.1	
4	Frailty in old age	0	0	0	1.9	15.7	
5	Respiratory diseases	3.1	22.1	29.8	21.4	15	
6	Gastrointestinal diseases	8.2	2.0	8.3	7.8	1.6	
7	Typhus and typhoid fevers	2.1	5.8	10.7	6.8	3.9	
8	Fevers with exanthems	3.1	3.5	1.2	0	0	
9	Undetermined fevers	2.1	4.7	0	1	0	
10	Cancer and ulcers	0	1.2	1.2	2.9	1.6	
11	Genital diseases	0	0	1.2	4.9	2.4	
12	Strokes	1.0	0	0	7.8	14.2	
13	Childbed	0	0	4.8	0	0	
14	Accidents and violence	1.0	5.8	8.3	7.8	2.4	
15	Miscellaneous	1.0	15.1	13.1	8.7	5.5	

artisans and in manufacture; and women working particularly in textile processing, as domestic servants and as day labourers. The small middle class (16% of the deceased population) was represented primarily by master craftsmen, retailers, factory owners and wholesalers. Only few women with middle class professions were registered, mostly as grocers and innkeepers. Seven percent of the working population belonged to the upper class, e.g. high-ranking officers, representatives of the state and senior officials of the old Bernese regime.

Ten years is an admittedly short period for a demographic study, but the following comparisons with other cities and regions of the same period (Imhof, 1990; Schelbert, 1989) show that the reconstructed mortality of the city of Bern fits well into a Central European context (Figs. 4–6).

Therefore, our short period is a valid basis for discussion.

The database BERNHIST enables us to show the demographic evolution of a greater period between 1750 and 1850 (Figs. 7 and 8).

According to the data in BERNHIST, the population's natural increase in the city of Bern stagnated until the 1840s. This stagnation is indicated in Figure 7 by the similar levels of annual death numbers and birth numbers in the period 1745–1845. On the other hand, the Bernese countryside (Fig. 8) shows a positive demographic development, a growing surplus of births since the last quarter of the 18th century, a phenomenon widely spread in Central Europe (Pfister, 1995). In general, the decline of mortality accounts for this phenomenon (Mesmer, 1987). Kintz (1975) states the city's stagnation was characteristic for the urban natural population change of this period. François (1978) explains it with the higher children's mortality in the cities as opposed to the surrounding countryside. Sharlin (1978) on the other hand considers an artificial overrepresentation of deceased in the burial registers. The increasing drift into the city by lower class employees with high mobility would have left a greater mark in the burial registers than in the birth registers. The data of the BERNHIST (Figs. 7 and 8) stem from burial registers of the older tradition (= "Totenrödel) and are based on a simple count of the deceased, whether they lived in Bern or not. Our main source – the Bernese burial register – on the other hand, states the individual's residence and thus allows the reconstruction of mortality closer to a stable population model. In fact, the Bernese burial register shows that 12% of deceased individuals in Bern did not live in the city. These persons were outsiders admitted to the city's hospital and eventually died there. Furthermore, only 3% of all registered deceased infants were outsiders. Over 60% of the deceased working population were journeymen, apprentices and servants (Rüttimann, 2008), classes renowned for their high mobility. The discount of the non-inhabitants resulted in a surplus of 1.3 births per death, unlike a deficiency of 0.9 births per death if non-inhabitants had been included. The countryside's birth surplus for 1805–1815 was 1.5 births per death (BERNHIST). Thus, Sharlin's (1978) thesis seems to apply for Bern. It follows that the city's and the countryside's populations increased

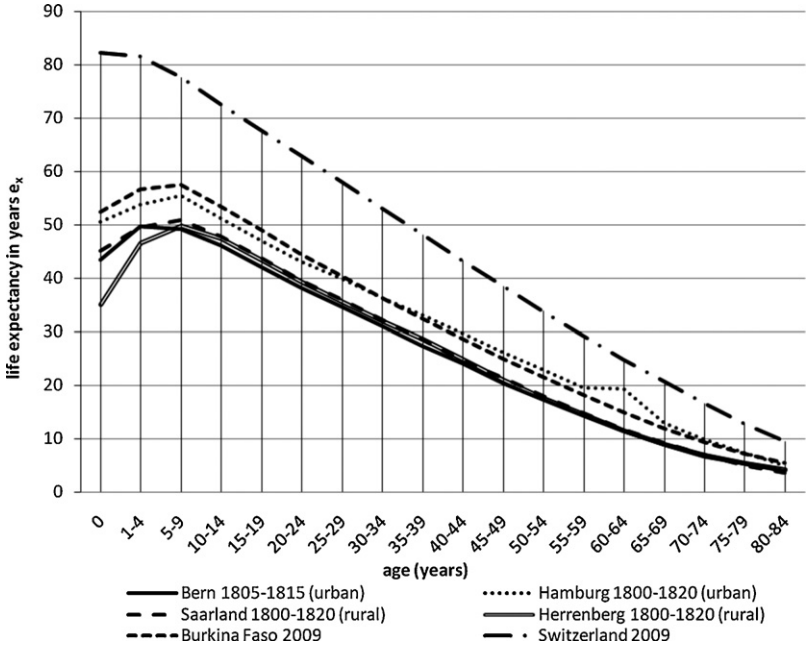

Fig. 4. Life expectancy (e_x) in Bern and cities and regions in Central Europe 1800–1820 (Imhof, 1990), Burkina Faso and Switzerland (WHO, 2009).

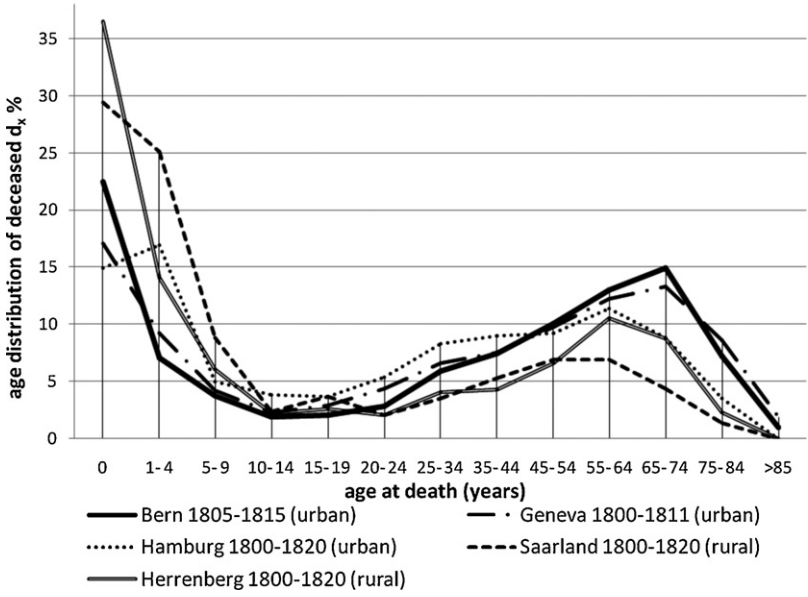

Fig. 5. Age distribution of the deceased of Bern (d_x), Geneva (Perrenoud, 1979) and other cities and regions in Central Europe 1800–1820 (Imhof, 1990).

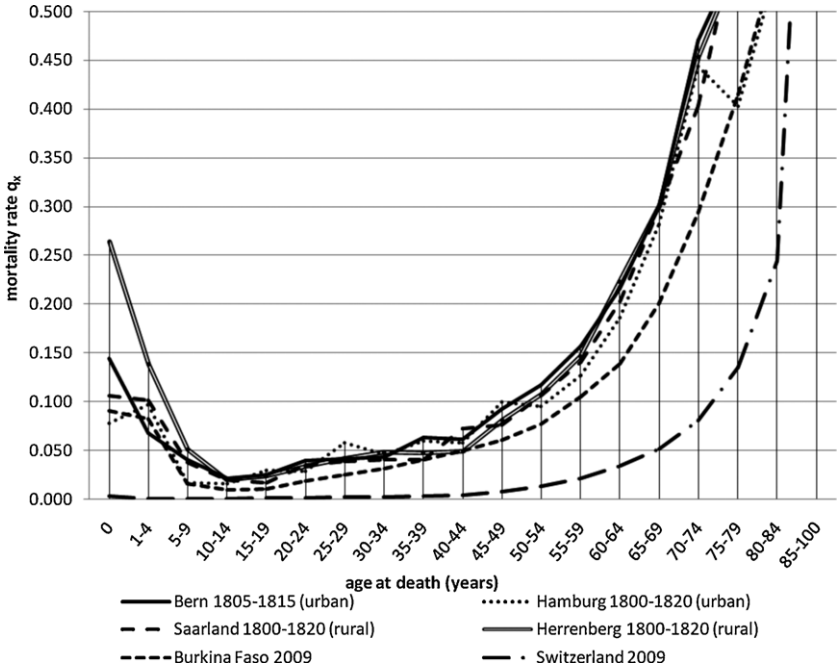

Fig. 6. Comparison of Bern's mortality rates (q_x) to cities and regions in Central Europe 1800–1820 (Imhof, 1990), Burkina Faso and Switzerland (WHO, 2009).

similarly and that the presumed urban stagnation is in fact a problem of data issue. Analyses of earlier registers – with no address given – are more likely to be distorted by the effect of mobility.

Mortality

Mortality crises in the decades before 1800 were predominantly caused by either subsistence difficulties or dysentery epidemics, the "Red Death" ("Rote Ruhr") in 1750 being by far the worst. Since then, the population of Bern only suffered minor threats, probably due to the efficiency of the

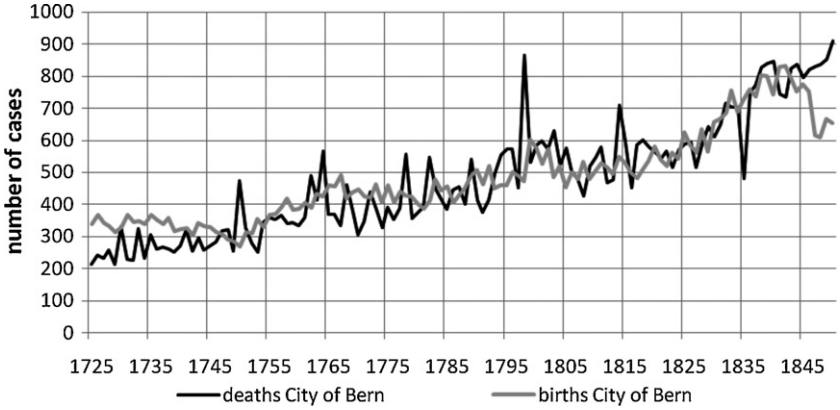

Fig. 7. Number of deaths and births in the City of Bern 1725–1850 (BERNHIST).

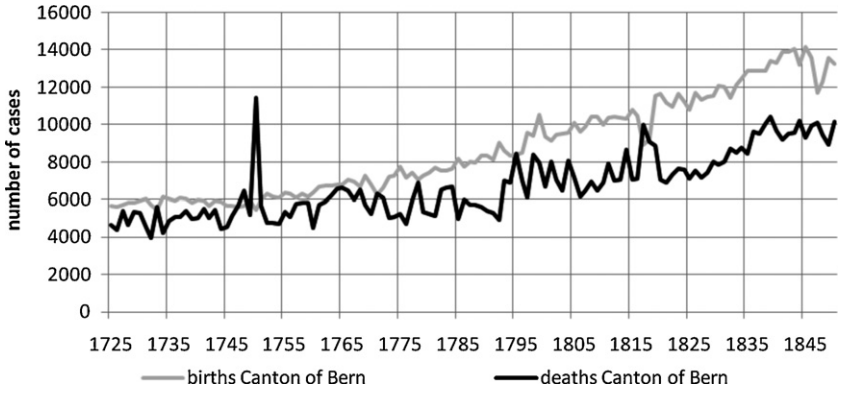

Fig. 8. Number of deaths and births in the Canton of Bern 1725–1850 (BERNHIST) within the modern boundaries.

authorities' grain policy and the early diversification of its agriculture (Pfister, 1995). The city's crude death rate (1764: 2.9%, 1810–1815: 2.4%) remained much lower than in eastern Switzerland (Mesmer, 1987). The war of 1798 had but local impact on the number of deceased. In 1814, Bern suffered from a short typhoid epidemic which was quickly subdued. Two years after the end of the study period, in 1817, a nationwide subsistence crisis occurred, but it had only a minor effect on the city's population (Pfister, 1995) (Fig. 7).

The progression of Bernese life expectancy (Fig. 4) showed closer affinity to rural regions, as opposed to urban Hamburg (Germany) where life expectancy was 5–7 years higher than in Bern. In Bern, life expectancy was highest for children between 1 and 4 years. In every other region it peaked later, for children between 5 and 9 years. Today, life expectancy of the Swiss population is dramatically higher. It is the highest at birth at 82 years (WHO, 2009). Life expectancy in Bern in the study period was lower than in, for example, today's Burkina Faso, one of the poorest countries in the world (WHO, 2009).

Bern's age distribution of the deceased (Fig. 5) is typical for Central European mortality of the late 18th and early 19th century (Perrenoud, 1979), i.e. the relatively high number of infants, minimal numbers between 10 and 24 years, and adults peaking after 50 years. Bernese age distribution of deceased is similar to that of other cities compared in Fig. 6, so a typical urban age distribution of deceased of this era might differ from that of a rural habitat as follows: fewer children died before the age of 10 in the cities than in the rural environment. This is probably due to better availability of medical care or due to a lower portion of this age class in a living urban population. Furthermore, the number of deceased adults between the ages of 25 and 45 is higher in the cities than in the rural setting. This might be partly linked to the cities' large portion of male menials and female domestic servants as stated by Rüttimann (2008) for Bern. These professions were primarily occupied by young adults before marriage. In Switzerland, during the study period, marriage would take place around the age of 28 years (Pfister, 1995). In the age distribution of deceased the peaks at old age are more pronounced in the urban than the rural environment. This has probably to do with the fact that more people live longer in an urban environment.

On the other hand, the progression of Bern's mortality rates (Fig. 6) shows no clear differences from the compared regions of the same period, apart from infant and child mortality, which will be discussed below in detail. Today, mortality rates in Switzerland remain close to zero until the age of 40, while Burkina Faso's mortality rates show close similarities to the rural Central Europe of the early 1800s (WHO, 2009).

The seasonal mortality in Bern was high in winter and spring, and decreased to a low level in summer, with a short rise in August (Fig. 1). It is similar to the rural Freienbach (Shelbert, 1989) and the city of Geneva (Perrenoud, 1979). The maxima of the three age groups appear successively through the seasons (Fig. 2). The oldest people died in winter, when low temperatures and harsher climate took its toll. Children primarily died in springtime, they seemed more susceptible to various viral infections, caused by changes in air temperature and humidity. Significantly, only children showed a second peak

Table 5
Comparison of Bern's infant and child mortality rates (q_0 an q_{1-4}) to cities and regions in Central Europe 1750–1820.

Place name	Infant mortality (q_0)	Child mortality (q_{1-4})	Period	Habitat	Region/religion	Author
Hamburg	0.078	0.097	1800–1820	Urban	Germany, Prot.	Imhof (1990)
Saarland	0.106	0.101	1800–1820	Rural	Germany, both	Imhof (1990)
Bern	**0.144**	**0.068**	1805–1815	Urban	Switzerland, Prot.	This article
Geneva	0.193	0.153	1790–1797	Urban	Switzerland, Prot.	Perrenoud (1979)
Ortenau	0.200	0.113	1800–1820	Rural	Germany, both.	Imhof (1990)
Herrenberg	0.292	0.139	1800–1820	Rural	Germany, Prot.	Imhof (1990)
Freienbach	0.293	0.209	1790–1809	Rural	Switzerland, Cath.	Schelbert (1989)
Offenburg	0.339	–	1750–1800	Urban	Germany, Cath.	François (1978)
Leipzig	0.300–0.400	–	1750–1800.	Urban	Germany, Prot.	François (1978)
Wroclaw	0.300–0.400	–	1750–1800	Urban	Poland, Cath.	François (1978)
Landsberg	0.440	–	1750–1800	Urban	Germany, Cath.	François (1978)
Memmingen	0.459	–	1750–1800	Urban	Germany, Prot.	François (1978)
Lucerne	–	0.123	Final 18th c.	Urban	Switzerland, Cath.	Reust (1980)
Paris Region	–	0.184	1750–1789	Both	France, Cath.	Reust (1980)

in August. Pfister (1995) linked this to the children's higher than adult susceptibility to dysentery, a disease more rampant in the warmest season of the year. Most juveniles and adults up to 59 years died in winter and early spring. Thus, the pattern of the overall seasonal mortality has been mostly affected by deceased adults. In fact, Perrenoud (1979) stated that the portion of the older population had drastically grown since the 1700s. Thus, Bern's seasonal mortality pattern eventually lessened the hitherto dominance of the children's death peak in August. Ultimately, this phenomenon was the consequence of the same factors which were held responsible for the ensuing population growth in Central Europe of the 18th and early 19th century, namely the increasing birth-rate and the decline of mortality (Mesmer, 1987).

Infant and child mortality

Infant mortality in Bern was relatively low compared to other cities and regions in Switzerland, Germany and Poland (Table 5). Only the city of Hamburg and the rural Saarland (both Germany) had considerably lower rates, although the run of their curves probably indicates an under-registration of infants (Fig. 6). Wroclaw (Poland), Leipzig, Lanzberg, and Memmingen (all three in Germany) suffered drastically higher rates between $q_0 = 0.300$ and $q_0 = 0.460$. Bern's low rates might be the result of improvement in medical treatment and hygiene precautions initiated after the major dysentery epidemic in 1750 (Pfister, 1995). In addition, a midwifery institute was established in 1781 (Jenzer, 1966). Indeed, Reust (1980) shows that infant mortality in Bern was steadily decreasing from $q_0 = 0.220$ in 1760 down to $q_0 = 0.170$ in 1780.

Children between the age of 1 and 4 in Bern had by far the best chances of survival, compared to the cities and regions shown in Table 5 ($q_{1-4} = 0.068$). Hamburg and the rural Saarland followed behind with approximately $q_{1-4} = 0.100$. Rural Freienbach had the highest rate at $q_{1-4} = 0.210$. The reason for Bern's large offset remains unclear. Imhof (1981) found higher counts of deceased infants in some Catholic communities of this time. He considered this phenomenon partly as a religio-economical phenomenon and partly as an effect of registry practice. In Protestant parishes, stillborn babies were not counted as baptised and thus were ignored by the early registries. Catholic priests on the other hand, would occasionally baptise a stillborn and thus increase the number of dead infants in their registers. Table 5 tends to corroborate this: the top five cities and regions are of Protestant or of mixed religious denominations.

Comparing our counts of stillbirths and dead, unbaptised children with contemporaneous and older data has been difficult since they were rarely registered (Imhof, 1976; Mattmüller, 1987; Pfister, 1995). According to the analysis of the Bills of Mortality for London, stillborn percentages of all deceased were relatively close to Bern's values, namely 7% in 1730 and 4% in 1848 (Molleson et al., 1993). The data issue has improved in the course of the 19th century. Of all births in 1850 and 1875 in the Canton of

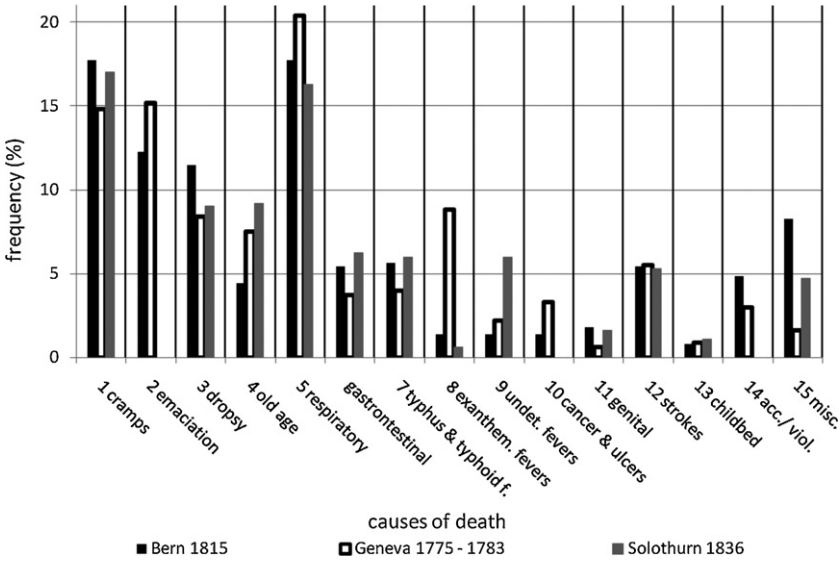

Fig. 9. Causes of death in Bern, Geneva and Solothurn.

Bern, Pfister (1986) calculated 5% to 6% as stillbirths and observed a death count rising up to 9% within two weeks of birth. Obviously, the death risk for unborn and newborn infants remained constant for most of the 19th century. From 1876 onwards, the number of stillbirths constantly decreased throughout Switzerland due to progress in the medical field. In the Canton of Bern, in 1899, the rate of stillbirths dropped to 3.8%. In 1996 the rate has reached 0.4% (Ritzmann-Blickenstorfer, 1996), whereas it remains unclear whether intended abortions were included in this calculation. Perinatal mortality remained linked to poverty and precarious working and living conditions. For example, in 1899 the stillbirth rate remained on a high level of 4–5% in centres of home industries such as Neuchâtel and Herisau in Switzerland (Pfister, 1986; Ritzmann-Blickenstorfer, 1996).

Morbidity

Reliable information on the frequency of diseases is almost nonexistent for the period discussed here. The availability of data on the causes of death is a bit better, but it is difficult to assign them to specific illnesses. Before 1875 no standard diagnostic nomenclature was established in Switzerland and nationwide periodical surveys were not conducted. Attestation of the cause of death by doctors was not consistently regulated by law as was the case in Bern, and the data from other places are by far incomplete (Steinke, 2011). Thus, the comparison with the cities of Solothurn and Geneva should be viewed with caution (Fig. 9). In general, frequencies of the causes of death rank roughly in the same order in all three cities. There are in particular respiratory diseases (16–20%), cramps (15–18%) and dropsy (8–12%). Death by stroke appears in all three cities at almost identical frequencies (5–6%). Fevers with exanthems only appear in Geneva at a considerable rate of 9% – including pox. In the Canton of Bern, pox never seemed to be a major threat. The endemic and severe outbreaks had but local impact (Pfister, 1995). Vaccination started in Bern in 1796 but its public enforcement remained unsuccessful until the mid 1800s (Siffert, 1993; Pfister, 1995). Other discrepancies, e.g. the low frequency of deaths through frailty in old age in Bern and the low frequency of deaths through indetermined fevers, cancer and ulcers, reflect the problematic data issue. The same has to be said about the missing categories of causes of death in case of Solothurn, such as debilitation or accidents. Taken with the aforementioned caution, Bern's frequencies of the causes of death fit well into the regional and chronological setting.

The high frequency of cramps in Bern actually reflects infant mortality, and probably in Geneva and Solothurn too. In the register, these cramps are literally referred to as the "gichteren". This is an

old and no longer used German expression for seizures and was exclusively used for infants. Andral (1848) described them as "child's convulsions" and "epilepsy" that can lead to death within four days after a complicated and painful birth. Signs of cramps are sequences of short fits and hours of rigidity of the body. In each case, autopsy revealed residues of coagulated blood behind the occipital lobe. Virchow (1855) called it "*Eclampsia infantum*". He described it as an irritation of the central nervous system with epileptic symptoms, recurring predominantly in male infants – which fits well with the excess mortality of male infants who died of cramps, as proven by the data of our register. As causes, he presumed a high febrile condition, fits of temper and unbalanced diet, and believed it to be inherited. We think there are two modern interpretations for these "gichteren": neonatal epileptic tonic seizures and neonatal tetanus.

Neonatal epileptic tonic seizures have various origins. Most common is oxygen deficiency at birth, cerebral haemorrhage or malformation. Other causes are meningitis, encephalitis, genetic disorders or febrile illness. Signs are apnoea and tonic seizures and 80% occur in the first week of life. Today, the overall incidence is 3‰ and approximately 15% of the incidences are lethal (Panayiotopoulos, 2007).

Neonatal tetanus is caused by wound inflammation from poison generated by bacteria *Clostridium tetani*, most likely after an unclean cut of the umbilical cord at birth. It is highly lethal and can lead to death within 4–21 days after birth, rarely within several months (Pschyrembel, 2010; Roche Lexikon Medizin, 2003). Death comes through suffocation by cramps of the respiratory muscles and starvation. The infected child's jaw is locked and thus prevents breastfeeding. Inoculation was introduced in 1890. Infants acquire passive immunity through an immunised mother. In 1998, neonatal tetanus was still common in many developing countries and was responsible for about 14% of all neonatal deaths worldwide, while the disease was practically eliminated in developed countries (UNICEF, 2000). Nevertheless, the exact identification of the "gichteren" remains unclear.

Maternal death

Maternal death in childbed is rarely registered in Bern, Solothurn and Geneva (Fig. 9). There is no specific increase in the female probability of dying (Fig. 3) in the prevalent reproductive age between 15 and 40 years. Indeed, the exposure to death of birth-giving women is often overrated, as already stated by Herrmann and Grupe (1986), Labouvie (2000) and Laget (1982) – especially in the field of physical anthropology. Bern's maternal death rate of 0.72% is comparable to Sweden's 0.78% in 1801–1805 (Curtis, 2005) and lower than the rural Belm's 0.98% (Schlumbohm, 1994) and Würtemberg's 1.03% (Maisch, 1992) at the beginning of the 19th century. Various authors state similarly low rates for this period (Imhof, 1983; Loudon, 1992; Perrenoud, 1981; Schofield, 1986).

The exact cause of dying remains unclear. Puerperal fever is a possibility. This is an infectious disease, which afflicted women within a few days of delivery. Because of unhygienic conditions at birth, streptococci and other bacteria may enter the body and cause a febrile illness and in most cases a sepsis which can lead to death. Semmelweis (1861) proved that the infection was a relatively modern disease, predominant in modern hospitals with pathological anatomy departments, where the doctors with no knowledge of antisepsis or epidemiology were carriers of infection through contaminated instruments, hands and clothing. For the period of 1784–1822, he reported low yearly puerperal fever mortality rates between 0.4% and 3.6% for birth-giving women at Vienna General Hospital. After the advent of pathological anatomy, rates rose up as high as 15.8% in 1842. Rates were drastically lowered when Semmelweis introduced hygienic measures in 1847 (Semmelweis, 1861). In Sweden, the frequency of cases of puerperal fever rose between 1861 and 1874 to 51% of all maternal causes of death, alongside Norway and Britain. Even if comparison with our rates is limited, the low rate of obstetric causes of death in Bern is not exceptional for its time period. The rates from Solothurn, Geneva and Sweden affirm that maternal death rates were clearly lower than in the later 19th century. Today, this infectious disease is treated with antibiotics. Maternal mortality remains relatively high in developing countries, where rates often exceed 0.65% of live births, that is twenty-five times higher than in the developed world (Curtis, 2005).

Conclusion

Bern in 1805–1815 shows a positive demographic development and contradicts the thesis that stagnating population growth is characteristic of European cities of this period. Comparative analyses are most likely distorted by overrepresentation of deceased outsiders in burial registers.

Bern's age distribution of deceased is typical for the late 18th and early 19th century with a relatively high number of deceased infants, minimal numbers of dead between 10 and 24 years, and deceased adults peaking later than 50 years. The elderly died primarily in wintertime, and children passed away mostly in spring and also in August.

The infant mortality rate was relatively low because of the improvement in medical treatment and hygiene precautions after the major dysentery epidemic in 1750, and the establishment of a midwifery institute in 1781. Bernese children between the age of 1 and 4 years had by far the best chances of survival in comparison to other cities and regions in Central Europe. Of all born infants, 5.3% were stillborn. This rate remained constant in Switzerland for most of the 19th century.

The recorded causes of death are difficult to assign to specific illnesses because no standard diagnostic nomenclature has been established yet. Bern's frequencies of the causes of death fit well into the regional and chronological setting. In particular, respiratory diseases, cramps and dropsy were most prominent in Bern.

Seventy-five percent of the deceased infants died of cramps. There are two modern interpretations of this illness: neonatal epileptic tonic seizures, and neonatal tetanus.

Maternal death in childbed is rarely registered in Bern and there is no specific increase of female probability of dying. This is also observed in several European regions in the same time period. Puerperal fever is a possibility though it was most dominant later in the 19th century in hospitals before antisepsis was known.

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