proper subjects of an experimental course".[59] They paid the price for medical progress, often with their lives. For what progress? Undoubtedly, man-midwifery advanced, and expert knowledge, coded in the language of medical science, was accumulated. It is puzzling that the directors of the maternity hospitals were widely recognised as the leading authorities in the field, although, in terms of maternal mortality rates, their institutions produced results that were far worse than those achieved by the most 'ignorant' untrained midwives in the countryside, and that although this fact was well known to the public, so much esteem was conferred upon these obstetricians. A more thorough investigation is needed to discover how these experts won such a high reputation, and what audiences were convinced by what arguments.

With regard to the medicalisation of childbirth as a cause of a decline in maternal mortality in the 18th and 19th centuries, it can, at best, be argued that the new expert knowledge had a beneficial effect in an indirect way: Doctors were able to give better instructions to female midwives, so that they could reap the benefits which hospital directors, and probably men-midwives in private practice, were unable to achieve. But even this hypothesis needs closer scrutiny.

59. Aikin, *Thoughts on Hospitals*, pp. 79. Cf. above, with note 33.

Mapping Infant Mortality in the Netherlands. Its History and Current Status*

Frans van Poppel and Erik Beekink

The use of mortality data in public health

In the Western world much significance is attached to the collection of reliable and up-to-the-minute information on the health status of the population. This information is among other things used for the surveillance of health, for the elucidation of important public health problems and for the evaluation of the effectiveness of health care policies and systems.[1] Although mortality statistics have their limitations as an indicator of the health status of the population, they have proved extremely useful as a basis for national and international comparisons. As cultural considerations determine how much disease or sickness is perceived as illness, the meaning of sickness changes over time and space; therefore, health data based for example on sickness leave or subjective health complaints do not lend themselves easily to comparisons over time and space. Mortality lacks this multidimensional complexity of morbidity. Mortality is deprived of the durational dimension which morbidity has, and it does not have a severity dimension either.[2] Few individuals exist in a biological state which requires doctors to decide whether or not a person is alive or dead, making it comparatively easy to measure the incidence of mortality in a given time period. For comparisons of the health status of the population within but also between the various European countries use is therefore frequently made of mortality measures.

Compared with present-day developed countries, comparisons of the level of public health of historical societies are very problematic. Objective and quantitative measures that give an impression of different aspects of health can hardly be found for historical populations. Historical data on morbidity are hardly available and where they do exist they mostly relate to small segments of the population and more often refer to 'the unusual rather than to what occurs as a rule'.[3] The only more objective measures available to the historian to study the level of public health and the changes therein are mortality data. For the historical study of public health, mortality data have important advantages. In most countries of Europe mortality registration was institutionalised relatively early.[4] The accessibility of these

1. C.J.L. Murray and A.D. Lopez, 'Estimating causes of death: New methods and global and regional applications for 1990' in: C.J.L. Murray and A.D. Lopez, *The global burden of disease: a comprehensive assessment of mortality and disability from diseases, injuries, and risk factors in 1990 and projected to 2020.* Vol. 1, (Boston, Geneva, Washington, 1996) 118-200.
2. S.R. Johansson, 'The health transition: the cultural inflation of morbidity during the decline of mortality', *Health transition review* 1 (1991) 39-68.
3. Vereeniging voor de statistiek in Nederland, *Algemeene statistiek van Nederland.* Tweede Deel (Leiden 1877).
4. Johansson, 'The health transition'.

data for analysis is also quite good. In most countries of Europe too, death certificates contain the same kind of information from the beginning of the nineteenth century, record many relevant characteristics of the deceased such as sex, age at death, occupation etc., and can be linked nominally to other sources of individual level data, such as population registers, tax records, etc., thereby making such characteristics as income, religion etc. available for analysis. Comparisons of the health situation of different time periods, different regions, and different social groups thus become possible. The quality of these mortality data is fairly good and they usually cover the whole population and not just a privileged group. Thus mortality data, from its accessibility and coverage, as well as from the availability of additional information permitting a comparison over time and between regions, have clear advantages. Last but not least, the mortality level is considered a good indicator of population health as, for a long time, a strong positive association existed between mortality and morbidity.

Mapping the biometer

In many European countries, the use of mortality data for public health purposes dates back to the eighteenth century. In the United Kingdom, numerical analysis of mortality records became a standard practice for a variety of health problems from the 1830s onwards.[5] William Farr and other medical reformers used mortality rates to monitor changes in health over time, to compare the salubrity of various geographical regions, and to explore the causes of high mortality. Mortality rates served as sanitary yardsticks which were used as a standard of health by calculating 'degrees of salubrity' for town districts. Local authorities could compare the mortality rates of their own town with the rate of 17 per 1000, known as the 'healthy district' mortality rate, to check whether or not their community lived in a satisfactory hygienic state.[6] According to Farr the mortality rate was a 'biometer', a scale which 'serves to measure the life-force, or the complementary death-force, in the same way as the centigrade scale of the thermometer serves to measure heat'.[7]

Inspired by these English (and French) examples medical statistics in the Netherlands got off the ground in the 1850s. An important role in this was played by the younger generation of medical practitioners, known as the sanitary reformers or hygienists. Their action was an answer to the scientific and political crisis in health care in the 1830s and 1840s, which was caused by the deterioration in the physical condition of the population in the wake of bad harvests and growing poverty, and epidemics of typhus and cholera. It became clear that the system of health care for the poor, and governmental policies on health, were dramatically

5. E.S. Houwaart 'Medische statistiek' in: H.W. Lintsen, M.C.S. Bakker, E. Homburg, D. van Lente, J.W. Schot and G.P.J. Verbong (eds.), *Geschiedenis van de techniek in Nederland. De wording van een moderne samenleving 1800-1890* Vol. 2 (Zutphen 1993) 19-45, in particular 29.
6. See J.M. Eyler, *Victorian social medicine. The ideas and methods of William Farr* (Baltimore 1979) in particular 68-74.
7. Houwaart 'Medische statistiek' 28-29; Eyler, *Victorian social medicine.*

defective. The medical doctor's dissatisfaction with their low social status also played a role in this fight for social and sanitary reform. In 1848, medical doctors united themselves in the *Nederlandse Maatschappij tot bevordering der Geneeskunst* (Dutch Society for the Improvement of Medical Science, hereafter N.M.G.). The hygienists were actively involved in the improvement of public hygiene and the introduction of preventive medical legislation. They stressed the need for an objective measurement of the health situation, and for empirical research and statistics to meet this need.

Nation-wide birth and death registration had been introduced in the Netherlands in 1811, at the time of the incorporation of the Netherlands into the French Empire. Obviously, in the first years after the start of the registration, the quality of the data was not very good. The lack of experience of the registration officers; their ignorance, and that of the general public, of the official regulations; war, and other complications, were responsible for this. Comparisons of the civil and the parish registers of births and baptisms and of deaths and burials therefore show that a small proportion of births and deaths escaped registration.[8] In general it is assumed, however, that by 1840, registration was virtually complete and reliable.

Although death certificates were available from the second decade of the nineteenth century, this did not mean that statistical data on mortality were published. Before 1840, however, there were local administrators and medical doctors who used information from the vital registers. Municipal and provincial mortality data were calculated from this source but, for the most part, this was done on an occasional basis. Besides, the mortality studies based on these data were largely only simple numerical reports of absolute and relative numbers of deaths with which not much could be done. This was also partly due to the fact that information on the population at risk was lacking. In the published national statistical reports on mortality, age and sex of the deceased were usually not distinguished and hardly any regional distinctions were drawn. Another weakness is that up to 1837 death registers included children who were stillborn.[9]

A great deal of the efforts of the hygienists was directed at increasing the quantity and quality of data on health and mortality, and at the standardisation and wider dissemination of these data.[10] In their opinion, it was the medical practitioner's task to collect and analyse empirical facts and to describe the relationship between such things as the number of deaths, and the chemical composition of water, soil and air. From 1850 onwards, population statistics improved considerably so that the number of deaths could be related to the population size and annual

8. See for example J. Kok, *Langs verboden wegen. De achtergronden van buitenechtelijke geboorten in Noord-Holland 1812-1914* (Hilversum 1991) 34 and D.J. Noordam, *Leven in Maasland. Een hoogontwikkelde plattelandssamenleving in de achttiende en het begin van de negentiende eeuw* (Hilversum 1986) 219-220.
9. C.A., Oomens, *De loop der bevolking van Nederland in de negentiende eeuw* (Den Haag 1989) 20-26. See also the remarks made about the completeness of registration in the *Sterfte-atlas van Nederland* (Amsterdam 1866).
10. E.S. Houwaart, *De hygiënisten. Artsen, staat en volksgezondheid in Nederland 1840-1890* (Groningen 1991) 343-346; E.S. Houwaart 'Medical statistics and sanitary provisions. A new world of social relations and threats to health', *Tractrix. Yearbook for the history of science, medicine, technology and mathematics* 5 (1993) 81-119.

mortality rates calculated.[11] The hygienists mapped the health situation of local populations with the same devices as Farr had proposed. Death rates made it possible to recognise at a glance the 'sick' areas of the country or the city and a comparison with mortality rates from other places showed the extent to which conditions were healthy or not, and offered a clear perspective for improving health conditions.[12]

The first Dutch statistical study in which the concept of the biometer was incorporated was carried out by the Hague doctor Johannes Willem Schick (1818?-1853).[13] According to Schick, to acquire knowledge of the causes of diseases one had to study 'where diseases manifest themselves, how they emerge at different places and times and under various circumstances. By comparing and contrasting we will be able to ascend to knowledge of the causes'. In the opinion of Schick, the Netherlands were pre-eminently suited to this kind of study. The country was small, as a consequence of which the processing of the data cost relatively little time, but at the same time the diversity was great due to the location and nature of the soils. Knowledge of the health situation of the various localities had to be the basis for the study of the causes of diseases. As a test of the way in which one could arrive at an understanding of the fundamental causes of health, Schick presented an overview of mortality in the province of Zuid-Holland in relation to the situation and condition of the soil. Municipal crude death rates for the period 1837-1848 made up the basis of his presentation.

Schick provided a map of mortality rates, to demonstrate that the 'mortality ratio in particular places shows a very striking similarity', and that there were 'circumstances that did exert an influence over a particular area'. He added a diagram with a summary of all the 'natural and societal causes' of differences in deaths and incidence of disease. Together with other municipal data on the geographical condition he deemed relevant, these mortality rates were mapped in such a way that at a single glance the insalubrious places could be identified. In this way one could get a 'general and overall impression (...), as could not be given by any comparison of extensive tables'. On the map, death rates were presented for each municipality in the shape of a pie chart, consisting of 16 parts: the higher the death rate, the larger the proportion of the pie that was filled. Among the factors that could affect the differences in mortality between municipalities Schick included the geographic location (the vicinity of sea and lakes, altitude), atmospheric conditions, geological factors (clay, peat or sand soil) and soil use. The geographic variation in these factors was also depicted on the map.

Schick realised that a survey on a much wider scale than that of the province was necessary to draw more definite conclusions on the observed relationship

11. Houwaart, 'Medische statistiek' 30-39; E.S. Houwaart 'Professionalisering en staatsvorming' in: H.W. Lintsen, M.C.S. Bakker, E. Homburg, D. van Lente, J.W. Schot and G.P.J. Verbong (eds.), *Geschiedenis van de techniek in Nederland. De wording van een moderne samenleving 1800-1890* Voll. 2 (Zutphen 1993) 81-92, in particular 82-85.
12. Houwaart, 'Medical statistics, in particular 107-110.
13. J.W. Schick, 'Over sterfteverhouding in verband tot hare oorzaken', *Tijdschrift Nederlandse Maatschappij tot Bevordering der Geneeskunst*, 2, 1851 II, 31-47. We do not mention here the many studies in which maps were given depicting the variation in mortality in the various neighbourhoods of large municipalities.

between mortality and the nature and location of the soil. He argued that the material for such a study could be found in the vital registers.

Dutch Mortality Atlases: Historical background

Fifteen years later, in 1866, on the initiative of the N.M.G. the first map of mortality for the country as a whole was published by the medical doctors De Man, Boogaard and Zeeman.[14] The twenty-year period 1841-1860 was adopted, so that the major, albeit temporary upheavals, brought about by the potato blight, cholera and the political upheavals of the 1840s, did not exert too strong an effect on the outcomes.[15]

The N.M.G. had hoped that the Atlas would 'alert the local administrations to the fact, that the regularities which are a consequence of our social order, are not regular enough to be termed immutable laws'. In addition to that, the N.M.G. also wanted 'to show the citizens themselves in a simple way the differences, so as to get them to understand the need for statistical studies and the protection of public health one has the right to demand.' The N.M.G. was convinced that the mortality figures, which were made public annually by the provincial administrations, did not attract the attention that they deserved and that by publishing mortality data, in the form of an atlas, this failing could be rectified. Data on mortality were according to the N.M.G. 'the only available foundation from which to assess the general health situation'.

The Atlas consisted of a table in which for every municipality, listed by province, for the whole period 1841-1860 information was given on the number of children who died in the first year of life, and, for higher ages, the number of deaths by age groups. In addition, the number of inhabitants, and the number of stillborn and live-born children was given. The Atlas also contained maps of each province showing the mortality rate for each municipality. Unfortunately the amount of information included in these maps was so great that they proved difficult to interpret. For every municipality the geological situation was shown by a differential shading of the surface. This made it possible to bring to light the relationship between mortality levels and soil type. For each municipality the number of deaths per 1000 inhabitants was presented in the form of a pie diagram, which was further differentiated by lines and shaded surfaces. Alongside the pie diagram, two numbers were given, indicating respectively the number of stillborn children per 1000 births and the number of births per 1000 inhabitants. Finally, the name of each municipality was given in different fonts to indicate its population size. Separate data on infant mortality were not given in the map.

The authors realised that the data had their shortcomings but were confident that their successors 'would, without doubt have more accurate material at their dis-

14. *Sterfte-atlas van Nederland*, uitgegeven door de Nederlandsche Maatschappij tot Bevordering der Geneeskunst (Amsterdam 1866).
15. J. Zeeman, 'Sterfte-statistiek'. *Catalogus der Historisch-Geneeskundige Tentoonstelling te Arnhem* (Arnhem 1899) I.

posal.' Full of optimism the authors, therefore, stated: 'Undoubtedly, in the near future, figures on mortality from all the municipalities of the Kingdom will be communicated by the government every five or ten years; these figures will easily be linked with those of the tables given here and in that way increase the value of the averages obtained by us'. In view of this the N.M.G. requested that the Secretary of State for Home Affairs get his Ministry to prepare a similar atlas for the years 1860-1874. The Secretary complied with this request, but it was the Dutch Society for the Improvement of Medical Science that had to bear the costs.[16] The second mortality atlas, published in 1879, again focused on crude death rates; municipal data on infant mortality were once more included in the tables but again not shown in the form of a map.

In 1895, sixteen years after the publication of this atlas, the Medical Statistical Committee of the N.M.G. got in touch with the Ministry of Home Affairs and asked it to promote the publication of a sequel to their latest mortality atlas. Such a publication was considered by the N.M.G. to be for the public good. The Home Secretary asked the Central Statistical Committee for advice. This Committee, founded in 1892 to provide the government with advice on statistical matters and to draw up statistical plans for the different ministries, endorsed the N.M.G.'s statement.[17] 'Graphical displays of mortality', it was said, could do more to raise the 'general interest' than could tables. An atlas was also considered an excellent means to 'induce the experts to start studies into the causes of the observed differences and to make efforts to clear these away'. The Central Committee did propose some changes in the way the data were presented in the maps. It suggested there be one national map instead of the eleven separate provincial ones. As data on the geological condition of the regions made it difficult to get a clear impression of the situation and was only one of the many potential factors affecting mortality, it was decided to exclude it. The 'connection between man's life and death and the soil' that had been of prime importance for the authors of the earlier mortality atlases was thereby abandoned.[18] The Secretary of State also asked the Public Health Inspectorate for advice and it was this advice which finally led to the publication of maps with crude death rates for each municipality for the periods 1875-1879, 1880-1884 and 1885-1889.[19]

16. *Sterfte-atlas van Nederland.* See also: Algemeen Rijksarchief (ARA), Den Haag, Inventaris van het archief van de Nederlandsche Maatschappij tot Bevordering van de Geneeskunst, Inv. Nr. 100 Sterftekaarten, sterfte-atlas 1862-1897.
17. Algemeen Rijksarchief (ARA), Den Haag, Inventaris van het archief van de Afdeling Medische Politie, (1850-1901), van het Ministerie van Binnenlandse Zaken (1878), 1881-1901. Inv. Nr. 613. Stukken betreffende behandeling van het verzoek van de Commissie voor Geneeskundige Statistiek van de Nederlandsche Maatschappij tot Bevordering der Geneeskunde om van regeringswege een sterfte-atlas uit te geven. 1895.
18. Zeeman, 'Sterfte-statistiek', VIII-IX.
19. See H.W. Methorst, *Geschiedenis van de statistiek in het Koninkrijk der Nederlanden* (Den Haag 1902) 92. The first map was published under the title, Departement van Binnenlandsche Zaken, *Grafische voorstelling der sterfte (zonder de levenloos aangegevenen) in iedere gemeente van Nederland op 1000 inwoners gedurende het vijfjarig tijdvak 1875-1879.*

In the 1880s the attention of politicians, public health authorities and statisticians shifted more and more away from mortality rates for the total population to the death of infants and children. The creation and publication of specific mortality rates for infants has been interpreted as an indication of the emergence of a social awareness of these young deaths and of the recognition by society of the infant as a discrete entity.[20] At the same time it was a recognition of the fact that for making comparisons of the health of different populations, crude death rates had become less appropriate than infant mortality, which 'to such a high degree influences the total death rate, what's more, rules it'.[21] The fact that infant mortality as such led to new large scale studies was an international phenomenon although it was explained in each country by a specific set of factors. Saltet and Falkenburg for example argued that the decrease in the birth surplus in a number of European countries was the most important factor giving rise to these studies. The fall in the surplus of births constituted a danger in the competitive struggle between nations that could lead to defeat. In this context, it was quite natural that infant mortality, which made up such a large proportion of total mortality, became the object of study: 'saving existing lives appeared to be more feasible than stimulating the number of births'.[22]

When, in the 1880s, medical doctors and statisticians became aware of the large social and regional inequalities in infant mortality in the Netherlands, maps were also published that focused on municipal differences in the mortality in this age group. The first map was the result of the work of a Commission, established in 1885 by the Public Health Inspectorate to initiate a comparative study on infant mortality.[23] In the Annual Report of the Public Health Inspectorate for 1886 tables were included which, for each municipality, gave the number of children born in the years 1875-1880 and 1880-1885, who had died before their first birthday in the years 1875-1881 and 1880-1886 respectively.[24] Professor Anthony Beaujon, director of the *Statistisch Instituut* and extra-ordinary professor in statistics at the University of Amsterdam, had suggested that the Public Health Inspectorate look in particular at the situation in individual municipalities and for that reason it was considered valuable to present the figures in the form of a map. Remarkably, however, the publication of this first map dealing with the years 1880-1884 did not arouse much of a response among the parties concerned.

Although the Central Statistical Committee had expressly stated its wish to publish a map with municipal data on infant mortality for the years 1886-1890 as well, fifteen more years elapsed before a map again became available in which infant

20. D. A. Armstrong, 'The invention of infant mortality', *Sociology of Health and Illness*, 1986, 211-232.
21. Zeeman, 'Sterfte-statistiek', VIII.
22. R.H. Saltet en P.H. Falkenburg, *Kindersterfte in Nederland in de jaren 1881-1905* (Amsterdam 1907) 2-3. Other authors have pointed to the effect of the French defeat in the Prussian-French War in 1870, and the shock brought about by the Boer War.
23. *Verslag aan den Koning van de bevindingen en handelingen van het Geneeskundig Staatstoezigt in het jaar 1885* ('s-Gravenhage 1886) 14.
24. *Verslag aan den Koning van de bevindingen en handelingen van het Geneeskundig Staatstoezigt in het jaar 1886* ('s-Gravenhage 1887) 11.

mortality rates were given for individual municipalities. This time the map was published by the Central Bureau of Statistics (NCBS)[25], which was established in 1899. It related to the years 1904-1908.[26] Although in later years specific attention was given to municipal data on infant mortality on several occasions, maps were no longer published by the NCBS.[27]

This job was taken over by *the Nederlandsche Bond tot Bescherming van Zuigelingen* (Dutch Society for the Protection of Infants). This Society, established in 1908, had as its objective 'to promote all that could be beneficial to the improvement of the living conditions of the infant'.[28] By publishing infant mortality maps, the Society tried to arouse interest in the 'shame of the high infant mortality in various places, a subject to which until now not sufficient attention has been paid'. In the opinion of the Society, maps were an excellent means of attracting attention and, in a series of pamphlets with telling titles, produced maps of NCBS municipal infant mortality rates. Those communities, which, in the opinion of the Society, had unacceptably high levels of infant mortality, were always depicted in striking colours. For the purpose of the 'practical fight' against infant mortality great value was attached to the maps: in this way 'almost automatically municipalities are grouped into areas with more or less infant mortality'. If blocks of municipalities appeared as areas with high infant mortality 'then it must be worthwhile to study, in a more detailed way, whether it is possible to elicit the causes of this and if so, whether these causes are constant and can be removed'. With the figures in mind, every municipality and local health committee could judge whether it compared favourably or unfavourably with municipalities that were in the same demographic or economic situation.[29] In a first brochure, which covered the years 1909-1913, infant mortality rates of more than 14 per 100 live births were still labelled as 'disgracefully high'. In the overview of the years 1914-1918 a more subtle view of the situation was given. The situation in municipalities where values of more than 16 per 100 were found was called the most alarming; a little bit less worrisome was the situation in municipalities where infant mortality rates were between 10.5 and 14 or 14 and 16 per 100 live births.[30] Several years later the standards were set even higher: alarming was now the situation in all municipalities with rates above 9 per 100

25. Methorst, *Geschiedenis van de statistiek*, 17-41.
26. CBS, *Sterfte van kinderen beneden het jaar in elke gemeente van Nederland, in elke provincie en in de 9 groepen van gemeenten van elke provincie, in de perioden 1880-1884 en 1904-1908.* Bijvoegsel tot de Sterftestatistiek over 1909 ('s-Gravenhage 1910).
27. See CBS, *Statistiek van de sterfte naar den leeftijd en naar de oorzaken van den dood over het jaar 1918* ('s-Gravenhage 1919). Aanhangsel. Cijfers over 1880-1884, 1904-1908, 1909-1913, 1914-1918; CBS, *Statistiek van de sterfte naar den leeftijd en naar de oorzaken van den dood over het jaar 1913* ('s-Gravenhage 1914) Aanhangsel. Cijfers over 1880-1884, 1904-1908, 1909-1913.
28 . N. Knapper, *Een kwart eeuw zuigelingenzorg in Nederland : uitgegeven bij gelegenheid van het zilveren jubileum van den Nederlandschen Bond tot Bescherming van Zuigelingen en Kleuters en ter bevordering der prenatale zorg* (Amsterdam 1935).
29. Nederlandsche Bond tot Bescherming van Zuigelingen, *Beschamende zuigelingen-sterfte* (Utrecht 1915).
30. Nederlandsche Bond tot Bescherming van Zuigelingen, *Nog altijd: Beschamende zuigelingen-sterfte* (Utrecht 1920).

but this group was again divided into four, according to the seriousness of the situation.[31] In 1930 a map was published showing infant mortality rates over the years 1924-1928 in which three categories of municipalities were distinguished. An in depth survey of infant mortality was recommended in particular for those municipalities that had figures higher than 10.5 per 100 live births.[32]

Historical mortality atlases: new initiatives

Historians of mortality have increasingly begun to question the value of national-level mortality data for explanatory purposes. In a recent special issue of *Historical Methods* on 'Spatial variations in mortality' Johansson and Kasakoff stress that until the first decades of the twentieth century the 'disease environment' and economic circumstances varied enormously from place to place.[33] That could lead to large differences in the expectation of life at birth between regions, of the order of 15-30 years.[34] In their opinion a national value of the expectation of life is not a measure that describes the experiences of the majority of the population but a statistical artefact. Regional differences in the level of mortality can make the use of national-level mortality data empirically misleading. Woods and Shelton argue that mid-Victorian England contained at least sixteen different disease environments that require separate historical treatment.[35] It would be a mistake to assume that one factor (be it improved nutrition or better water supply or public health measures) was equally relevant to the mortality transition in all these types of disease environments. Johannson therefore argues that in studying national-level mortality trends it has to become standard methodological practice to determine whether that trend is telling one coherent story about most ordinary lives in a large population or telling a collection of different stories.[36]

It is obvious that the growing awareness among historians of the importance of regional mortality differences has led to a renewed interest in mortality maps. Infant mortality rates at the municipal level can make a contribution to the discussion on a number of existing controversies relating to the nineteenth-century mortality transition. That applies for example to the effect of processes such as urbanisation and industrialisation on the European mortality transition. Knowledge of the regional differences in this process is important to gain an insight into the determinants of this social change and atlases are an excellent means of presenting this local variation in mortality levels and trends. The growing understanding that an atlas is a very useful tool for gaining an

31. Nederlandsche Bond tot Bescherming van Zuigelingen, *Dalende, hoewel nog niet bevredigende zuigelingensterfte (met een kaart)* (Utrecht 1924).
32. Nederlandsche Bond tot Bescherming van Zuigelingen, *Nog altijd dalende, hoewel nog niet bevredigende zuigelingensterfte (met een kaart)* (Utrecht 1930).
33. S.R. Johansson and Alice B. Kasakoff, 'Mortality history and the misleading mean', *Historical methods*, 33 (2000) 56-58.
34. R. Woods & N. Shelton, *An Atlas of Victorian Mortality* (Liverpool 1997).
35. R. Woods and N. Shelton, 'Disease environments in Victorian England and Wales', *Historical methods*, 33 (2000) 73-82.
36. S.R. Johansson,'Macro and micro perspectives on mortality history', *Historical methods*, 33 (2000) 59-72.

insight into regional inequality added to the enormously increased possibilities of geographic information systems - present-day geographic information systems make the time-consuming and expensive shading and colouring of maps superfluous and offer the user the opportunity to visualise in advance the effect that a map will have - has in several countries resulted in projects attempting to realise historical mortality atlases.[37] Recently an atlas was published showing mortality rates for all of the United Kingdom's Registration Districts for ten-year periods between 1850 and 1900, differentiated according to age, sex and cause of death.[38] In the Scandinavian countries atlases for infant and childhood mortality are in preparation.[39]

There are several reasons for focussing in particular on mapping the historical pattern of infant mortality. There is first of all the higher vulnerability of children in general, there being more markedly affected by changing regional circumstances. Furthermore, because children have no choice in their living and environmental conditions, mortality differences between children from different regions are generally regarded as even more unacceptable, than are those of an adult population. Unlike mortality at higher ages, which depends on the prevailing as well as on the past socio-economic situation of the persons concerned, infant and childhood mortality is solely dependent on the current situation of the child and its family. More practical factors play a role as well. In general there is a better access to death records for children, and a wider range of options for calculating death risks. In addition to that, the youngest age groups are usually more numerous, making it possible to calculate statistically more reliable figures than for higher ages. Furthermore, selection processes caused by the presence of health facilities such as hospitals in certain areas, leading to an overrepresentation of deaths in these areas, do not play an important role as far as children are concerned. Lastly, there is a very strong relationship between total mortality, expectation of life, and infant and child mortality in populations of the past. For example, of the total change in life expectancy between 1850 and 1999 in the Netherlands, 37% and 44% for females and males respectively was caused by the decrease in infant mortality (Van Poppel, 2000).

37. Geographic maps are still used frequently to present information on regional differences in mortality. These atlases are for example used to study the continuity of mortality rates across national boundaries and to evaluate the importance of national versus regional differences in mortality levels. Recent examples include the atlas of mortality by cause of death for geographic regions in more than 50 European countries, published by the WHO (WHO European Centre for Environment and Health, *Atlas of mortality in Europe: subnational patterns, 1980/1981 and 1990/1991* (Copenhagen 1997), and the atlas of mortality from avoidable causes of death for Central- and Eastern -Europe (P.E. Józan en R.Prokhorskas (eds.), *Atlas of leading and 'avoidable' causes of death in countries of Central and Eastern Europe* (Budapest 1997). On a national level mention can be made of two atlases dealing with regional differences in cancer mortality published in the past twenty years by the Dutch Central Bureau of Statistics (Centraal Bureau voor de Statistiek, *Atlas van de kankersterfte in Nederland, 1969-1978* ('s-Gravenhage 1980); Centraal Bureau voor de Statistiek, *Atlas van de kankersterfte in Nederland 1979-1990* ('s-Gravenhage 1992).
38. Woods & Shelton, *An Atlas.*
39. At the Demographic Data Base in Umeå an atlas of infant mortality for the Nordic countries at the "läns" (provincial) level for the period around 1870 is in preparation. In the individual countries several projects are going on which make use of more detailed data.

The construction of an historical mortality atlas for the Netherlands

In the Netherlands, a cartographic portrait at the municipal level, of the size and development of infant mortality over a long period of time can only be gained by consulting a large number of relatively inaccessible maps. Besides, the ways in which these maps depict mortality rates vary so markedly that comparability is absolutely out of the question. In addition we do not have maps of infant mortality rates for the period before 1880 and for the years between 1884 and 1904.[40] In the past two years an effort has, therefore, been made to construct one historical mortality atlas for the Netherlands as a whole. The atlas is intended to give a quick and easily accessible picture of the mortality pattern in the Netherlands in the nineteenth and the first half of the twentieth century. It will offer the opportunity to compare, at the municipal level, mortality rates in different periods and to relate these rates to each other. The atlas will make it easier for the researcher to trace specific factors that might have had an effect on the mortality in a given region.

The database for this atlas contains, for each and every single municipality in the Netherlands, the infant mortality rate (number dying under one year of age per 1000 live births) over the period 1841-1939.To achieve this an inventory was made of the available data on infant mortality at the municipal level. Unfortunately, published annual data were only available from 1880. It was therefore decided to use sources that give data for longer periods of time. Extending the time frame from periods of one to four or even twenty years has advantages as well: variations in levels and trends of mortality on the small scale presented here consist of a mix of real trends that carry information about social and economic change, and random fluctuations.[41] This applies in particular in smaller municipalities where small number problems can arise when short periods are studied. Adding together data for a longer period of time reduces the above-mentioned problems. In a later stage, the user can also combine contiguous municipalities with similar demographic, economic and cultural characteristics into larger regions to create more robust data sets with analytically meaningful sub-populations.[42]

The indicator for the infant mortality level used here is the number of infants who died before reaching one year of age per 100 live born children. Simple as this may sound, it needs some further clarification, because the method of notification of births and deaths in the Netherlands had specific consequences for this measure. Births had to be reported to the Registrar of the municipality in which they occurred. The registrar had to be notified within three days following the delivery. Deaths too had to be reported to the Registrar of the municipality in which they occurred. However, in the case of deaths no specific time within which notification had to take place was stipulated by law. Due to the fact that since 1869 no one

40. S. R. Johansson, 'Putting death in its place. A review essay' *Historical methods*, 32 (1999) 189-192.
41. A. Brändström, S. Edvinsson and J. Rogers, 'Infant mortality in Sweden: Creating regions from nineteenth-century parish data', *Historical methods*, 33 (2000) 105-114.
42. Brändström, Edvinsson and Rogers, 'Infant mortality'.

could be buried without a certificate filled in by the medical examiner or the attendant general practitioner, and that burial had to take place not later than five days after death, in practice, all notifications after 1869 occurred within a five-day period after death. In cases where the deceased person was a resident of a municipality other than in which death occurred, the registrar had to send a copy of the death certificate to the registrar of the municipality of residence of the deceased where it was then included in the death register.[43]

Whenever a child died before a birth certificate had been made out, or was stillborn, a special certificate was made out and entered in the death register. This certificate did not state if the child had lived. Children registered as stillborn were neither included among the live births, nor among the infant deaths, so that both the nominator and the denominator of the infant mortality rate are lower than they ought to be. As a consequence infant mortality rates underestimate the real level of the risk of dying of the newly born. The degree to which this was the case varied, however, over time and across regions. From 1924, live born children who died before notification were excluded from the stillbirths, and included among live births as well as infant deaths.[44] The infant mortality rates before 1924 thus differ from those published after that date.

After the data were entered in a database, maps were constructed. The intention was to realise a cartographic presentation that did justice to the municipal boundaries as they existed during the period to which the infant mortality rates refer. An essential part of the atlas therefore consists of a dynamic system with digitised boundary data making it possible to build a computerised map of the Netherlands with municipal boundaries that are correct for every single date between 1840 and 1939. This makes it possible to display accurately the enormous changes which took place in the boundaries of the Dutch municipalities during the past 150 years, a period during which the number of municipalities decreased from 1138 in 1840 to 1054 in 1939 (see Table 1). The nucleus of this system is a list with the names of all municipalities that have existed between these two dates and a list of geographic co-ordinates linked to these names. This mapping program originated within the Department of Economic and Social History of the University of Nijmegen (Dr. O. Boonstra).[45]

In calculating mortality rates for periods of more than one year boundary changes may affect the calculations. The standard solution chosen is to assume that

43. Since 1850 the vital registration classified deaths according to the place of residence of the deceased; for births, the distinction between children born of parents who had their usual residence in the municipality and children whose parents had residence elsewhere was introduced in 1860. The system was not operating perfectly during the first decades, leading to inconsistencies in the regional data.
44. In fact, the new classification system had already started in 1917, but the NCBS continued publishing information on stillbirths, infant deaths, and live births according to the old and new definition of stillbirths for several years. According to the NCBS estimate, 'old' numbers of stillbirths in the years 1917-1923 contained about 68% of foetal deaths and 32% of live born children who had died before notification.
45. O.W.A. Boonstra, 'Over computers, cartografie en de expliciteringsplicht bij kwantitatief historisch onderzoek' in: *A.A.G. Bijdragen 28, Dertig jaar afdeling Agrarische Geschiedenis* (Wageningen 1986) 43-56.

the boundaries as they existed at the end of the period apply to the whole (four-, -five- or ten-year) period under study. Numbers of infant deaths and numbers of births thus correspond with the municipal boundaries at the end of each period.

Infant mortality in the Netherlands: regional variation

Table 1 summarises the changes in the regional variation of infant mortality rates by presenting some simple descriptive statistical measures of dispersion and central tendency. The table shows that the level of infant mortality started to decrease after 1884, when for the first time the (weighted) average fell to below 18 per 100 and declined markedly after 1903. Also, the differences between the more than 1000 municipalities decreased continuously, most notably after 1884.

Table 1. Main indicators of municipal infant mortality rates, 1840-1939

	Period								
	1840-61	1861-74	1875-84	1885-94	1895-1903	1904-13	1914-23	1924-33	1934-39
Mean	18.24	19.61	18.49	16.37	14.84	12.17	8.72	5.85	4.16
Median	16.62	8.53	17.49	15.76	14.41	11.49	8.11	5.49	3.95
Stand. dev.	7.28	7.03	6.39	5.19	4.44	4.28	3.26	2.18	1.76
Range	36.66	40.67	38.66	31.42	31.53	28.69	21.79	14.46	14.99
Minimum	4.68	6.73	5.70	3.27	5.10	1.54	0.00	0.00	0.00
Maximum	41.34	47.40	44.36	34.69	36.63	30.23	21.79	14.46	14.99
N	1138	1129	1124	1123	1121	1120	1083	1076	1054

To illustrate the potential use of the historical mortality atlas, four maps are presented. These maps display the enormous variation in the death risks of the newly born in the middle of the nineteenth century, and the changes in this pattern, which took place in the late-nineteenth and early-twentieth centuries. To ease the interpretation, Map 1 presents the provincial boundaries and names of the provinces and the names and location of some of the main cities.

Map 2 displays the regional differences in infant mortality in the period 1841-1860, a period during which, in the country as a whole, 18.9 per 100 live born children died in the first year of life. The map shows a clear dichotomy existing till the beginning of the 1880s. In large parts of the western Netherlands (almost the whole province of Zeeland, the province of Zuid-Holland - excepting the coastal municipalities - the southern part of the province of Noord-Holland and the most western part of the province of Utrecht), infants had a one in four chance of dying within a year after birth. In 7% of all municipalities the IMR was higher than 30%. These municipalities were, without exception, in Zuid-Holland (40), Zeeland (27), Utrecht

(12) and Noord-Holland (6). Infant mortality rates were very low in the eastern part of Friesland, the western part of Groningen, in Drenthe, in the eastern part of Overijssel, in parts of Gelderland, in the southern part of Noord-Brabant and in northern Limburg. Here less than 10% of all live born children died before reaching age one. Not a single municipality in Zuid-Holland or Zeeland was below this value and only two in Utrecht and one in Noord-Holland. How large the differences between the West and large parts of the North, East and South of the Netherlands were, becomes clear when one realises that the figures which were common then for these last-mentioned regions (around 10%) were only reached by the country as a whole after 1912. Thus, large parts of the North, East and South of the Netherlands were 50 years ahead of the West of the country.

In the last decades of the nineteenth century this regional pattern had changed considerably and the contours had become visible of the regional pattern of mortality that still exists today. Map 3 displays the changes that had taken place by the end of the nineteenth century (period 1895-1903). The IMR had fallen nationally to a value of 14.8 per 100 live births. The general decrease of mortality went hand in hand with a lessening of the differences between the regions, without, however, implying the disappearance of these differences. On the one hand the western part of the country can be seen to have improved its position. Now it was mainly the western parts of the province of Utrecht and parts of Zeeland, which still experienced high IMRs, but other parts of the West, such as Zuid-Holland, now had much lower ones. On the other hand, the eastern part of Gelderland now had a relatively high IMR. The most remarkable differences occurred, however, in the provinces of Noord-Brabant and Limburg. Contrary to the situation 35 years earlier, a large band of municipalities in the northern part of Noord-Brabant now showed high death risks for children and the same applied to the southernmost part of Limburg.

Map 4 presents municipal values of the IMR for the period 1934-1939, a period during which the rate for the country as a whole had fallen to 3.8 per 100 live births. The western and especially the northeastern part of Noord-Brabant; the neighbouring part of northern Limburg; southern Limburg and parts of Gelderland now strike one by their relatively high mortality. Municipalities in the provinces of Zuid-Holland, Noord-Holland, Zeeland and the western part of Utrecht now have the lowest IMR with Friesland maintaining its favourable position. A considerable number of municipalities in Zuid-Holland and Zeeland had an IMR below 2 per 100 live births, a level that the country as a whole reached only in the 1950s. In 123 municipalities the IMR was still above 6 per 100, the level that the country as a whole had permanently left behind in 1926. Of these municipalities, 44 were in Noord-Brabant and 32 in Limburg whereas only 27 municipalities in Zeeland, Utrecht, Noord- and Zuid-Holland were in this category.

Explaining regional differences in infant mortality

It stands to reason that numerous studies have been devoted to the underlying causes of the regional mortality differences in the Netherlands.[46] Debates have mainly focused on the situation in the middle of the nineteenth century and in particular on the unfavourable position of the West in that period. De Vooys explained this position by, among other things, the high incidence of malaria (which did not cause many deaths but did have a deleterious effect on human health), by the low incidence of breast-feeding and the early adoption of regular feeding.[47] In areas dominated by non-agrarian employment for women and in areas where field labour for women was common, mothers were not in a position to schedule their own time and were often too far away from home to be able to breast-feed their babies.[48] The poverty in the old Dutch cities, insufficient nourishment in the cities and countryside, and the poor quality of drinking water also played a role. Hofstee indeed emphasised the salinisation of the surface and ground water in the western part of the Netherlands, this salinisation occurring wherever seawater could penetrate inland.[49] Salinisation could result in a lack of water acceptable for household purposes (washing the body, clothes, the house, and other objects). The use of contaminated surface water had particularly dire consequences for babies and infants. Where infants were bottle-fed, the quality of the water was important for cleaning bottles, nipples, and other eating utensils, for making gruel, and for thinning milk. There was not enough rainwater in the cities and the rural areas in the West, with their dependence on well water, often had the same problems as those using surface water. By contrast, in the East and South of the contrary, good ground water was generally available in wells.[50]

The earlier onset of the mortality decline in the western part of the Netherlands was ascribed to the fact that a modern cultural pattern, characterised by a rational outlook on life and a modern attitude towards medical care and personal hygiene, was

46. We mention here E.W Hofstee, 'Geboorten, zuigelingenvoeding en zuigelingensterfte in hun regionale verscheidenheid in de 19e eeuw', *Bevolking en gezin* (1983)2 suppl., 7-60; E.W. Hofstee, *Korte demografische geschiedenis van Nederland van 1800 tot heden* (Haarlem 1981); F. van Poppel, 'Religion and Health: Catholicism and Regional Mortality Differences in 19th Century Netherlands', *Social History of Medicine* V (1992) 229-253; C. Vandenbroeke, F. van Poppel & A.M. van der Woude, 'Le développement séculaire de la mortalité aux jeunes âges dans le territoire du Bénélux', *Annales de démographie historique* 1983 (Paris 1984) 257-289; J. Wolleswinkel-van den Bosch, *The epidemiological transition in the Netherlands* (Rotterdam 1998).
47. A.C. de Vooys, 'De sterfte in Nederland in het midden der 19e eeuw. Een demogeografische studie', *Tijdschrift van het Koninklijk Nederlandsch Aardrijkskundig Genootschap*, 8 (1951) 233-271.
48. Vandenbroeke et al., 'Le développement séculaire'.
49. E.W. Hofstee, *De demografische ontwikkeling van Nederland in de eerste helft van de negentiende eeuw. Een historisch-demografische en sociologische studie.* (Deventer, 1978).
50. P.C. Jansen ('Demografie in Nederland', *Kleio* (1979) 20, 353-357) also attributes a large influence to water quality but, in addition, emphasises that a very dense population in the West, mainly packed together in cities, depended on the unfavourable market situation for their food.

introduced sooner and more rapidly there (and in the North) than in the East and South. This led to a greater openness to information in the medical and hygienic domain; to confidence in scientific findings and in doctors; to the rejection of home remedies, traditional folk medicine or traditional nutritional habits; and to an affinity with clubs and organisations aimed at improving public health. Thus, 'hygienic awareness', based on the knowledge of the benefits and significance of many types of hygienic measures, was the key concept. The reason why the modern-dynamic cultural pattern was introduced sooner in the West and North was because the coastal provinces were more open to cultural influences from other countries; were more urbanised; had a relatively well-developed transportation network (waterways); had contacts with other countries via their seaports, and were engaged in agricultural activities that were highly market-oriented. The South and East had more *closed* communities in which farming was self-sufficient and which had little contact with surrounding communities. Life was controlled by traditional standards and morals maintained by strict social control. The modernisation of the socio-cultural situation only took place when self-sufficiency made room for agrarian market production and modern transport, modern education, and modern mass communication developed.[51]

Other authors have argued that the main factor in mortality decline in the West was the increased resistance to contagious diseases, brought about by the improvement in nutritional conditions.[52] The economic revival, which occurred after 1875 in the West, made an increase in the consumption of primary foodstuffs possible. This increase was also related to the repeal of milling and municipal excise, reduced unemployment, and falling prices resulting from the agricultural crisis.

In a recent study by Wolleswinkel, Roman Catholicism turned out to be significantly associated with higher infant mortality rates in 1875-79, and this association became stronger in 1895-99, in particular for infant mortality from convulsions and acute digestive diseases.[53] The authors argued that this association was due to less frequent breastfeeding. Female employment was, in most cases, associated with low infant mortality and this suggests that the positive effects of increased household income were more important than its negative effects such as less breastfeeding or reduced childcare. As far as the effect of public health is concerned, infant mortality did not show the expected association between a high percentage of the population having access to clean drinking water and low mortality rates. An increase in the percentage of the population with access to piped water was associated with more rapid mortality declines. The results for *medical care factors* were either not significant or the association was not in the expected direction.

51. E.W. Hofstee, 'Regionale sterfteverschillen' in: Vereniging voor Demografie, *Differentiële sterfte* (Den Haag 1958) 9-21.
52. J.A. de Jonge, *De industrialisatie in Nederland tussen 1850 en 1914* (Amsterdam 1968); P.C. Jansen & J.M.M. de Meere, 'Het sterftepatroon in Amsterdam 1774-1930. Een analyse van de doodsoorzaken' *Tijdschrift voor sociale geschiedenis* (1982) 8, 180-223; Jansen, 'Demografie'.
53. Wolleswinkel-van den Bosch, *The epidemiological transition.*

Conclusion

It is important to realise that the current atlas differs in several respects from the nineteenth-century atlases, notably in its aims, the method of investigation, the use of sources and the results of the studies based upon it. The nineteenth-century atlases were inspired by the medical doctors (in particular those belonging to the hygienist movement) organised in the Dutch Society For the Improvement of Medical Science (N.M.G). With the help of the atlas, and the 'biometer' it depicted, the hygienists attempted to set in train a scientific as well as a social programme. They tried to discover the epidemiological pattern and the aetiology of diseases in a miasmatic context, whilst, at the same time, improving the position of their own professional group. In contrast, the mortality atlas presented here stems from the work of late-twentieth-century historical demographers. Secondly, it is not the use of the atlas as a health-policy device that is central here, but the benefits it has for social history and historical-demographic research. Thirdly, whereas the hygienists tried to find patterns in the mortality regime of the period in which they themselves were living, the present atlas has a retrospective aim and covers a long period of time: 1840-1939. The most important difference between the two traditions, however, lies in the perspectives they offer. For whereas the hygienists wished to ascend from medical topography and the local biometer to etiological generalisations, the aim of the current historical mortality atlas is precisely the opposite, namely to stimulate the researcher to descend from generalisation to the local context, and to track in this way the subtle demographic dynamics. Finally, the type of explanations for which nineteenth-century atlases were used also differs from those for which the historical mortality atlas is mainly suited. For whereas the nineteenth-century atlases in particular were founded on an internal-medical explanatory framework, in which miasma and hygiene were key concepts, the main use of the historical mortality atlas will be in the study of the historical development of public health in the Netherlands. It is in particular the study of the effect of more general historical processes on mortality, such as industrialisation, urbanisation, economic depression and recovery, women's labour market participation etc. that might benefit from the information supplied in the atlas.

This overview of some of the outcomes of the historical mortality atlas has clearly shown that even in a small, homogeneous country like the Netherlands large differences in the levels of infant mortality can be found between regions. This has implications for the historical study of mortality and for the study of social history in general.

The maps presented here make clear that municipal mortality rates offer a much more subtle picture of the regional mortality pattern than the commonly used provincial figures. This judgement applies not only to the size of these differences in the middle of the nineteenth century but also to the identification of forerunners and backwaters in the mortality transition. The maps show that it is hardly possible, so far as infant mortality is concerned, to speak of 'the mortality decline in the Netherlands'. The pulverisation of this old idea might be useful in looking for the factors responsible for the mortality decline in the various regions, each with its own weight.

Without knowledge of the health situation of ordinary people and the variation in this situation over time and space it is impossible to reconstruct the living environment and the daily life of historical populations. After all, sickness, physical handicaps and death were essential and integral elements of life that had enormous consequences, not only for the person who became ill, injured or died, but also to persons in the household and the larger community. It brought about large changes in income and consumption, it reallocated labour within and outside the household, and caused the dissolution of households etc.[54] Where one lived had a great bearing on when and how one died. By introducing this regional variation in mortality, our knowledge of the historical variation in living conditions can be increased considerably. In this context it has to be stressed that it is not only interesting to focus on areas of excessive mortality. It might sometimes be even more valuable to direct attention at areas of low infant mortality because they confirm the idea that, even before the bacteriological discoveries of the late nineteenth century had an impact, certain population groups were able to offer a healthy and safe environment to their new-born children. The maps then, might also be useful for the evaluation of the effect of medicalisation. Although one could argue that the infant mortality rate is not a very sensitive indicator of the effectiveness of public health reforms in general, it certainly is so for those programmes that focussed specifically on the health of mothers and children.

Finally, historical atlases also have great value for research into the present-day pattern of regional mortality differences, as in many countries there exists a remarkable continuity in these regional patterns, even though the size of these differences has weakened over time. Historical knowledge of the origin and development of these regional mortality differences can be of great importance in locating the factors behind such differences.[55]

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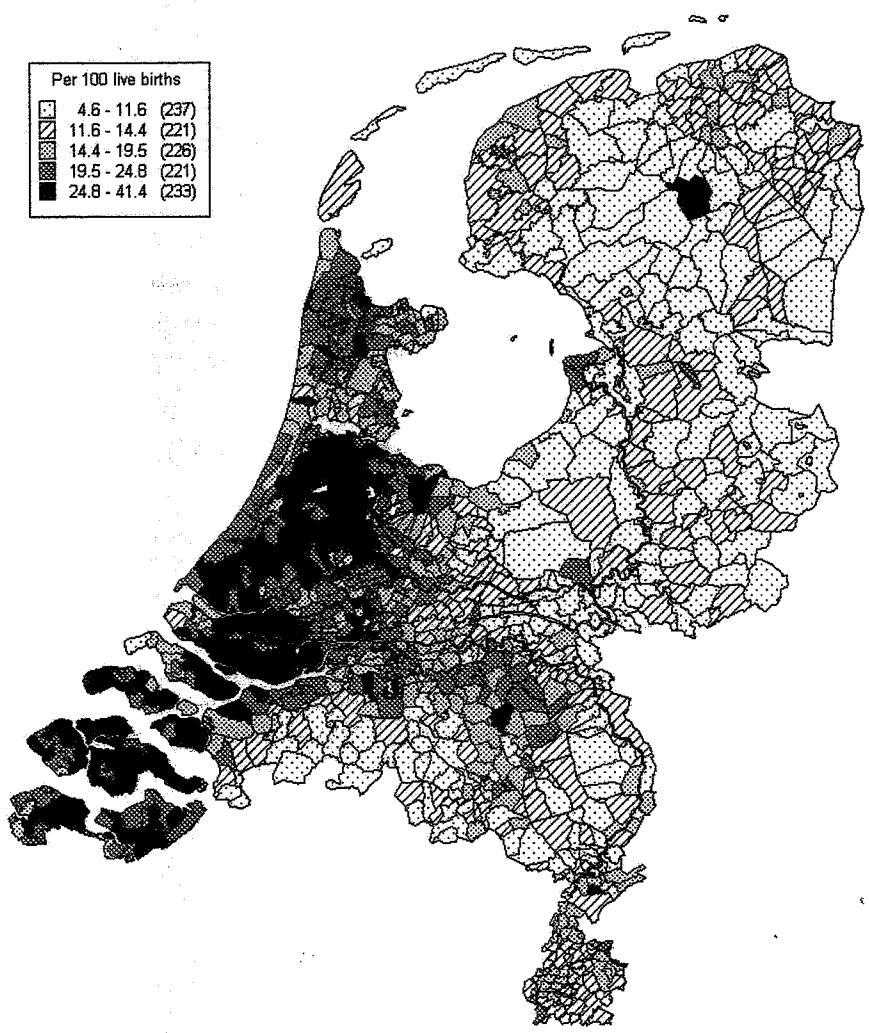
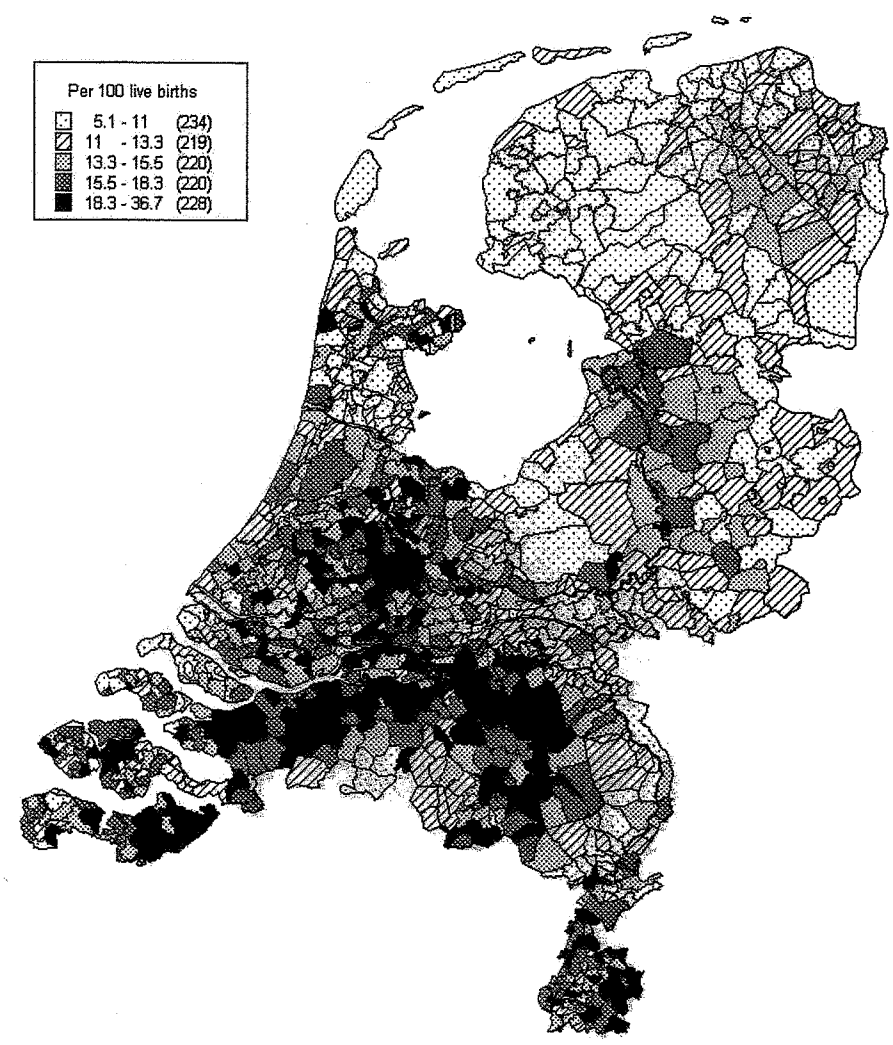
54. M. Over, R. P. Ellis, J.H. Huber en O. Solon, 'The consequences of adult ill-health', in: R. G. A. Feachem et al. (eds.), *The health of adults in the developing world* (New York 1992) 161-208.
55. See for example J.A.M. van Oers, H.T. Kroesbergen, B.P.M. Bloemberg, R. da Costa Senior and S.A. Reijneveld, 'Geografische gezondheidsverschillen', in: J.P. Mackenbach en H. Verkleij (eds.) *Volksgezondheid Toekomst Verkenning 1997; II: Gezondheidsverschillen* (Maarssen 1997) 267-301.

Map 1. Map of the Netherlands, showing provincial boundaries and location of main cities

Map 2. Infant Mortality Rates (per 100 live births) by municipality, Netherlands 1841–1860



Map 3. Infant Mortality Rates (per 100 live births) by municipality, Netherlands 1895–1903



Map 4. Infant Mortality Rates (per 100 live births) by municipality, Netherlands 1934–1939