

# Linnaeus: alive and well

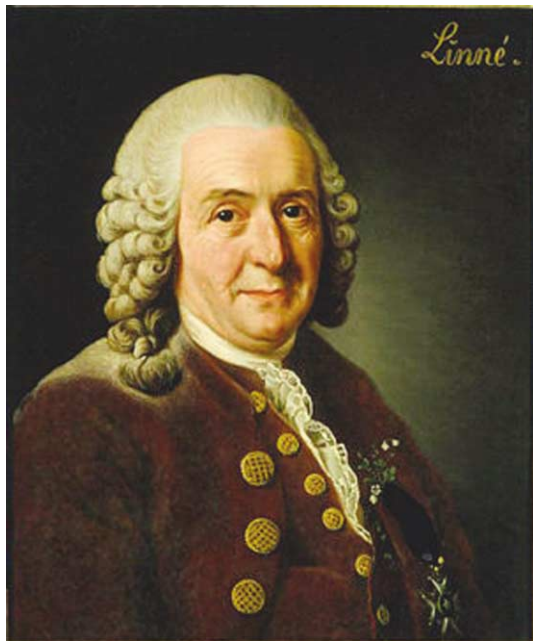
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Carl Linné, more widely known as Carolus Linnaeus, died in 1778 but his spirit lives on in the many classification systems he developed, as well as in a more recent Swedish innovation, the Linnaeus Database (1), a major contributor to an understanding of ageing from a life course perspective. Linnaeus is widely regarded as the founder of modern taxonomy, responsible (in 1735) for introducing the concept of hierarchical ordering of botanical and zoological classification.



*Alexander Roslin's portrait of Carl von Linné from 1775.*

Although new ways of measuring and categorising natural sciences were developed long ago, very little was then known about the health of populations. Sweden, in the tradition of Linnaeus, has categorised all deaths in its population by cause, age, and sex to observe trends in mortality; the first annual summary tables were presented almost 250 years ago in 1756 (2). The allocation of a unique

personal number to all Swedish citizens and in-migrants facilitated a national database that is envied by many countries still grappling with the difficulty of accurately assessing basic aspects their population's health.

National hospital registers can be a useful resource for epidemiological research (3), but few have a personalised registration number to allow linkages to national vital statistics. Sweden, prompted by the development of new multidisciplinary approaches to research as part of the Ageing and Living Conditions (ALC) programme established at Umeå University in 2006, is now favoured with a demographic database for longitudinal analyses of health status, cognitive functioning, and socio-economic conditions in the ageing population.

The Linnaeus database, established in 2009, encompasses socio-economic and demographic information taken from registers administered by Statistics Sweden (vital statistics) and the National Board of Health and Welfare (hospital in-patient data and discharge diagnoses). It includes annually updated information about family networks, mobility, employment, retirement, and residence for the entire Swedish population for the period 1990 to 2006 (more than 12 million individuals); it is planned to extend this from 1986 to 2008. In addition, two important databases have been added and linked. The first relates to a large population-based health screening programme spanning two decades, the Västerbotten Intervention Programme (VIP) owned by Västerbotten County Council (4). This large population-based screening programme provides additional information on self-reported health, quality of life, social support, and networking as well as a wide range of behaviours such as tobacco and alcohol use and physical activity patterns for over 89,000 people since 1985. The second database known as the Betula Database, developed in 1988 by the Department of Psychology at the University of Umeå (5), further expands the range of information by including details on 4,500 individuals on daily living, critical life events, and cognitive functions related to aspects of the development of memory function and health in adult and late life. The data from these two registers were sent to Statistics

Sweden for linkage using personal identification numbers into national databases and subsequent anonymisation, resulting in strongly linked but non-identifiable individual data being available – under strict conditions – for use by researchers associated with the University-wide ALC programme. The Linnaeus Database also includes everyone covered in the national censuses for 1960, 1970, 1980, and 1990 with similar, but less detailed information (1). The full data set contains 55 million records.

Because of obvious security concerns, the Linnaeus Database contains no personal names, personal identity numbers, addresses, or other identifiers that can be linked to real people. The data are preserved in a secure data server at the Centre for Population Studies in the University of Umeå; the data server and researchers who use it are only connected through a closed network. This is both a strength and a limitation. As such, it is not a public database, but rather one restricted to use by bona fide researchers who follow strict protocols as to its use.

There are other important databases in Europe, some of them accessible to the public, but many have as their prime interest benefit:risk ratios of pharmaceuticals, drug safety, adverse events, and rare diseases; many are funded by the pharmaceutical industry. One such network led by the European Medicines Agency is the European Network of Centres for Pharmaco-epidemiology and Pharmaco-vigilance (ENCePP, <http://www.encepp.eu/>), provides a database of European Union research centres and networks with expertise in pharmaco-epidemiology and pharmaco-vigilance.

Only one of the accessible patient registers, the General Practice research database operating in the United Kingdom, offers longitudinal data linked to other health care data sources. Described as the world's largest computerised database of anonymised longitudinal medical records comprising four million patients from 500 practices, it is useful, especially for the pharmaceutical industry, for investigating drug utilisation and treatment patterns, but is unable to address interdisciplinary questions related to the changing impact of social and economic phenomenon on population groups or population processes such as ageing. Most of the available data sources are based on voluntary reports such as adverse events, prescription monitoring, disease registries, administrative databases, primary care electronic patient

records, or pharmacy dispensing databases. Efforts to work collaboratively to expand the denominators of these disparate sources are hampered by different formats, definitions, variability in quality of data entry, let alone cost of access for research purposes.

At a time when many countries, especially in Europe, are facing the challenges of population ageing, the Linnaeus Database provides a vital source of longitudinal data for multidisciplinary research on ageing cohorts for a wide range of disciplines (medicine, social sciences, and the humanities) to investigate how aspects of living conditions such as economics, society, health, and cognition interact and shape the experience of successful ageing. Its ability to scrutinise the trends in care and support burdens in different geographical contexts makes this an invaluable investment for Sweden in general and Swedish researchers in the ALC programme and their collaborators in particular. The challenge will be to balance the necessary security and access restrictions with an environment conducive to researchers so that they might fully exploit the riches of the legacy of Linnaeus and observe the experience of ageing in a way that enlightens our societal responses.

## References

1. Malmberg G, Nilsson LG, Weinehall L. Longitudinal data for interdisciplinary ageing research. Design of the Linnaeus database. *Scand J Public Health* 2010; 38: 761–7.
2. Sköld P. The birth of population statistics in Sweden. *Hist Fam* 2004; 9: 5–21.
3. Vestergaard M, Obel C, Henriksen TB, Christensen J, Madsen KM, Ostergaard JR, et al. The Danish National Hospital Register is a valuable study base for epidemiologic research in febrile seizures. *J Clin Epidemiol* 2006; 59: 61–6.
4. Norberg M, Wall S, Boman K, Weinehall L. The Västerbotten Intervention Programme: background, design and implications. *Glob Health Action* 2010; 3: 4643–4.
5. Nilsson L-G, Bäckman L, Nyberg L, Erngrund K, Adolfsson R, Bucht G, et al. The Betula prospective cohort study: memory, health, and aging. *Aging, Neuropsychology and Cognition* 1997; 4: 1–32.

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