STATISTICAL METHODS USED FOR IDENTIFYING DEMENTIA AND MILD COGNITIVE IMPAIRMENT

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Abstract

Population ageing belongs to the most discussed topics and main challenges of the 21ˢᵗ century. As people are getting older, their health status is affected by diseases of circulatory system, respiratory system and increasingly by nerve system. The main objective is to identify whether symptoms such as memory loss are related to normal ageing or to decline in cognitive functions, which is the key feature of dementia. In the identification of people with dementia little attention has been paid to statistical methods and approaches that may contribute to early diagnosis and identification of dementia. For example, logistic regression helps to explain which characteristic or variable is an important criterion for dementia. Submitted article deals with the statistical methods, such as logistic regression, multiple logistic regression, used for identifying dementia and mild cognitive impairment.

Key words: Cognitive Impairment, Dementia, Logistic Regression, Population Ageing, Statistical Methods

JEL Code: I1, J14

Introduction

Populations around the whole world are getting older. This process has been observed for approximately the last 50 years and it is becoming more and more noticeable. It is also a well known fact that the pace of changes has intensified recently and it is predicted that it will continue gaining momentum in the future, thus further worsening the current situation. From certain point of view, this dynamic evolution means that recent declines in fertility rates and increases in life expectancy are causing a significant shift in the global age structure. The median age of the world's population increases from 26.6 years in 2000 to 37.3 years in 2050 and then to 45.6 years in 2100 (Lutz, Sanderson, & Scherbov, 2008). The number of people age 60 and more is estimated to reach 1 billion by 2020 and nearly 2 billion by 2050, encompassing 22 percent of the world's population (Bloom, Canning, & Fink, 2011). Therefore, it means several implications for economic growth.

It is especially a threat to social or health system due to increasing expenditures which are necessary to keep up with the issue. The welfare state, for example, cannot be longer based on a life course that matches this current experience. In the past, many people did not survive to enjoy their pensions and welfare systems coped reasonably well. Nevertheless, future outlook does not seem to be positive in this respect. There is a need for improved health which enables older people to remain in work for longer and allows them to enjoy better their eventual retirement. Healthier lives can slow the progress of many disorders or diseases (Doyle, McKee, Rechel, & Grundy, 2009). Prevention of cognitive decline or dementia is thus one of key features required to solve this issue.

Moreover, current research connected to investigation of ageing shows that good health of elderly persons affects not only the quality of their lives or potential longevity, but also their work performance. Some research shows the importance of cognitive abilities and offers different and inconsiderable insight into labour market. For example, the construct of general mental ability (GMA), introduced more than 100 years ago, has regained interest and attention in recent decades. Current findings about GMA confirm that mental ability is in fact the most important performance factor which affects occupational level attained and job performance, although the opposite is generally assumed. Other traits, particularly personality traits, specific aptitudes, and even the job experience are ranked among less important determinants than mental or cognitive abilities as implied by certain studies (Schmidt & Hunter, 2004). Of course there is some variability concerning the mental and cognitive abilities of each person, but certain statistical methods may therefore be one of the way how to diagnose and identify some serious diseases like dementia in its early stages and contribute to better overall health status of elderly persons.

1   The old age cognitive decline

The ageing and the old age itself is often connected with general decline. As for the cognitive functions, decrease is regarded as inevitable and consequences of this presumption are obvious. The majority of elderly people complain about forgetfulness and decreased concentration, and this compromises their quality of life. These complaints are based upon objective changes in cognitive function, as it is well established that virtually all aspects of cognitive functioning deteriorate with age (Riedel, 1995).

Some cognitive skills like autobiographical or semantic memory remain stable or even improve with age, but decline affects for example the memory performance, adaptability or perception, although not all people show the same level of cognitive deterioration through time. While cognitive performance was assumed to be worse in the elderly compared to their younger counterparts, the same comparison between age groups revealed that elders present more variability in cognitive performance. (Lupien & Wan, 2004).

Nevertheless, this is one of the reasons why the negative demographic trend and the issue of ageing requires increased attention. Ageing itself has been traditionally described from a negative perspective both by the scientific community and the general public alike. Gerontology (the science of ageing) can be traced back to the early 1900s when Stanley Hall and Lillian Martin advocated shifting the study of psychology from the early stages of life towards the later stages of life (Lupien & Wan, 2004). Many contemporary authors also argue that age is the biggest risk factor for the development of dementia and neurocognitive frailty is the biggest threat to successful ageing in the society (Park & Reuter-Lorenz, 2009). Dementia itself is consequently one of the most common causes of disability among older people and it can affect life of older people on daily basis. Maintaining the good level of cognitive skills and functions is thus essential for quality of life.

1.1 Prevalence and connection between mild cognitive impairment and Alzheimer's disease

As mentioned above, dementia is considered to be the most prevalent neurodegenerative disease of old age and one of the major concerns in present world. The prevalence of dementia has increased during just the few past decades and it is estimated that while 13.5 million people suffered from dementia in 2000, the number will rise to 21.5 million in 2025, and 36.7 million in 2050 (Xie, 2011). Moreover, it is leading cause of disability and dependency in later life in most developed countries. It accounts for 5% of the years lived with disability in high-income countries. It also accounts for 2.6% of deaths in high-income countries making it the seventh most common cause of death (Lopez, Mathers, Ezzati, Jamison, & Murray, 2006).

Alzheimer's disease is the most common form of dementia, which accounts for 50-70% of all cases of dementia (Riedel, 1995). In this respect, it is Alzheimer's disease which is connected to various intellectual or memory functions, especially to deficits in episodic memory, working memory, and executive function. More specific examples include poor selective and divided attention or poor manipulation skills.

As disease progresses, the symptoms are becoming more observable and serious. In addition to inconsiderable mental and physical suffering, that also means greater burden to patients themselves, caregivers, and consequently to health system in terms of costs. Earlier identification of Alzheimer's disease and faster prescription of corresponding therapy or drugs would definitely lead to delaying the development of disease.

Apart from some sudden decrease in cognitive performance caused for example by stroke, there is a gradual drop during life which accelerates with advancing age. Therefore, there is ambiguous borderline between normal and pathological cognitive aging. More recent research thus investigated the importance of mild cognitive impairment (MCI). There are some other concepts, but MCI has become widely accepted and used in research in recent times. MCI is defined as transitional state between normal aging and dementia. Not all MCI cases will later develop into Alzheimer's disease, but there is a strong link between both diseases. It is estimated that MCI has approximately 17% prevalence in the population and about 50% of those with MCI progress to some kind of dementia within 5 years (Rockwood, Howard, Macknight, Darvesh, 1999). MCI can last many years before its manifestation or progression into Alzheimer's disease, working as its precursor. It is characterised by cognitive performance that is below the expected level for age and education, but that does not significantly affects common daily activities. Memory problems are most prevalent, but it can also affect language, attention or executive function (Petersen, Smith, Waring, Ivnik, Tangalos, & Kokmen, 1999). In other words, patients in this early phase may exhibit some mental issues, but these are insufficient to confirm the diagnosis of Alzheimer's disease. MCI is a critical period during which cognitive therapies could have beneficial effect and it was proved that working memory and executive function decline during MCI period (Kirova, Bays, & Lagalwar, 2015).

1.2   Dementia prevalence according to different studies

Age-specific estimates of dementia have been more consistent worldwide with a predicted exponential increase in dementia with age. Prevalence studies indicate that dementia doubles approximately every 5 years after the age of 65 (Jorm et al. 1987). This increase is more significant for females for whom prevalence is higher in the oldest-old compared to males. Results of prevalence rates of dementia differ according to different meta-analysis.

Comparison of prevalence rates according to age-specific prevalence meta-analysis, Matthews and Brayne (2005) and prevalence estimates from Knapp *et al.* (2007) can be found in the Tab. 1.

Tab. 1: Prevalence rates of dementia after the age of 60 years

	Jorm et al. 1987	Ritchie et al. 1992	Hofman et al. 1991	Matthews and Brayne 2005	Knapp et al. 2007
60-64	0.7	–	–	1.5	1.3
65-69	1.4	1.3	1.4	2.6	2.9
70-74	2.8	2.4	4.1	6.3	5.9
75-79	5.6	4.4	5.7	13.0	12.2
80-84	10.5	8.1	13.0	25.3	20.3
85-89	20.8	14.9	21.6	–	28.6
90-94	38.6	27.3	32.2	–	32.5
95+	–	50.2	–		–

Source: Stephan, B., Brayne, C. Prevalence and projections of dementia

Fig. 1: Prevalence and projection of prevalence of dementia in 2020 and 2040
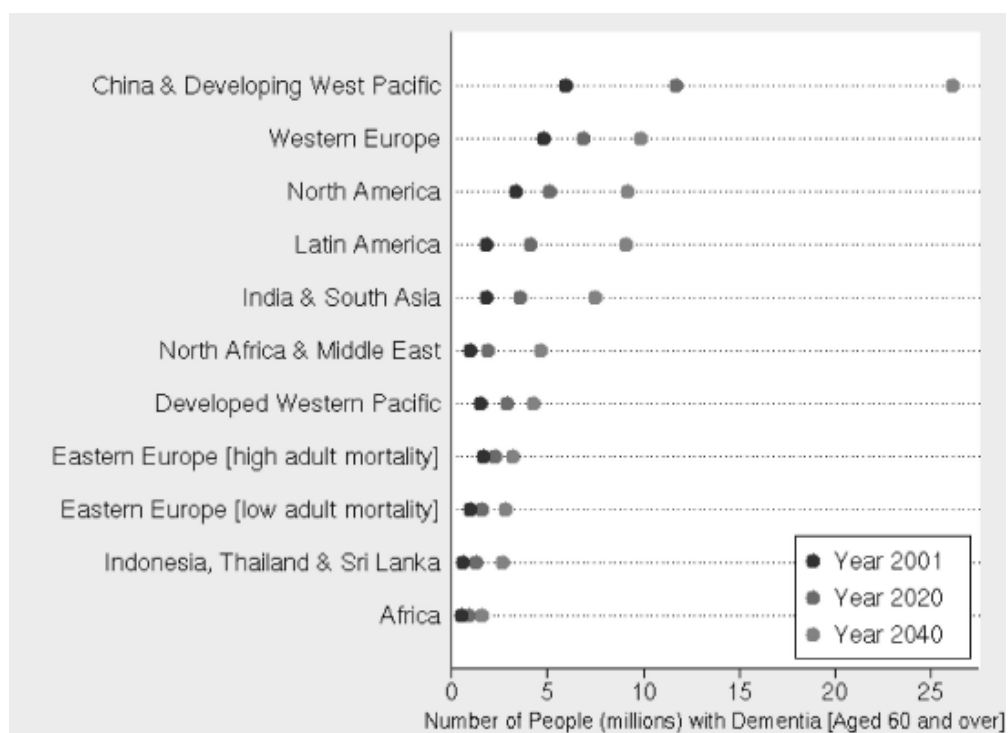
Source: Ferri *et al.* (2005), in: Stephan, B., Brayne, C. Prevalence and projections of dementia

Projections of demented people (in millions) in 2020 and 2040 in different regions are shown in the Fig. 1. From results it is visible that Europe (mainly Western Europe) will face to a rapid increase of demented people until 2040. Increase in the number of demented people is strongly influenced by the increasing number of old people who survive to very high age groups.

Conclusion

Dementia and mental disorders epidemic will remain as highly and advanced explored research areas. In the following years, it is going to be the collective task of researchers to collaborate, share and discuss the possible solutions, innovations, developments, results, theories that may help in improvement of AD treatment. According to projections for the Czech Republic in 2050, the number of seniors aged 65-74 years will increase by 50%, the number of seniors aged 75-84 years will grow by almost 94% (Stejskal, 2014). It is highly urgent to take into account the high current and future treatment costs of dementia and other mental diseases.

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