STATISTICAL METHODS FOR THE DETECTION OF INFECTIOUS FOODBORNE DISEASES

Ladislav Mura – Lucia Zeleňáková – Jana Žiarovská - Ľuboš Török – Martin Boďa

Abstract

The high quality and safety of food must be of primary interest not only for food producers, but also the state, as foodborne diseases are most commonly of infectious origin. Epidemiologists focus on the detection of diseases from the point of view of its agent; therefore, the aim of this presented article is written through applied statistical methods for the detection of infectious foodborne disease incidences and the analysis of change in their epidemiology. Within the framework of the international activities in the field of alimentation diseases and zoonoses on the European level, the Slovak Republic cooperates with the EU, the WHO, the EFSA and mainly with the ECDC based in Stockholm. Apart from sending data to the TESS (a European surveillance system), the implementation of tasks is guaranteed by an individual European programme known as the FWD. For the statistical analysis of the epidemiological infectious foodborne diseases incidence it was necessary to gather the required factual material which was acquired from secondary information sources. As the result, it has been proven that the most frequent infectious food borne diseases agents are campylobacterioses and salmonella.

Key words: statistical methods, statistical analysis, infectious diseases, food

JEL Code: C19, C49, L66

Introduction

Milk and dairy products maintain their main role in the healthy diet of the modern man. [4] These products are characterised by typical sensorial features, original and well-balanced content and a wide spectrum of essential components necessary for a healthy diet and disease prevention. The unique combination of vitamins and mineral substances in milk cannot be found in any other food. [8]

Many European and national producers of milk and dairy products are eager to win the consumer's favour. [5] Gradually a higher emphasis is put not only on the freshness and taste of dairy products but also, and primarily, on food safety. Therefore, infectologists and food producers scrutinise the incidence of infectious diseases with an interest in minimising the possibility of their occurrence. [11]

1 Material and methods

The aim of this article is to analyse changes in the salmonellosis and campylobacteriosis epidemiology in Slovakia in the last ten years and compare the results to the epidemiological changes within the EU. In order to reach this goal, it was necessary to obtain factual data on foodborne infectious diseases from the Slovak Epidemiological Information System and other worldwide databases mentioned further in the Results and discussion part.

As for the methodological approach, we employed statistical methods, such as Anova test with Scheffe´s method, time series and other scientific procedures. Our findings have been summarised not only in the text, but also by means of visual graphical representations, i.e. the accompanying tables and figures.

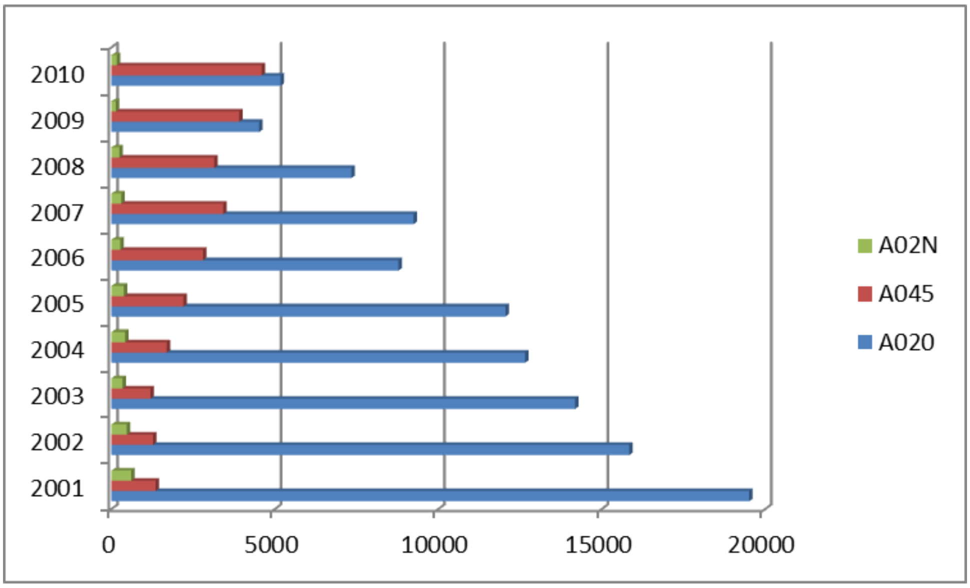
2 Results and discussion

The Slovak Republic is actively involved in the Early Warning Response System (EWRS) in cases of the incidence of an extraordinary epidemiological situation in the EU states. [10] The task of the System is the quick exchange of information on the occurrence of infectious diseases, or epidemics, which have the potential of spreading beyond the border of the country of outbreak; which can pose a threat to the populations of other EU countries; which are rare and, thus, require special attention of professionals. Within the framework of the international activities in the field of alimentation diseases and zoonosis on the European level, the Slovak Republic cooperates with the EU, the WHO, the EFSA and mainly with the European Centre for Disease Prevention (ECDC) based in Stockholm. Apart from sending data to the TESS (a European surveillance system), the implementation of tasks is guaranteed by an individual European programme known as the Food and Waterborne Diseases (FWD). Within the FWD programme a special European network − the Epidemic Intelligence System (EPIS) for the FWD has been established. The EPIS network participates on the solving of the so-called “urgent inquires”, which are signals of possible international epidemic threats. ECDC teams send data to contact points in all member states, including Slovakia.

As for the surveillance [7], the FWD focuses primarily on six diseases (Salmonellosis, Campylobacteriosis, VTEC – Verotoxigenic *E. coli*, Yersinosis, Shigellosis and Listeriosis) and partially on ten other diseases (Botulism, Brucellosis, Creutzfeldt–Jakob disease, Cryptosporidiosis, Echinococcosis, Giardiosis, VHA, Norovirus infections, Toxoplasmosis and Trichinellosis).

As for foodborne infectious diseases, salmonellosis (diagnosis code A02) counts among the diseases with the highest morbidity rate in the Slovak Republic. [11] In the years 2001 – 2010 in total 109 304 cases of salmonellosis and 3 327 incidents of Salmonella carrier cases were reported in Slovakia. The highest number of cases, 19 511 reported in 2001, represents a morbidity of 361.14 per 100 000 inhabitants. In the following years a gradual decrease of incidents was recorded (Fig. 1). The occurrence in 2010 (morbidity of 94.58 per 100 000 inhabitants) is 73.48% lower than in 2001 and 38.3% lower than a 5-year average (2005 – 2009). Also the number of reported carriers decreased from 604 cases in 2001 to 164 in 2010.

Fig. 1 The trend in the total number of salmonellosis and campylobacteriosis cases in Slovakia in 2001 – 2010



Source: own processing

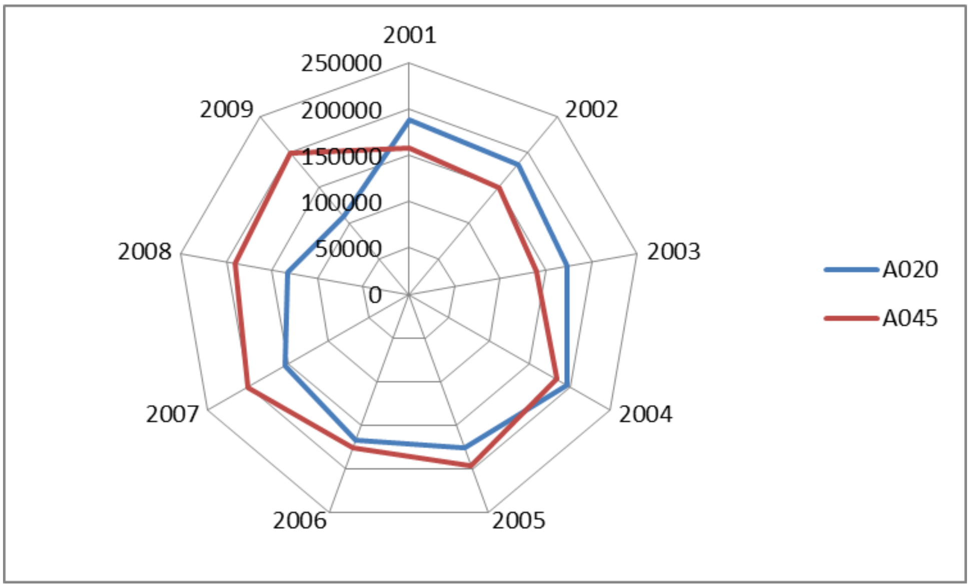
We assume that the significant decrease of human salmonellosis cases was affected by the following factors: the accession of Slovakia to the EU (2004); the gradual harmonisation of law in the EU (e.g. Directive 2003/99/EC4 on the monitoring of zoonoses and zoonotic agents; other Commission Regulations (EC) which laid down general and specific rules for food business operators on the hygiene of food stuff, etc.) and the enforcement of the given laws and regulations in the food industry and in the part of the consumer health protection; the active international cooperation of Slovakia with the EU, the WHO, the EFSA and the ECDC; the participation of the Slovak Republic in the EWRS.

Campylobacteriosis (diagnosis code A045) is thought to be in one of the leading positions regarding agency of foodborne diseases in the last 5 years in Slovakia. This situation correlates well with other member states where campylobacteriosis is the second most frequent agent of foodborne disease outbreaks following salmonellosis [2].

In the years 2001 – 2010 25 574 cases of campylobacteriosis were reported in the Slovak Republic. The highest number of incidents, 4 591, was reported in 2010 (a morbidity of 84.63 per 100 000 inhabitants), which means an increase of 17.5% compared to 2009. The increase of incidents with an annual average of 22% has been evident since 2003 (Fig. 1).

Campylobacteriosis remained the most reported zoonotic disease with humans, showing a slight increase with 198,252 cases in 2009 compared to 190,566 in 2008. The fatality rate was 0.02%, lower than for salmonellosis. The number of total cases in 2001 – 2010 varies: from 139,581 in 2003 to 200,889 in 2007. [11] It is interesting to note that the number of cases of campylobacteriosis in 2003 was the lowest not only in Slovakia but also in the EU as a whole. The campylobacteriosis occurrence trend within the EU can be evaluated as linearly slightly increasing (Fig. 2).

Fig. 2 Total number of salmonellosis (A020) and campylobacteriosis (A045) cases in the EU in 2001 – 2009



Source: own processing

Monitoring and surveillance schemes (MSs) for some zoonotic agents are not harmonised between MSs and findings must, therefore, be interpreted with care. The data presented may not necessarily derive from statistically designed sampling plans and may not accurately represent the national situation regarding zoonoses. Results are generally not directly comparable between MSs and sometimes not even between different years in one country (The community summary report... 2005 – 2010). At the same time, in some years there was no surveillance system in some countries. The total number of reported human salmonellosis and campylobacteriosis cases in the EU is marked by a EU-wide gradual rise in 2004, with the accession Estonia, Latvia, Lithuania, Poland, the Czech Republic, Hungary, Slovakia, Slovenia, Malta and Cyprus, and in 2007, with the accession of Romania and Bulgaria. [10]

In the following part we shall deal with a more thorough epidemiological analysis of salmonellosis and campylobacteriosis in relation to the agent, the focus of infection, age and sex, the mechanism of transmission, the place and seasonality of place of infection, the epidemics.

The incidence of Salmonella in Slovakia and its characteristics do not differ from the incidence in other European countries. The current state is caused by the strong activity of *S. Enteritidis*, which has dominated the salmonella disease etiology since the beginning of the last decade.

In the studied period of 2001 – 2010 *Salmonella enteritidis* represented 86% of salmonellosis cases in the Slovak Republic. The second most common serotype, *S. typhimurium*, represented 3% and *S. infantis* only 1%. Other serotypes occurred rarely and represented only a fraction of the percentage of the total number (8%). As stated earlier, the number of salmonella diseases has been constantly decreasing since 2001; however, new Salmonella serotypes have been isolated from the infected and the carriers. While in 2001 there were 35 new serotypes reported, in 2010 epidemiologists identified 52 serotypes with new phage types. There were only two deaths related to salmonella reported in 2010. In recent years, there have been no deaths reported. Own analysis is in table 1.

Tab. 1 Verification of differences in the incidence of salmonellosis for the Factor Year with Anova test-Scheffe's method

Year	Average	Groups homogenity					
2009	2259.50	X					
2010	2587.50	X	X				

2008	3668.00		X	X			
2006	4392.00			X			
2007	4620.50			X			
2005	6027.50				X		
2004	6328.50				X		
2003	7092.00				X	X	
2002	7909.50					X	
2001	9755.50						X

Source: own processing

The number of salmonellosis epidemics in the studied years varied from 22 epidemics (in 2010) to 72 (in 2007). These epidemics, which have been reported since 2005 within the surveillance in the Slovak Republic, were mainly caused by using contaminated ingredients in food processing and the employment of incorrect food processing techniques, such as insufficient heat treatment and defective storage of feed stock and final products.

Among the most common transmission factors were: eggs from home and commercial production, egg products, insufficiently processed and unpasteurized milk, water from individual sources, mixed diet, confectionery products, cheese and poultry. These transmission factors have been proved in the laboratory and also by means of epidemiological examination.

The analysis of each epidemic according to the place of origin has shown that most cases occur at home (usually at family gatherings) and also in the both communal catering forms: interior closed establishments (schools, factories) and exterior open (public open-air establishments). *Salmonella* spp. is an enteric pathogen associated with animal and slaughter hygiene. In the EU, eggs and egg products are the most frequently implicated sources of human salmonellosis. Meat is also an important source, with poultry and pork implicated more often than beef and lamb [6]. The two most common *Salmonella* serotypes are *typhimurium* and e*nteritidis*. With human salmonellosis, *S. typhimurium* is the most frequent serotype. *S. enteritidis* is associated primarily with poultry and eggs. It has been observed that *Salmonella* spp. usually persist during chilling.

Overall, in the EU, *S. enteritidis* and *S. typhimurium* are the serotypes most frequently associated with human disease. Human *S. enteritidis* cases are most commonly associated with the consumption of contaminated eggs and poultry meat, while *S. typhimurium* cases are mostly associated with the consumption of contaminated pork, poultry and beef [9] *Salmonella* was rarely detected in other foodstuffs, such as dairy products, fruit and vegetables. Products non-compliant with the EU *Salmonella* criteria were mainly observed in mincemeat and meat preparations as well as in live molluscs.

From 1984 to 2005, there were 17 major outbreaks of human salmonellosis (*S. typhimurium* and *S. enteritidis* being involved in at least seven of those outbreaks) from meat, poultry and derived products, mostly in North America and Europe. The sources were raw and minced pork; cooked chicken and turkey; raw, ground, and roast beef; liver pâté, deli meats, kebab etc. Six outbreaks had ca. 100 to 400 confirmed cases; four outbreaks were with ca. 600 to 850 cases; one outbreak with >2,100 cases in Spain in 2005 [3].

[1] analysed data collected by OzFoodNet on food- and waterborne disease outbreaks occurring in LTCF (long-term care facilities) in Australia from 2001 to 2008. They compared outbreaks by the number of persons affected, the etiology, and the implicated connection. These LTCF outbreaks affected a total of 909 people, with 66 hospitalized and 23 deaths. *Salmonella* caused 17 outbreaks and *Campylobacter* 8 outbreaks. Residents were at higher risk of death during the outbreaks of salmonellosis than during all the other outbreaks combined (relative risk 7.8, 95% confidence intervals 1.8–33.8).

The dominant etiologic agent in campylobacteriosis was the C. *jejuni*; however, it must be stressed that this species had been specified no sooner than 2006. The most common transmission factors were insufficient heat treatment of beef and milk from milk automats. Own analysis is in table 2.

Tab. 2 Verification of differences in the incidence of campylobacteriosis for the Factor Year with Anova test-Scheffe's method

Year	Average	Groups homogenity				
2003	598,50	X				
2002	633,50	X				
2001	675,50	X				

2004	844,50	X	X			
2005	1103,00	X	X	X		
2006	1398,50		X	X	X	
2008	1573,50			X	X	
2007	1711,00			X	X	X
2009	1953,50				X	X
2010	2290,50					X

Source: own processing

The most commonly reported species in the EU was the *C. jejuni* followed by the *C. coli*. Community incidence increased, but no common trend within the MS was evident. MS provided information on the origin (domestic vs. imported) of the infections, and the situation varied considerably between the MS. In foodstuffs, the highest proportion of the *Campylobacter*-positive samples was reported for fresh broiler meat where, on average, 29.03% of samples were positive (2007 – 2009). Campylobacter was also commonly detected from live poultry, pigs and cattle [6].

Conclusion

The primary objective of the foodborne zoonotic pathogen control is to reduce the incidence of human disease. Ideally, this is achieved by elimination of the pathogen at the most appropriate stage(s) in the food chain. Where this is not feasible, the alternative is to incrementally reduce the risk at various stages of production by introducing ‘hurdles’, i.e. taking measures that limit the growth of or partially eliminate pathogens. Obviously, the latter should be combined with consumer information on the residual risks prevailing and on how to manage these.

We recommend continued surveillance and ongoing analysis of these trends over time. Even though the pathological consequences of campylobacteriosis (and salmonellosis) in most cases are relatively minor for the individual, the social costs can be high. There are direct social costs associated with zoonotic infections in terms of medical treatment and lost production due to sick leave. In addition to these direct costs, there are also indirect social costs associated with general anxiety regarding the risk of zoonotic infections.

The decreasing trend in the notification rate of salmonellosis cases in humans continued in the last years, while salmonellosis still remained the second most commonly reported zoonotic disease in Slovakia and in the EU as well. Campylobacteriosis remained by far the most frequently reported zoonotic disease in humans. It is assumed that the observed reduction of salmonellosis and campylobacteriosis cases is mainly attributed to the successful implementation of national Salmonella and Campylbacter control programmes in fowl populations; also other control measures along the food chain may have contributed to the reduction.

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Contact

Ing. et Bc. Ladislav Mura, Ph.D.

J. Selye University, Faculty of Economics, Bratislavská cesta 3322, 945 01 Komárno, Slovakia

E-mail: ladislav.mura@gmail.com

Ing. Lucia Zeleňáková, Ph.D.

Slovak University of Agriculture, Faculty of Biotechnology and Food Science, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia

E-mail: lucia.zelenakova@azet.sk

Ing. PaedDr. Jana Žiarovská, Ph.D.

Slovak University of Agriculture, Faculty of Agrobiology, Tr. A. Hlinku 2, 949 76 Nitra, Slovakia

E-mail: jana.ziarovska@uniag.sk

PhDr. Ľuboš Török, Ph.D.

Constantine the Philosopher University, Faculty of Arts, Štefánikova 67, 949 74 Nitra, Slovakia

E-mail: ltorok@ukf.sk

Ing. et Bc. Martin Boďa, Ph.D.

Matej Bel University, Faculty of Economics, Tajovského ul., 974 01 Banská Bystrica Slovakia

E-mail: martin.boda@umb.sk