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# Ticks and Tick-borne Diseases

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## Self-reported tick-borne encephalitis (TBE) vaccination coverage in Europe: Results from a cross-sectional study

Wilhelm Erber<sup>a,\*</sup>, Heinz-Josef Schmitt<sup>b</sup>

<sup>a</sup> Pfizer, Vienna, Austria

<sup>b</sup> Pfizer, Paris, France

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### ABSTRACT

Adequate vaccination is effective in preventing tick-borne encephalitis (TBE). A population survey conducted in 2015 in Czech Republic, Estonia, Finland, Germany, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia, and Sweden obtained information on TBE vaccination. Respondents answered 10 questions for themselves and household members. Data were weighted according to age and fine-tuned for geographical spread. Across the 10 countries (excluding Poland), TBE awareness was 83%; of all respondents, 68% were aware of TBE vaccines and 25% had  $\geq 1$  injections. Vaccination rates were lowest in Finland and Slovakia ( $\sim 10\%$ ), highest in Austria (85%, results from a separate 2015 survey), and varied widely in Germany. Across the 11 countries (excluding Austria), compliance with vaccination schedule among TBE-vaccinated respondents was 61%; 27% and 15% of respondents received first and second booster injections; strongest motivators for vaccination were fear of TBE (38%) and residence/spending time in high-risk areas (31–35%); main reasons for not receiving vaccination were beliefs that vaccination was unnecessary (33%) and that there was no risk of contracting TBE (23%). TBE vaccine uptake and compliance could be improved with effective public health information to increase TBE awareness and trust in vaccination and by updating recommendations to include all subjects visiting TBE-risk areas.

### 1. Introduction

Tick-borne encephalitis (TBE) is a disease of the central nervous system caused by a virus of the flavivirus genus that is transmitted to humans by ticks or through consumption of unpasteurized dairy products from infected cows, goats, or sheep. TBE is the most important viral tick-borne disease in Europe (Gunther and Haglund, 2005; Heyman et al., 2010; Kunze, 2011) and is endemic in 27 European countries including areas of Central and Eastern Europe and Russia, where it has become a growing public health concern (Mansfield et al., 2009). TBE is spreading to new areas including those at higher altitudes in Central Europe, such as mountainous areas in Slovakia (Daniel et al., 2003; Lukan et al., 2010).

Most cases of TBE occur during the period of highest tick activity, which is from April to November in Central Europe (Lindgren and Gustafson, 2001). The incidence and severity of disease are highest in people aged  $\geq 50$  years (Lundkvist et al., 2011). Clinical presentations of TBE are non-specific and range from meningitis, mild central nervous system involvement to severe encephalitis or myelitis or both. TBE caused by the TBE virus European subtype (TBEV-Eu) usually follows a

biphasic course in approximately two-thirds of patients who experience initial non-specific (fever, headache, asthenia, and arthralgia) symptoms before presenting with meningitis or meningoencephalitis. Infection may result in long-term neurological complications in up to 58% of patients, or death in 0.5–2.0% (Haglund and Gunther, 2003; Bogovic et al., 2010).

There is no specific antiviral treatment available for TBE. Vaccination remains the most effective protective measure against TBE for people living in endemic areas, occupationally exposed subjects, and travelers to endemic areas. The recommendations for TBE vaccination vary considerably across the countries in which TBE virus (TBEV) foci are found. In areas where TBE is highly endemic (average pre-vaccination incidence of clinical disease is  $\geq 5$  cases/100,000 population per year) the World Health Organization (WHO) recommends that vaccination be offered to all age groups, including children (WHO Publication, 2011). The European Centre for Disease Prevention and Control (ECDC) recommends immunization for people who live in TBE risk areas or who frequently visit forests and grasslands in TBE risk areas. In 2017, European Academy of Neurology recommended TBE vaccination for all age groups above 1 year in highly endemic areas ( $\geq 5$

\* Corresponding author at: Medical and Scientific Affairs, Global Vaccines TBE, Pfizer Vaccines, Pfizer Manufacturing Corporation, Floridsdorfer Hauptstrasse 1, 1210 Vienna, Austria.  
E-mail address: [Wilhelm.erber@pfizer.com](mailto:Wilhelm.erber@pfizer.com) (E. Wilhelm).

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**Table 1**  
Vaccination in 11 European countries evaluated: full and main samples .

| Country        | Population <sup>a</sup> (millions, approximate) | Full sample (N = 25,600) <sup>b</sup>           | Main sample (N = 2427) <sup>c</sup> | The household members for whom the respondents gave information (N = 1520) <sup>d</sup> | Main sample, TBE vaccinated, respondent and household member data merged (N = 3947) <sup>e</sup> |
|----------------|---|---|-------------------------------------|---|--|
| Czech Republic | 10.5  | 4000  | 501                                 | 335   | 836  |
| Germany        | 82.2  | 4000  | 500                                 | 397   | 897  |
| Lithuania      | 2.9   | 3000  | 130                                 | 109   | 239  |
| Latvia         | 2.0   | 2900  | 300                                 | 237   | 537  |
| Poland         | 38.4  | TBE vaccinated: 100<br>TBE unvaccinated:<br>300 |                                     | 33  | 133  |
| Estonia        | 1.3   | 1500  | 100                                 | 50  | 150  |
| Finland        | 5.5   | 1000  | 120                                 | 77  | 197  |
| Hungary        | 9.8   | 1200  | 100                                 | 40  | 140  |
| Slovakia       | 5.4   | 5000  | 300                                 | 91  | 391  |
| Slovenia       | 2.1   | 1000  | 126                                 | 54  | 180  |
| Sweden         | 9.9   | 2000  | 150                                 | 97  | 247  |

<sup>a</sup> [https://en.wikipedia.org/wiki/List\\_of\\_countries\\_and\\_dependencies\\_by\\_population](https://en.wikipedia.org/wiki/List_of_countries_and_dependencies_by_population).

<sup>b</sup> Actual number of participants from the ‘coverage sweep’ excluding Poland.

<sup>c</sup> Actual number of participants from the ‘main survey’ including the 100 TBE vaccinated participants from Poland.

<sup>d</sup> The number of household members of the participants of the main sample whose information was provided by the participant.

<sup>e</sup> The sum of direct and indirect respondents from the ‘main survey’, i.e. the participants included in the ‘main sample’ plus the household members for whom they provided vaccination information.

cases/100,000/year) and for individuals at risk in areas with a lower incidence (Taba et al., 2017). Austria is the only European country since 1980 to implement an annual, national TBE awareness and vaccination campaign that targets the whole population; this has led to a substantial decline in the number of TBE cases in Austria (Heinz et al., 2013). Use of TBE vaccine is widespread in other Central European countries.

In Europe, two inactivated cell culture-derived TBE vaccines are available in adult and pediatric formulations, FSME-IMMUN<sup>®</sup> (Pfizer) and Encepur<sup>®</sup> (GlaxoSmithKline). FSME-IMMUN<sup>®</sup>, which is based on the Neudoerfl strain, has been approved in Europe since 1976 (WHO Publication, 2011). The Encepur<sup>®</sup> vaccine is produced by using strain K23. Both vaccine strains belong to TBEV-Eu (WHO Publication, 2011).

The recommended conventional schedule for the primary vaccination course consists of three vaccinations administered intramuscularly (0.5 ml for adults and 0.25 ml for children [1–15 years old with FSME-IMMUN (Junior)<sup>®</sup> and 1–11 years old with Encepur-K<sup>®</sup>]) at day 0, 1–3 months, and 5–12 months after the preceding vaccination for FSME-IMMUN<sup>®</sup> (FSME-IMMUN Summary of Product Characteristics) or at day 0, 1–3 months, and 9–12 months for Encepur<sup>®</sup> (Haute Autorite De Sante, 2011). Accelerated schedules can be implemented in special situations (e.g., “short-notice-travelers”: vaccination with FSME-IMMUN<sup>®</sup> on days 0 and 14, followed by the regular third dose 5–12 months after the second; vaccination with Encepur<sup>®</sup> on days 0, 7, and 21, followed by a fourth dose 12–18 months after the third). The primary three-dose schedule may be followed by a first booster dose after 3 years and thereafter booster doses every 5 years (subjects < 60 years) or 3 years (subjects ≥ 60 years). The overall field effectiveness of TBE vaccines have been estimated to range between 96% and 99% in regularly vaccinated persons (Heinz et al., 2015). Irregular vaccination schedules are frequent in TBE vaccination, among residents of and travelers to endemic regions; this results in lower degrees of protection (Heinz et al., 2007; Schosser et al., 2014).

The aim of the present study was to gain insight into TBE vaccination status (vaccination coverage and compliance) and the personal factors influencing vaccination status, among a representative sample of the general population in several European countries.

## 2. Methods

### 2.1. Scope and sampling

A household survey was conducted in 2015 in 11 European countries: Czech Republic, Estonia, Finland, Germany, Hungary, Latvia, Lithuania, Poland, Slovakia, Slovenia, and Sweden.

In 10 countries except Poland, the survey included two sections. The first section was a ‘coverage sweep’ to obtain general information of unbiased disease awareness, vaccination knowledge and vaccine coverage for various diseases; the second was a ‘main survey’ to understand different issues related to TBE vaccination. Participants were primarily recruited via online panels, i.e., invitations for this study were sent out and answered by some of the panel members. For the ‘coverage sweep’, the participants were not necessarily vaccinated against TBE; for the ‘main survey’, only respondents who had required experience relevant to TBE vaccination were included.

The full sample (i.e., vaccine ‘coverage sweep’) included a geographically representative sample of the general population in the 10 countries excluding Poland. The main sample included participants who provided information for the ‘main survey’, which was the focused sample of adults who had received ≥ 1 TBE vaccination or who had a household member who had received ≥ 1 TBE vaccination.

In Poland, participants for the survey were recruited and interviewed via personal contact. The defined geographical scope was the TBE endemic area. Two focused samples were included: TBE vaccinated (N = 100) and TBE unvaccinated (N = 300); the former was a focused recruitment for TBE vaccinated participants. Results from Poland are reported with the other 10 countries where applicable.

In addition, a separate survey was conducted in Austria in 2015 via web-based interviews, which included 2200 target persons (4000 household members). The results are presented separately.

None of the survey participants was under 18-years-old, except for Austria, where respondents were ≥ 14 years. Data for persons under 18 years were collected via adult household member. All participants gave their written or verbal consent to participate in the survey.

### 2.2. Data collection

In the 10 countries except Poland, during the vaccine ‘coverage sweep’, each respondent answered 10 questions on age, gender, region, and vaccination status for themselves and other household members.

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