Seroprevalence of *Toxoplasma gondii* in domestic pigs, sheep, cattle, moose and wild boars in the Nordic-Baltic region: Methodological considerations

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BACKGROUND & OBJECTIVE

- The seroprevalence of *Toxoplasma gondii* in humans varies by country in the Nordic-Baltic region.
- Our objective was to estimate if meat of infected animals could explain this geographical variation.

METHODS

Systematic review and meta-analysis of existing

| Study (Country) | Pos | Total | Sero | prev [Cl] | | |
|-------------------------|-----|-------|------|--------------|-----|---|
| Eglite 2000a (Latvia) | 35 | 115 | 0.30 | [0.22; 0.40] | 1 | |
| Kofoed 2017 (Denmark) | 38 | 254 | 0.15 | [0.11; 0.20] | | - |
| Lind 1994a (Denmark) | 96 | 807 | 0.12 | [0.10; 0.14] | | - |
| Deksne 2010 (Latvia) | 16 | 232 | 0.07 | [0.04; 0.11] | - | |
| Santoro 2017 (Estonia) | 22 | 382 | 0.06 | [0.04; 0.09] | - | |
| Wallander 2016 (Sweden) | 55 | 972 | 0.06 | [0.04; 0.07] | | - |
| Lunden 2002 (Sweden) | 42 | 807 | 0.05 | [0.04; 0.07] | - | |
| Eglite 2000b (Latvia) | 13 | 265 | 0.05 | [0.03; 0.08] | - | - |
| Deksne 2013 (Latvia) | 34 | 803 | 0.04 | [0.03; 0.06] | | |
| Felin 2015 (Finland) | 43 | 1353 | 0.03 | [0.02; 0.04] | | |
| Lind 1994b (Denmark) | 124 | 4016 | 0.03 | [0.03; 0.04] | E . | |
| Skjerve 1996 (Norway) | 42 | 1605 | 0.03 | [0.02; 0.04] | = | |
| Felin 2019 (Finland) | 8 | 1116 | 0.01 | [0.00; 0.01] | + | |
| | | | | | | |

seroprevalence studies.

RESULTS

- From 271 studies identified, 32 were included in the meta-analysis.
- Eight studies reported both the sensitivity and the specificity of the serological test used.





Number of *T. gondii* seroprevalence studies in domestic pigs (N=13), sheep (N=6), cattle (N=3), wild boars (N=6), and moose (N=4) by country in the Nordic-Baltic region, 1990–2018 that qualified for a meta-analysis (Olsen et al. 2019)

Estimated *T. gondii* seroprevalence and heterogeneity measures by two age groups (young = \leq 1 year, old = > 1 year) in domestic pigs, sheep, wild boars and moose using mixed effects model in the Nordic-Baltic region (Olsen et al. 2019)

| Host | Age | Pooled | Heterogeneity | Statistical |
|------|-----|--------|---------------|-------------|
| | | | | |

| Deksne 2013 (Latvia) | 201 | 606 | 0.33 | 0.29; 0.37 | | | | | |
|---|---------------------------------------|---|---|--|---------|---------|------------|------|------------------|
| Jokelainen 2012 (Finland) | 65 | 197 | 0.33 | [0.26; 0.40] | | | | | |
| Laforet 2019 (Denmark) | 30 | 101 | 0.30 | [0.21; 0.40] | | | <u>:</u> | | |
| Malmsten 2018 (Sweden) | 80 | 276 | 0.29 | [0.24; 0.35] | | | ÷ | | |
| Jokelainen 2015 (Estonia) | 113 | 471 | 0.24 | [0.20; 0.28] | | - | | | |
| Random effects model | | | <mark>0.33</mark> | [0.26; 0.41] | <u></u> | _ | | 1 | |
| Heterogeneity: $I^2 = 96\%$, $\tau^2 = 0$ |).0084 | $\chi_5^2 = 136$ | 5.27 (p · | < 0.01) | I | 1 | 1 | | 1 1 |
| | | | | 0 | 0.1 0 | 0.2 0.3 | 3 0.4 | 0.5 | 0.6 0.7 |
| | | | | | | | | | |
| Study (Country) | Pos | Total | Sero | prev [Cl] | | ÷ | | | |
| Study (Country) Remes 2018 (Estonia) | Pos 111 | Total 463 | Sero 0.24 | prev [Cl] [0.20; 0.28] | | | | - 60 | |
| Study (Country) Remes 2018 (Estonia) Malmsten 2011 (Sweden) | Pos 111 85 | Total 463 417 | Sero 0.24 0.20 | prev [Cl] [0.20; 0.28] [0.17; 0.25] | | | | - | 112 6 V 1 |
| Study (Country) Remes 2018 (Estonia) Malmsten 2011 (Sweden) Vikøren 2004 (Norway) | Pos 111 85 270 | Total 463 417 2142 | Sero 0.24 0.20 0.13 | prev [Cl] [0.20; 0.28] [0.17; 0.25] [0.11; 0.14] | - | | | | ath offering w |
| Study (Country) Remes 2018 (Estonia) Malmsten 2011 (Sweden) Vikøren 2004 (Norway) Jokelainen 2010 (Finland) | Pos 111 85 270 116 | Total 463 417 2142 1215 | Sero 0.24 0.20 0.13 0.10 | prev [CI] [0.20; 0.28] [0.17; 0.25] [0.11; 0.14] [0.08; 0.11] | - | | _ | _ | 6% |
| Study (Country) Remes 2018 (Estonia) Malmsten 2011 (Sweden) Vikøren 2004 (Norway) Jokelainen 2010 (Finland) | Pos 111 85 270 116 | Total 463 417 2142 1215 | Sero 0.24 0.20 0.13 0.10 0.16 | prev [Cl] [0.20; 0.28] [0.17; 0.25] [0.11; 0.14] [0.08; 0.11] | - | | | R | 6% |
| Study (Country) Remes 2018 (Estonia) Malmsten 2011 (Sweden) Vikøren 2004 (Norway) Jokelainen 2010 (Finland) Random effects model Heterogeneity: $l^2 = 96\%$, $\tau^2 = 0$ | Pos 111 85 270 116 | Total 463 417 2142 1215 $\chi_3^2 = 68.6$ | Sero 0.24 0.20 0.13 0.10 0.16 57 (p < 0 | prev [CI] [0.20; 0.28] [0.17; 0.25] [0.11; 0.14] [0.08; 0.11] [0.10; 0.23] | - | | | R | 6% |
| Study (Country) Remes 2018 (Estonia) Malmsten 2011 (Sweden) Vikøren 2004 (Norway) Jokelainen 2010 (Finland) Random effects model Heterogeneity: $l^2 = 96\%$, $\tau^2 = 0$ | Pos 111 85 270 116 | Total 463 417 2142 1215 $\chi_3^2 = 68.6$ | Sero 0.24 0.20 0.13 0.10 0.16 57 (p < 0 | prev [Cl] [0.20; 0.28] [0.17; 0.25] [0.11; 0.14] [0.08; 0.11] [0.01) [0.01) 0 | | • | .2 | 0.3 | 6% |

Estimated pooled seroprevalence of *T. gondii* in domestic pigs, sheep, cattle, wild boars and moose respectively, in the Nordic-Baltic region using a random effects model (Olsen et al. 2019)



| species | group | seroprevalence | ellect of age | | | | |
|--------------|--------------|--------------------------------------|---------------|---------------|--------------|----------|--|
| - | | (%) (95% CI) | Q | Q-P | l² (%) | P-value | |
| Domestic pig | Young | 4.0 (2.0–6.3) | 69.6 | <0.01 | 90.0 | < 0.0001 | |
| | Old | 18.1 (12.0–25.2) | 32.8 | <0.01 | 91.0 | | |
| Sheep | Young | 13.1 (5.6–23.0) | 3.9 | 0.14 | 49.0 | | |
| | Old | 27.8 (17.9–38.9) | 188.4 | <0.01 | 99.0 | 0.04 | |
| Wild boar | Young Old | 25.7 (16.0–36.7) 38.4 (28.0–49.4) | 10.2 35.3 | 0.02 <0.01 | 71.0 91.0 | 0.10 | |
| Moose | Young | 8.3 (4.0–14.0) | 46.3 | < 0.001 | 85.0 | | |
| | Old | 19.4 (13.0–26.7) | 20.5 | < 0.001 | 94.0 | 0.01 | |

95% CI is confidence interval

NOTE: Cattle were omitted from subgroup analysis due to the low number of studies

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- Low number of studies and lack of information on sensitivity and specificity of the different serological tests prevented identification of patterns by country.
- Future studies should report the accuracy of the tests to allow comparison of results.
- Seroprevalence was high in all five species and significantly higher in older than in younger animals, except in wild boars.



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