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# Incidence of self-reported acute gastrointestinal infections in the community in Poland: a population-based study

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## SUMMARY

A retrospective cross-sectional survey of self-reported acute gastrointestinal infection (AGI) incidence in the community was performed in Poland, from December 2008 to November 2009. The aim of the study was to estimate the magnitude and distribution of self-reported AGI, in order to calibrate the routine AGI surveillance system in Poland. The study population were randomly selected residents of all Polish regions, having a fixed telephone line. An equal number of telephone interviews were collected each month, requesting the interviewee to identify gastrointestinal symptoms that had occurred in the previous 4 weeks. The international AGI case definition was used. In total 3583 complete interviews were obtained. The compliance ratio was 26%. Of 3583 respondents, 240 (6·7%) individuals fulfilled the AGI case definition. The annualized incidence of acute gastroenteritis was 0·9/person-year (95% confidence interval 0·8–1·0). Comparison of the obtained annual AGI estimate (33·3 million infections) with the number of cases reported to national surveillance during the corresponding period (73 512), yielded an underreporting factor of 453 cases occurring in the community for each reported case. Of the 240 AGI cases, 30·4% consulted a general practitioner, and 4·6% were admitted to hospital. Samples for microbiological confirmation were collected from four (1·6%) cases. This first population-based study in eastern Europe has confirmed that AGI places a high burden on Polish society, which is underestimated by national surveillance data. Efforts are necessary to improve AGI reporting and diagnostic practices in order to increase the effectiveness of the Polish surveillance system in detecting threats related to new AGI pathogens, new routes of transmission or the potential for international spread.

**Key words**: Cross-sectional study, gastrointestinal infection, incidence, Poland.

## INTRODUCTION

Acute gastrointestinal infections (AGI) are among the most common communicable diseases in humans, place a substantial burden on healthcare systems, and constitute a significant proportion of general practitioner (GP) consultations and hospitalizations. The most prevalent aetiological factors of AGI cases are viruses, bacteria and parasites; however, gastrointestinal symptoms are also commonly caused by physical or chemical intoxication. With increasing globalization of the world's population, the free movement of people and goods creates new threats, and local zoonoses may easily lead to international outbreaks [1–3].

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Therefore, it is important for the international community to obtain valid information on the incidence of AGI through well-calibrated surveillance systems. Such systems not only play a pivotal role in increasing the safety of exported food, water sources, and international travellers, but also ensure timely detection and prevention of threats that could result in transmission of AGI internationally.

In Poland, both clinically- and laboratory-confirmed AGI cases are reported by physicians through a routine, mandatory surveillance system. The information on cases reported to the national surveillance system, based on reporting ICD-10 codes, is published, after validation, in annual surveillance reports [4]. Accurate estimates of AGI frequency at the population level are, however, not available in Poland, and the sensitivity of the routine surveillance system is considered to be low and to vary according to region and disease aetiology [5, 6].

Currently, several studies have been undertaken to assess the AGI burden in Poland. Some of the activities were performed within the framework of the Med-Vet-Net network of excellence. One of the projects focused on estimating the incidence of common AGI pathogens from serum antibody levels in representative national samples. These recently published results indicate a much higher incidence of *Salmonella* infections (including asymptomatic ones) in Poland compared to other European countries [7]. The current study also formed part of the Med-Vet-Net collaboration with partners in Denmark, Germany, The Netherlands, and Italy. We developed a common protocol for community-based surveys assessing AGI incidence, adopting the methodology of the British IID-2 study [8]. In these parallel studies, the common AGI case definition was applied, as well as collection of an equal number of interviews on the occurrence of AGI symptoms over a 12-month period. This method of assessing the burden of AGI has been widely used during the past decade on several continents [9–14].

The objective of the study was to estimate the magnitude, distribution, and impact on society of self-reported AGI, in order to calibrate the routine surveillance system for diarrhoeal diseases in Poland.

## MATERIAL AND METHODS

### Selection of study participants

The retrospective cross-sectional telephone survey was conducted between December 2008 and November 2009 by a subcontracted company, GfK Polonia. The study participants were randomly selected residents of private households in Poland, with a fixed telephone line. The aim was to achieve 3600 interviews by conducting 300 interviews per month. The figure of 3600 interviews was based on sample size estimations for prevalence surveys. Assuming an expected AGI frequency of 10% (with $\pm 1\%$ precision, 95% confidence level), the resulting number of completed interviews required would be 3458. Three-stage sampling was applied. First, municipalities were selected in each of the 49 telephone zones in Poland, representing four categories: rural areas, towns with $<50\,000$ inhabitants, towns of 50 000–200 000 inhabitants, and towns with $>200\,000$ inhabitants. To reach inhabitants of all Polish regions, quotas were assigned to each region proportional to the population living in each township category. In the second stage, lists of telephone numbers were generated, based on prefixes assigned to selected municipalities. The interviewees were then randomly selected from a pre-generated list by a dialling program. The generation of numbers was restricted by pre-assigned regional quotas. The third stage consisted of selecting respondents in households by using the 'next-birthday method'. Phone calls were made at different times of day. Three attempts were performed on each randomly selected number. The monthly quota of interviews was performed during the first week of each month.

The study protocol was approved by the Institutional Review Board of the National Institute of Public Health – National Institute of Hygiene, Warsaw.

### Data collection

The computer-assisted telephone interviews (CATI) method was used. Interviewers were initially trained by the study coordinators from the National Institute of Public Health – National Institute of Hygiene (NIZP-PZH) in Warsaw. The selected respondents were recruited to the study after each participant confirmed that the phone number was linked to his/her place of residence and gave their consent to participate in the study. Verbal consent was sought from all adults before entry to the study. Children aged 12–18 years were interviewed after obtaining verbal consent from a parent or guardian. For children aged 0–11 years, their parents or guardians were interviewed on their behalf. All interviews were conducted in Polish and took approximately 30 min for

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respondents reporting AGI symptoms, and 10 min for non-AGI subjects.

The 40-item questionnaire was adapted from British IID-2 telephone interview. It contained questions about demographic characteristics (age, gender, current employment status of the person who provides the main source of income for the family, profession of the respondent, description of the home environment), symptoms of intestinal infection (type of symptoms, duration of symptoms), contacting a physician, hospitalization, medications taken, and being on sick leave. The majority of questions were close-ended, but some open questions were included. Following preliminary validation of the questionnaire contents by communicable disease epidemiologists, the questionnaire was reviewed and piloted by five experienced GfK interviewers among 20 randomly selected respondents.

### Case definition

The case definition used was compatible with the case definition proposed by the International Collaboration on Enteric Disease Burden of Illness [15]. A case of gastroenteritis was defined as an individual with $\geqslant 3$ loose stools, or any vomiting, for a period of 24 h during the 4 weeks prior to interview. The case definition excluded people with: bowel cancer, irritable bowel syndrome, Crohn's disease, ulcerative colitis, cystic fibrosis, celiac disease, or other chronic illness with symptoms of diarrhoea or vomiting, in addition to any symptoms that were related to pregnancy and drug or alcohol abuse.

### Statistical analysis

The statistical software packages SPSS v. 12 [16] and Stata v. 10 [17] were used for data analysis. Representativeness was assessed by comparing the study participants' characteristics with routine census data from 2008. We used the $\chi^2$ test to compare the distribution of demographic variables between the studied group and the general population. The compliance ratio was calculated as the proportion of persons interviewed compared to those who were successfully contacted by the interviewers. The monthly prevalence was estimated as the number of respondents reporting AGI in the previous 28 days divided by the population at risk. The definition of population at risk is provided in the Supplementary Appendix (available online).

We used a log binomial regression model to estimate the association between different factors and AGI prevalence in the studied population. The following parameters were considered for inclusion in the model: month of onset, region of residence, household size, urbanization level, age group, gender, and occupation of the studied subjects. To account for uneven probability of selection of respondents in households of different size, we added a probability weight constructed as the reciprocal of the number of household inhabitants. Due to important monthly differences in AGI prevalence, seasonal variation was modelled using sine and cosine functions of different periodicity. The robust standard error option was used to account for potential divergence from the binomial error distribution assumption. Backward selection procedure was used with $P \geqslant 0{\cdot}05$ as the cut-off level for elimination from the model. Confounding was assessed by examining the effect of adding each of the previously removed variables in the model. Both significant predictors and confounders were included in the main effects model. The model fit was assessed by inspection of residuals and through scatter plots.

The incidence of self-reported AGI and its 95% confidence intervals (CIs), were computed using formulas provided in the online Appendix. We computed the annual number of AGI cases in the community by multiplying the estimated annual incidence by the number of inhabitants of Poland. Similarly, we computed the range of uncertainly for the obtained estimates, using the values of lower and upper 95% CI limits. Furthermore, based on the information provided by the survey respondents, we estimated the number of patients visiting a GP (community consultation rate), the number of patients admitted to the hospital due to AGI symptoms (community hospitalization rate), and the number of days of absence from work as the result of AGI.

To assess the surveillance multipliers, we compared the survey results with results of the national AGI surveillance system in Poland, from November 2008 to October 2009. The period from November to October was chosen due to the fact that respondents were asked for the period of 4 weeks preceding the interviews. The following groups of diseases collected by routine surveillance system in Poland were used for the purpose of this evaluation: bacterial intestinal infections caused by: *Salmonella* spp., *Shigella* spp., *E. coli*, *Campylobacter* spp., *Yersinia* spp. and other bacterial pathogens (ICD 10: A01.0–3, A02.0, A03, A04.0–4, A04.5, A04.6, A00, A04.7–8), bacterial

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intoxication caused by: *Staphylococcus aureus*, *Clostridium perfringens* and other bacterial intoxications (ICD 10: A05.0, A05.2, A05.3–9), viral intestinal infections caused by: rotaviruses, noroviruses and other viruses (ICD 10: A08.0, A08.1, A08.2–3), parasitic intestinal infestations caused by *Giardia intestinalis* and *Cryptosporidium* spp. (ICD 10: A07.1, A07.2), and diarrhoea and gastroenteritis of presumed infectious origin (ICD 10: A09).

The AGI surveillance multiplier was calculated by dividing the number of AGI cases estimated by the survey in the community by the overall number of AGI cases reported to surveillance. Since very limited information is available for AGI notifications at the national level, we could not compute more precise age-specific multipliers. As the retrospective survey did not provide information on the aetiology of AGI cases we were also unable to estimate pathogen-specific multipliers.

## RESULTS

### Completeness and representativeness

The number of households successfully contacted was 13 731, of which 6902 persons (50·3%) refused to participate in the study, 3229 (23·5%) terminated the call before the interview was completed, and 3600 (26·2%) completed the interview. Seventeen interviews from patients reporting chronic intestinal illness as the cause of their AGI symptoms were excluded from the study population. The compliance ratio was 26·1%. The description of the studied population is presented in Table 1. The general population in Poland was well represented in terms of gender distribution, occupation and region of residence. However, the sampling process lead to underrepresentation of subjects aged 0–15 years and overrepresentation of the 40–64 years age group. Similarly, respondents residing in larger households and in towns with $<50\,000$ inhabitants were overrepresented. The differences between the studied group and the general population were statistically significant for all demographic variables, except for gender.

### Frequency and distribution of gastrointestinal illness episodes

In the studied population 328 (9·2%) respondents reported gastrointestinal illness episodes. Of these, 211 (64·3%) reported diarrhoea and 127 (38·7%) reported vomiting. Of the individuals reporting gastrointestinal symptoms, 88 (26·8%) did not meet criteria of AGI case definition. Two hundred forty individuals met the criteria of the AGI case definition, giving a monthly prevalence of 6·7%. Reporting of either respiratory symptoms, high temperature with or without chills, or headache during the 4-week period, was reported by 265 (7·4%) respondents, of which 192 were also reported as AGI cases. Statistically significant differences in AGI prevalence were found for age and household size. Children aged 5–14 years, and adults aged 25–39 years (possibly parents) had significantly higher AGI prevalence, compared to the oldest age group ($>65$ years). Persons living in households with 3 and 4 inhabitants had significantly higher AGI prevalence, compared to inhabitants of smaller households ($<2$ persons).

Table 2 presents age-specific distribution of symptoms, severity of illness and incidence estimates. Based on the monthly prevalence, we estimated an annual incidence of 0·9 AGI cases/person-year, or 873 cases/1000 person-years. In 240 cases, 115 (48%) reported only diarrhoeal symptoms, 52 (22%) reported only vomiting, and 73 (30%) reported both diarrhoea and vomiting. The most affected age group was aged 5–14 years (1·4 episodes/person-year, 95% CI 0·8–2·1), followed by those aged 0–4 years (1·1/person-years, 95% CI 0·4–2·6).

### Multivariable model

The log binomial regression assessed independent predictors of AGI prevalence in the studied population. The final model included age group, household size, and seasonality, modelled by 1 year and 6 months periodicity. The results of the final model are presented in the Table 3. The prevalence rate ratios for households having 3–4 and $>5$ inhabitants, were 1·79 (95% CI 1·01–3·20) and 1·28 (95% CI 0·70–2·33), respectively, compared to households having $\leqslant 2$ inhabitants. To investigate the effects of above-mentioned interaction, we plotted the predicted AGI prevalence estimates, stratified by age group and month of onset, adjusted to household size (Fig. 1).

### Seasonality and geographical distribution

The AGI incidence varied from 0·35/person-year (2·7%) in June to 1·48/person-years (11·4%) in January. The annualized incidence estimates by month

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Table 1. *Source population and 4-week prevalence of self-reported gastrointestinal symptoms and AGI cases, Poland, November 2008 October 2009*

| | Poland's population | | Survey respondents | | Gastrointestinal symptoms | | Cases meeting criteria of case definition | |
|---|---|---|---|---|---|---|---|---|
| | *N* | % | *N* | % | *N* | % | *N* | % |
| Total | 38 153 389 | 100 | 3583 | 100 | 328 | 9·15 | 240 | 6·70 |
| Age (years) | | | | | | | | |
| 0–4 | 1 929 987 | 5·06 | 58 | 1·61 | 5 | 8·62 | 5 | 8·62 |
| 5–14 | 3 885 582 | 10·18 | 183 | 5·11 | 26 | 14·21 | 19 | 10·38 |
| 15–24 | 5 592 049 | 14·66 | 563 | 15·71 | 52 | 9·24 | 34 | 6·04 |
| 25–39 | 8 858 222 | 23·22 | 870 | 24·28 | 98 | 11·26 | 74 | 8·51 |
| 40–64 | 12 741 255 | 33·39 | 1445 | 40·33 | 113 | 7·82 | 89 | 6·16 |
| ⩾65 | 5 146 294 | 13·49 | 464 | 12·95 | 34 | 7·33 | 19 | 4·09 |
| Gender | | | | | | | | |
| Males | 18 423 343 | 48·29 | 1694 | 47·28 | 158 | 9·33 | 120 | 7·08 |
| Females | 19 730 046 | 51·71 | 1889 | 52·72 | 170 | 9·00 | 120 | 6·35 |
| Occupation (aged >18 years) | | | | | | | | |
| Working | 14 037 221 | 51·28 | 1723 | 52·76 | 168 | 9·75 | 119 | 6·96 |
| Unemployed | 1 473 752 | 5·38 | 192 | 5·88 | 16 | 8·33 | 14 | 7·29 |
| Student | 1 911 520 | 6·98 | 252 | 7·72 | 25 | 9·92 | 18 | 6·75 |
| Looking after home or family | 1 588 000 | 5·80 | 114 | 3·49 | 10 | 8·77 | 9 | 7·89 |
| Disabled or retired | 8 363 000 | 30·55 | 985 | 30·16 | 75 | 7·61 | 54 | 5·48 |
| Region of residence* | | | | | | | | |
| Central Poland | 7 759 348 | 20·34 | 663 | 18·50 | 61 | 9·20 | 48 | 7·24 |
| Southern Poland | 7 935 747 | 20·80 | 726 | 20·26 | 64 | 8·82 | 46 | 6·34 |
| Eastern Poland | 6 722 230 | 17·62 | 672 | 18·76 | 60 | 8·93 | 41 | 6·10 |
| North-Western Poland | 6 106 079 | 16·00 | 520 | 14·51 | 49 | 9·42 | 34 | 6·54 |
| Northern Poland | 5 721 422 | 15·00 | 571 | 15·94 | 52 | 9·11 | 39 | 6·83 |
| South-Western Poland | 3 908 563 | 10·24 | 431 | 12·03 | 42 | 9·74 | 32 | 7·42 |
| Residence type | | | | | | | | |
| Village | 14 865 208 | 38·96 | 1106 | 30·87 | 102 | 9·22 | 81 | 7·32 |
| Town <50 000 inhabitants | 9 109 691 | 23·88 | 1351 | 37·71 | 123 | 9·10 | 90 | 6·66 |
| Town 50 000–200 000 inhabitants | 6 255 360 | 16·39 | 529 | 14·76 | 54 | 10·21 | 34 | 6·43 |
| Town >200 000 inhabitants | 7 923 130 | 20·77 | 597 | 16·66 | 49 | 8·21 | 35 | 5·86 |
| Number of residents in the household† | | | | | | | | |
| ⩽2 | 6 403 790 | 48·02 | 364 | 10·16 | 20 | 5·49 | 13 | 3·57 |
| 3 | 2 654 169 | 19·90 | 803 | 22·41 | 77 | 9·59 | 56 | 6·97 |
| 4 | 2 404 799 | 18·03 | 782 | 21·83 | 88 | 11·25 | 67 | 8·57 |
| ⩾5 | 1 874 282 | 14·05 | 1634 | 45·60 | 143 | 8·75 | 104 | 6·36 |

* Nomenclature of Units for Territorial Statistics (NUTS)1 division of the country, each region is divided into 2–3 provinces (NUTS2).

† Based on the national census of 13·3 million households, 2002.

of AGI onset are presented in Figure 2. During the study period, two peaks were observed, the first occurred during December–January and the second peak was during July–September. Such peaks coincided with an increase in reported infections caused by enteric viruses during winter months and bacterial infections in warmer months. Important differences in AGI incidence were observed between the regions. Figure 3 presents a comparison of the geographical distribution of annual incidence estimated in the present study, with the routinely reported AGI incidence, by province.

### Impact of AGI on daily activities

Seventy-three (30·4%) AGI cases contacted a physician about their current symptoms, giving an annualized consultation rate of 266/1000 person-years

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Table 2. *Incidence estimates of self-reported AGI, and selected characteristics of cases by age group and sex, Poland, November 2008–October 2009*

| Age (years) … | All | | 0–4 | | 5–14 | | 15–64 | | ⩾65 | |
|---|---|---|---|---|---|---|---|---|---|---|
| Gender … | Males | Females | Males | Females | Males | Females | Males | Females | Males | Females |
| Number of respondents | 1694 | 1889 | 32 | 26 | 119 | 64 | 1324 | 1297 | 219 | 502 |
| Number of cases meeting definition criteria | 120 | 120 | 3 | 2 | 10 | 9 | 100 | 83 | 7 | 26 |
| Monthly prevalence | 7·1 % | 6·4 % | 9·4 % | 7·7 % | 8·4 % | 14·1 % | 7·3 % | 6·4 % | 2·9 % | 4·6 % |
| Incidence per person-year (95 % CI) | 0·9 (0·8–1·1) | 0·8 (0·7–1·0) | 1·2 (0·3–3·6) | 1·0 (0·1–3·6) | 1·1 (0·5–2·0) | 1·8 (0·8–3·5) | 1·0 (0·8–1·2) | 0·8 (0·7–1·0) | 0·4 (0·1–1·0) | 0·6 (0·3–1·0) |
| Reported symptoms among AGI cases | | | | | | | | | | |
| Diarrhoea (%) | 98 (81·7) | 90 (75·0) | 3 (100·0) | 2 (100·0) | 6 (60·0) | 5 (55·6) | 82 (82·0) | 62 (74·7) | 7 (100·0) | 21 (80·8) |
| Bloody diarrhoea (%) | 6 (5·0) | 3 (2·5) | — | 1 (50·0) | — | — | 6 (6·0) | 1 (1·2) | — | 1 (3·8) |
| Vomiting (%) | 56 (46·7) | 69 (57·5) | — | 2 (100·0) | 7 (70·0) | 8 (88·9) | 48 (48·0) | 47 (56·6) | 1 (14·3) | 12 (46·2) |
| Nausea (%) | 51 (42·5) | 69 (57·5) | — | 2 (100·0) | 3 (30·0) | 7 (77·8) | 45 (45·0) | 49 (59·0) | 3 (42·9) | 11 (42·3) |
| Stomach/abdominal pain (%) | 80 (66·7) | 86 (71·7) | 2 (66·7) | 2 (100·0) | 5 (50·0) | 5 (55·6) | 71 (71·0) | 61 (73·5) | 2 (28·6) | 18 (69·2) |
| Fever (%) | 35 (29·2) | 40 (33·3) | 2 (66·7) | 1 (50·0) | 5 (50·0) | 5 (55·6) | 26 (26·0) | 27 (32·5) | 2 (28·6) | 7 (26·9) |
| Headache (%) | 70 (58·3) | 74 (61·7) | 2 (66·7) | — | 4 (40·0) | 7 (77·8) | 61 (61·0) | 54 (65·1) | 3 (42·9) | 13 (50·0) |
| Respiratory symptoms (%) | 56 (46·7) | 70 (58·3) | 1 (33·3) | 1 (50·0) | 5 (50·0) | 7 (77·8) | 46 (46·0) | 46 (55·4) | 4 (57·1) | 16 (61·5) |
| Severity/ duration of disease in AGI cases | | | | | | | | | | |
| Median number times vomiting in 24 h (range) | 3 (1–10) | 3 (1–10) | — | 4 (3–5) | 2 (1–6) | 3 (1–8) | 3 (1–10) | 3 (1–10) | 2 (2–2) | 4 (2–5) |
| Median number times loose stool in 24 h (range) | 4 (2–20) | 5 (2–20) | 6 (5–7) | 9 (8–10) | 6 (3–8) | 6 (4–15) | 4 (1–20) | 5 (2–20) | 4 (3–8) | 4 (2–6) |
| Visit to general practitioner (%) | 29 (24·2) | 44 (36·7) | 2 (66·7) | 2 (100·0) | 4 (40·0) | 6 (66·7) | 22 (22·0) | 33 (39·8) | 1 (14·3) | 3 (11·5) |
| Use of pharmaco-therapy (%) | 69 (57·5) | 85 (70·8) | 3 (100·0) | 2 (100·0) | 6 (60·0) | 9 (100·0) | 57 (57·0) | 63 (75·9) | 3 (42·9) | 11 (42·3) |
| Sick leave at school/ work (%) | 25 (20·8) | 29 (24·2) | — | 1 (50·0) | 5 (50·0) | 4 (44·4) | 20 (20·0) | 23 (27·7) | — | 1 (3·8) |
| Median duration of absence in days (range) | 3 (1–30) | 2 (1–30) | — | 19 (n.a.) | 4 (1–7) | 4 (1–14) | 2 (1–30) | 2 (1–30) | — | 2 (n.a.) |
| Hospitalization (%) | 4 (3·3) | 7 (5·8) | — | — | — | 1 (11·1) | 4 (4·0) | 5 (6·0) | — | 1 (3·8) |
| Median duration of hospitalization in days (range) | 6 (1–14) | 3 (1–8) | — | — | — | 3 (n.a.) | 4 (1–14) | 1 (1–7) | — | 8 (n.a.) |

CI, Confidence interval.

Table 3. *Results of the final log-binomial model assessing the association between seasonality and demographic factors and AGI prevalence, Poland, November 2008–October 2009*

| Variable | Coefficient | S.E. | *Z* | *P* value | 95% CI |
|---|---|---|---|---|---|
| Seasonality | | | | | |
| sin (2∗Π∗month/12) | 1·78 | 0·663 | 2·68 | 0·007 | 0·48 to 3·08 |
| sin (4∗Π∗month/12) | 0·21 | 0·102 | 2·10 | 0·036 | 0·01 to 0·41 |
| cos (2∗Π∗month/12) | 0·34 | 0·103 | 3·35 | 0·001 | 0·14 to 0·55 |
| Number of household residents | | | | | |
| ⩽2 | Ref. | | | | |
| 3–4 | 0·62 | 0·312 | 2·00 | 0·046 | 0·01 to 1·23 |
| ⩾5 | 0·26 | 0·324 | 0·79 | 0·430 | −0·38 to 0·89 |
| Age group (years) | | | | | |
| 0–4 | 1·42 | 0·779 | 1·82 | 0·068 | −0·10 to 2·95 |
| 5–14 | 1·89 | 0·583 | 3·24 | 0·001 | 0·75 to 3·03 |
| 15–24 | 1·37 | 0·552 | 2·49 | 0·013 | 0·29 to 2·46 |
| 25–39 | 1·65 | 0·533 | 3·10 | 0·002 | 0·61 to 2·70 |
| 40–64 | 1·16 | 0·527 | 2·20 | 0·028 | 0·13 to 2·19 |
| ⩾65 | Ref. | | | | |
| Interaction between age group and season | | | | | |
| [0–4 years] ∗ [sin (2∗Π∗month/12)] | −2·71 | 1·108 | −2·45 | 0·014 | −4·88 to −0·54 |
| [5–14 years] ∗ [sin (2∗Π∗month/12)] | −1·96 | 0·758 | −2·58 | 0·010 | −3·45 to −0·47 |
| [15–24 years] ∗ [sin (2∗Π∗month/12)] | −1·63 | 0·732 | −2·22 | 0·026 | −3·06 to −0·19 |
| [25–39 years] ∗ [sin (2∗Π∗month/12)] | −1·67 | 0·693 | −2·42 | 0·016 | −3·03 to −0·32 |
| [40–64 years] ∗ [sin (2∗Π∗month/12)] | −1·58 | 0·696 | −2·27 | 0·023 | −2·95 to −0·22 |
| [⩾65 years] ∗ [sin (2∗Π∗month/12)] | | | | | |
| Constant | −4·44 | 0·539 | −8·24 | 0·000 | −5·50 to −3·39 |

S.E., Standard error; CI, confidence interval.

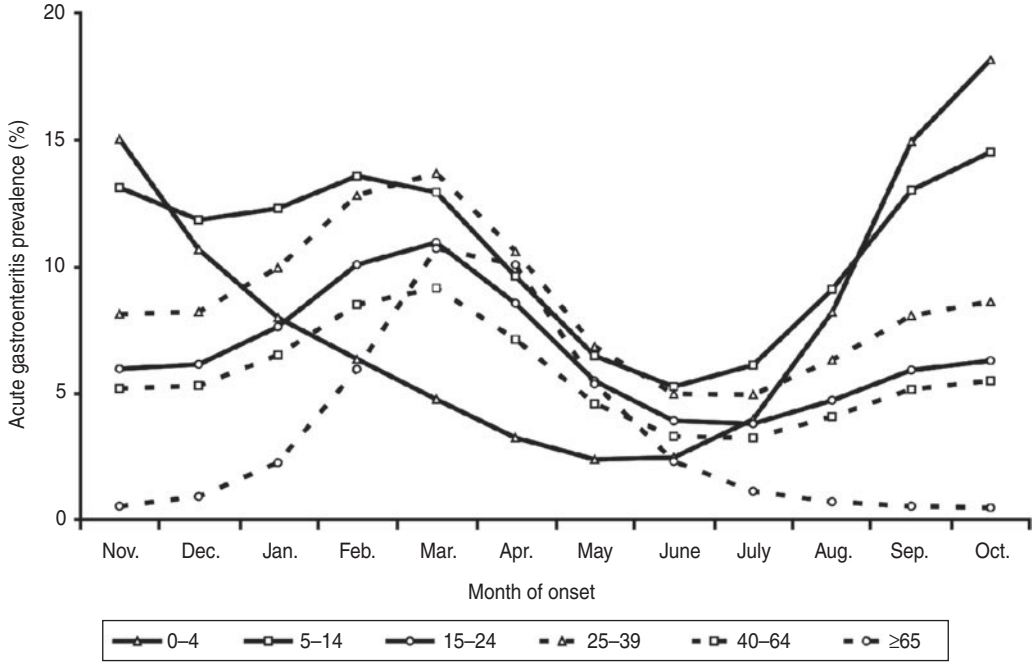


**Fig. 1.** Self-reported acute gastrointestinal infection (AGI) prevalence, adjusted to household size, by month of onset and age group, predicted by the log-binomial regression model, Poland, November 2008 to October 2009.

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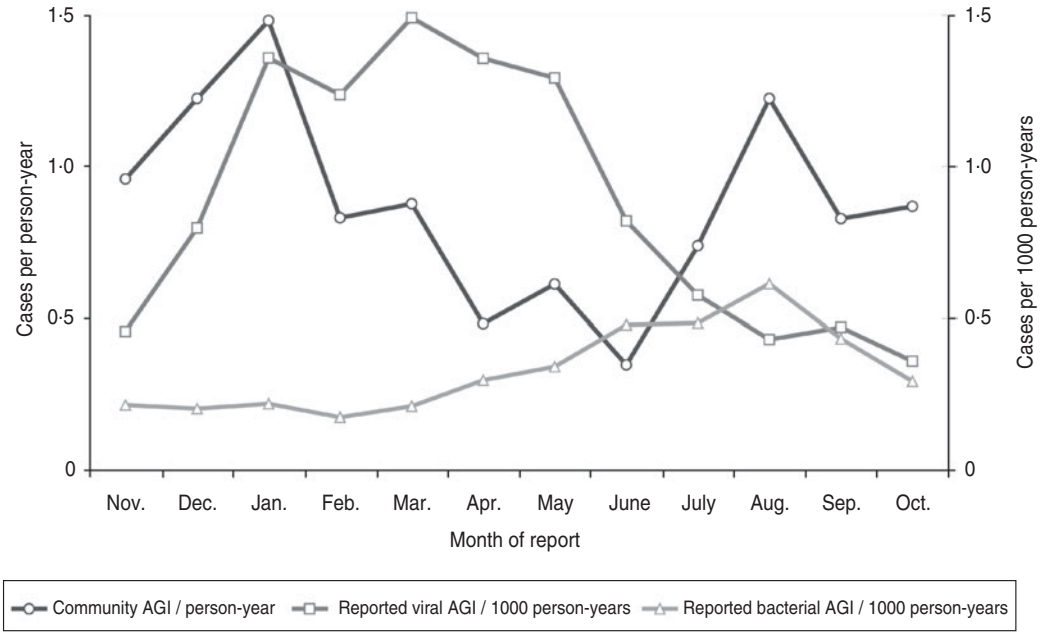


**Fig. 2.** Incidence of self-reported acute gastrointestinal infection (AGI) in the population; calculated for bacterial and viral intestinal infections reported to surveillance, by month, Poland, November 2008 to October 2009.

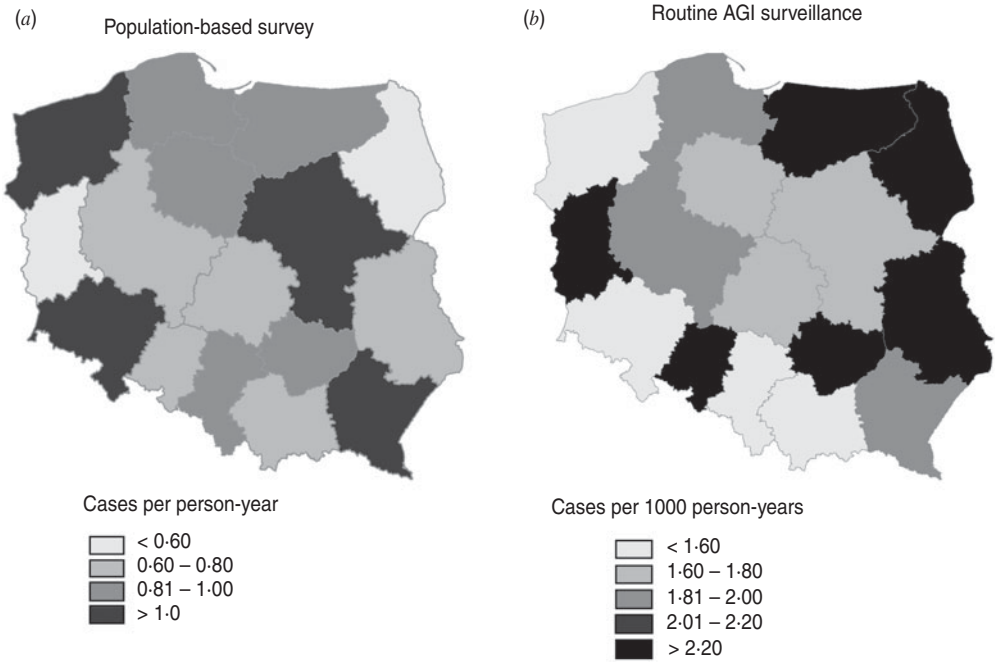


**Fig. 3.** Incidence of self-reported acute gastrointestinal infection (AGI) estimated in the (*a*) cross-sectional study and (*b*) AGI cases reported to routine surveillance, Poland, November 2008 to October 2009.

(95% CI 208–334). AGI cases aged 0–4 years most frequently consulted a physician (80·0%), compared to other age groups. Women consulted their GP more often (36·7%), compared to men (24·2%). Cases with bloody diarrhoea consulted GPs more frequently (5/8, 62·5%), compared to other clinical presentations. A sample for microbiological investigation was collected from two AGI cases consulting their GP. One-hundred fifty-four (64·2%) AGI cases received medications, of which 108 (70·1%) received over-the-counter medication, and 55 (35·7%) received prescriptions. Fifty-four cases were absent from school

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or work because of AGI symptoms. When considering only working adults (37 cases, median 3 days of absence), we estimated that 11·7 million days of absence were related to AGI cases each year. Eleven (4·6%) cases were admitted to hospital because of AGI symptoms, with an annualized hospitalization rate of 40/1000 person-years (95% CI 20–72). According to respondents' recall, the median duration of hospitalization was 5 days (range 1–14). Samples for microbiological confirmation were only collected for two hospitalized cases.

### AGI surveillance calibration

During November 2008–October 2009, there were 33 718 viral, 15 550 bacterial, and 2479 parasitic intestinal infections, 1963 bacterial intoxications, and 19 802 intestinal infections of probable infectious origin, reported to the routine AGI surveillance system in Poland. Seventy-four percent of reported cases were hospitalized. Comparing the number of reported infections (73 512) with the estimated number of 33·3 million AGI episodes during the study period, we obtained the multiplier of 453 cases occurring in the community, for each reported case. Comparing the number of reported infections that were admitted to the hospital (53 727), with the estimated number of 1·5 million hospitalized patients, a multiplier of 28 was obtained.

## DISCUSSION

The present survey is the first national study performed in Poland to estimate the community-based incidence of AGI episodes. The estimated AGI incidence based on a 28-day recall period was 0·9 case/person-year, with a monthly prevalence of 6·7%. Of the cases meeting the AGI case definition, 30% visited their GP, and 5% were hospitalized.

We compared our results with recently performed surveys employing similar selection methods and compatible case definition [9–14]. The AGI incidence estimated in the Polish population was similar to estimates in the USA and Canada (1·0 episode/person-year; monthly prevalence 7·6%). Estimates were, however, lower when compared with New Zealand (1·1/person-year, 8·6%), Norway (1·2/person-year, 9·3%) and Denmark (1·4/person year, 10·7%), and higher compared with Australia (0·8/person-year, 6·4%), Ireland and Argentina (0·4/person-year, 3·4%). In Poland the highest AGI prevalence was found in females aged 5–14 years, males aged 0–4 years and inhabitants of villages compared to town inhabitants. Differences in age groups were statistically significant. Our study yielded a relatively lower AGI prevalence in the youngest group of Polish children compared to other national studies that reported an incidence in children aged $<5$ years ranging from 2·79 episodes/person-year in Denmark to 1·0 episode/person-year in Ireland. Differences between countries could be related to diverse human contact patterns, food consumption habits, and/or other factors. Furthermore, differences in methodologies could exist owing to different weighting of the samples, differences in the selection process, or different compliance rates obtained in particular studies. Interestingly, two studies investigating AGI prevalence using a 7-day recall period found that AGI symptoms were more prevalent in subjects aged 20–29 years [9] and subjects aged 5–19 years [13] compared to children aged $<5$ years. In the same studies using a 30-day recall period children aged $<5$ years experienced the highest AGI incidence. These results could indicate that smaller children are prone to remember events at a later date, leading to an overestimate of AGI incidence in the youngest age groups. These differences also highlight the need for further standardization of the survey methods used.

Factors that independently influenced AGI prevalence were identified by the log binomial regression model. This regression method was used to directly estimate prevalence rate ratios, as the typically used logistic regression models report odds ratios and are not appropriate for cross-sectional studies [18]. The model confirmed the association between the size of the household and AGI prevalence, i.e. inhabitants of medium-sized households have a higher prevalence compared to the smallest ($<2$) and most crowded ($>5$) households. The model identified the modification of the effect of age group by the season of AGI onset. According to these findings, the youngest age groups ($<15$ years) were most affected during the autumn AGI peak. Inversely, the oldest age groups ($>40$ years) were most affected during the spring AGI peak, having the lowest prevalence during winter. Such results compound the hypothesis that viral pathogens causing AGI frequently affect children during the autumn–early winter peak, while other viral agents such as noroviruses predominate during the winter–spring–early summer peak, causing symptomatic infections in all age groups. When comparing surveillance data seasonality with the results of the

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model, the less-pronounced summer peak characterizing bacterial AGI may also affect children aged <15 years.

Important differences may be seen in the proportion of cases consulting a GP and who are referred for microbiological testing. The proportion of cases that consulted their physician regarding their AGI episode in Poland (30%) was lower compared with Argentina (37%), but higher compared with New Zealand (22%), Ireland (20%), or Denmark (12%). On the other hand, the proportion of cases for which a sample was submitted for microbiological investigation was lower in Poland (1·7%) compared with Denmark (3%), New Zealand (7%), Norway (13%), Ireland (15%), or USA (21%). Such discrepancies may reflect important differences in healthcare systems in the studied countries. Although individuals with diarrhoeal symptoms in Poland frequently contacted their physician, they typically received only supportive treatment and no aetiological investigation was performed. Samples were referred for microbiological testing during the course of 3% of GP consultations, and 18% of hospital admissions. In Poland, there is a universal public healthcare system accessible to each citizen, covered by obligatory insurance. Since the diagnostic costs for most AGI pathogens are paid by healthcare providers, they supposedly save money by not referring patients for microbiological testing.

The present study is the first population-based survey performed in an eastern European country, and creates an opportunity to stress the importance of compatibility between national surveillance systems. Although national administrations are responsible for their own surveillance systems, the consequences of inadequate surveillance of AGI pathogens can easily affect citizens in other countries. Furthermore, if surveillance systems perform differently between countries and even in different regions of a country (Fig. 3), outbreaks of known and unidentified pathogens would not be efficiently detected in a timely fashion, which would delay implementing interventions. The present population-based survey allowed the Polish AGI surveillance system to be calibrated. Based on the evidence obtained, we estimated that for every AGI case reported to national surveillance, 453 cases occurred in the community. This evaluation also indicates that hospitalized cases are much more likely to be reported to surveillance. In a few published studies, authors provided country-specific surveillance multipliers [19, 20]. The first British IID study estimated an underreporting factor of 136 for all-cause gastroenteritis [19]. The low sensitivity of the Polish AGI surveillance system may be related to the uncommon referral of AGI cases for laboratory diagnosis compared to other countries. The present survey shows regional differences in AGI surveillance sensitivity. It is indeed surprising that two of six provinces with the highest reported AGI incidence ranked lowest in terms of annualized incidence rates, and the two provinces reporting the lowest AGI incidence ranked highest, according to the survey estimates (Fig. 3). On one hand, pathogen-specific underreporting may vary because access to a laboratory-based diagnosis differs between regions, as it differs between countries. The regional differences in surveillance sensitivity, however, cannot be explained solely by diverse pathogen-specific underreporting ratios because we included all-cause AGI cases, including those without laboratory confirmation.

The present study has important limitations. Since the sampling frame used did not include persons using mobile telephones, we may have missed the most mobile and professionally active individuals, as well as homeless or institutionalized persons. The statistically significant differences between the study sample and the general Polish population may indicate a generally low representativeness of the study population. The very low representation of children aged <5 years is particularly problematical, since the low number of respondents limits the precision of the estimates in this age group. In the overall picture, the underrepresentation of children aged <15 years may lead to underestimated incidence figures in the overall population, since the AGI symptoms are more common in the youngest age groups. Another representativeness problem relates to the poor compliance of study respondents living in small households. Although people in Poland tend to live in small households with ⩽3 residents, the majority of our respondents were recruited from larger households. This may reflect better availability of larger-household residents when random digit dialling is used. The overrepresentation of larger households may lead to an overestimate of AGI incidence. Another limitation of our study was caused by the potential co-existence of AGI symptoms with acute respiratory illnesses (ARI), both of which can be caused by either enteric disease or respiratory infection [20]. In the analysis presented, we did not adjust for the coincidence of AGI with respiratory

symptoms. Finally, the widely discussed limitation of retrospective studies that collect information on self-reported AGI episodes, resulting in an overestimate of intestinal illness prevalence by so-called telescoping, i.e. where respondents perceive AGI symptoms to have occurred more recently than they actually did, should not be dismissed [8]. Recent studies, however, refute this hypothesis, since longer recall periods lead to underestimates of AGI burden [9, 13, 21]. In this context, it is important to compare the results of studies that use the same recall period and AGI case definition.

In conclusion, despite numerous limitations in this cross-sectional survey, we were able to select a fair representation of inhabitants of all Polish regions and document a high incidence of self-reported AGI cases in Poland. AGI constitutes a considerable burden to society, with an estimated 33·3 million infections, 10·1 million GP consultations, 1·5 million hospital admissions, and 16·3 million lost work days among professionally active people. The present results are a starting point for the next phase of AGI burden studies in Poland, which will consist of calibrating disease-specific surveillance estimates, and further identification of gaps in AGI case reporting. Future studies should consider inclusion of mobile telephone numbers, focus more on concomitant respiratory symptoms, and select larger samples weighted by age distribution in the community.

## NOTE

Supplementary material accompanies this paper on the Journal's website (http://journals.cambridge.org/hyg).

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## DECLARATION OF INTEREST

None.

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