Prevalence And Distribution Of Acute Gastrointestinal Illness In The Community Of China: A Population-Based Face-To-Face Survey, 2014-2015

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Abstract

Background: The true incidence of acute gastrointestinal illness in China is underrecognized by surveillance systems. The aims of this study were to estimate the incidence and prevalence of self-reported AGI in the community of China, and to investigate sociodemographic and epidemiological determinants of AGI.

Methods: We conducted a 12-months cross-sectional population-based survey in eight provinces of China during 2014-2015. The survey determined the prevalence and incidence of acute gastrointestinal illness (AGI) in the total permanent resident population in China according to the census of the population in 2010. The random multilevel population sample was stratified by geographic, population, and socioeconomic status. We used a recommended case definition of AGI, with diarrhea three loose or watery stools and/or any vomiting in a four-week recall. A face-to-face survey was conducted by selecting the member in the household with the most recent birthday.

Results: Among 56,704 sampled individuals, 948 (1,134 person-time) fulfilled the case definition; 98.5% reported diarrhea. This corresponds to 2.3% (95% CI:1.9%-2.8%) of an overall standardized four-week prevalence and 0.3 (95% CI: 0.23-0.34) episodes per person-year of annual adjusted incidence rate. There was no significant difference between males and females. The incidence rates were higher mong urban residents, and in the spring and summer. In the whole study period, 50% of the cases sought medical care, of which 3.9% were hospitalized and 14.3% provided a biological sample for laboratory identification of the causative agent. Children aged 0–4 and young adults aged 15–24, people living in rural areas and people who traveled frequently had higher prevalence of AGI.

Conclusion: Results showed that AGI represents a substantial burden in China, and will contribute to the estimation of the global burden of AGI. Complemented with data on the etiologies of AGI, these estimates will form the basis to estimate the burden of foodborne diseases in China.

Introduction

Acute gastrointestinal infections (AGI), including foodborne diseases, are common and cause substantial public health and socioeconomic impact globally. The World Health Organization (WHO) estimated that, in 2010, 22 foodborne enteric agents caused two billion illnesses, over one million deaths, and 78.7 million DALYs [1]. Although enteric disease manifests primarily as self-limiting AGI, appearing as diarrhea or vomiting, more severe disease and even death can occur [2].

Knowledge of the magnitude, distribution, and demographic factors associated with AGI is a requirement for estimating the burden of disease of acute gastroenteritis of foodborne origin, the burden caused by specific pathogens commonly transmitted through foods, and the burden caused by specific foods or food groups [3]. Such evidence is key to define strategies for disease prevention. However, data obtained from public health surveillance does not reflect the true burden of AGI, reflecting any failure in the process between a patient becoming ill and the case being reported: patients often do not seek medical care, samples and laboratory analyses may not be performed, and results may go unregistered [4–6]. In China, a pilot study preformed in six sourthen provinces between 2010 to 2011 estimated the incidence of AGI [7]. However, it did not include northen and western provinces, and thus was not representative of the whole China. Inspired by this survey, some provinces estimated their own provincial data in the survey or conducted the similar national survey in the next year follow the China CDC's instruction [8, 9].

The main aims of this study were to estimate the incidence of self-reported AGI in China using a face-to-face method, and to investigate sociodemographic and epidemiological factors as determinants of AGI. Furthermore, we also assessed clinical manifestations and utilization of medical services in cases of AGI. This third nationwide population-based study on AGI covered eight provinces in the period between 2014 and 2015. The estimated AGI incidence will also provide an important parameter for estimation the burden of foodborn diseases in China.

Methods

Study design and population

We conducted a nationwide population-based retrospective face-to-face survey, implemented over 12 months. The population under study comprised persons resident in the survey site for more than six months; infants born within six months were included. The targeted sample size was calculated according to the residential population of selected provinces, expected incidence, and relative risk (allowed error) with 95% confidence intervals and 20% of the loss rate of follow-up using EPI INFO 3.5.1 .

We used a multi-stage stratified random sampling method to select the subjects. In the first sampling stage, eight survey provinces or municipalities from China were selected according to geographic, population and socioeconomic status, and food preference by stratified random sampling method. These sites were: Jilin province, Northeast China; Beijing, North China; Shanghai and Jiangsu province, East China; Guangdong province, South China; Henan province, Central China; Gansu province; Northwest China; and Sichuan province; Southwest China (Figure 1). In the second stage, three cities within each province were selected by simple random sampling method from each province. In the third stage, one district and one county were chosen from each city. In the fourth stage, five villages and towns from each district and county were selected. Finally, 96 households within each villange or town were selected by simple random sampling for 12 months, among which eight households were visited per month in one selected district or county.

Contact of the selected households was attempted up to three times. To allow for the maximum number of people to be contacted, social workers or villager's committees acquainted with household registration were contacted in advance. The interviewers and social workers made an appointment with the members of the household during off-dutty hours if some of them were working in the daytime. The household was calculated as a loss to follow-up if it household remained uncontacted up to three times or refused to be interviewed without a neighboring replacement. The interviewer determined if the household contained two or more adults, and then asked to speak with the adult household member with the most recent birthday. Study participants were enrolled from April 2014 to March 2015. All the interviews were conducted in Chinese with local accent, including Cantonese to make understandable.

The representativeness of the sample was improved by weighing. These weights were generated to avoid deviation of the target population to the whole chinese population based on data from 2010 (6th) National population census in China [10].

The questionnaire collected socio-demographic information on the respondant (gender, age, education, occupation of the main earner, family income and jurisdiction), recent travelling history, information on the etiology of infection, AGI symptoms, related health care-seeking behaviors, treatment, eventual absence from work associated with illness and direct/indirect expenses.

Case definition

To ensure that the case definition was simple and applicable, as well as comparability with the results from other surveys conducted globally, we used the standard case definition advocated by the international collaboration on enteric disease 'Burden of Illness' Studies [11]. AGI was defined as *having had at least three episodes of loose stools or any vomiting in any 24-h period*. Participants who reported having fewer than three loose stools in a 24-h period were not counted as a case. Any AGI symptoms caused by a non-infectious gastrointestinal illness like chronic gastrointestinal diseases (Crohn's disease, ulcerative colitis, stomach cancer, and intestinal tumors, irritable bowel or coeliac disease), or alcohol or drugs, or normal physiological phenomena like pregnancy and menstruation were also excluded.

Data analysis

EpiData version 3.1 (EpiData Association, Odense M, Denmark) was used for data collection. All data were weighted by sampling frame and adjusted by age, gender and residency based on the sixth national population census data in 2010. The analysis was performed using SAS 9.4 (SAS Institute Inc., Cary, NC, USA).

Four-week incidence (I4 wk) and incidence proportion (expressed in %) were calculated, along with 95% confidence intervals (CIs). The annual incidence (I annual) was calculated as I annual= I4 wk × (365/28) and expressed in terms of episodes/person per year [11]. Qualitative data were described using percentages or proportions, and quantitative data were statistically described using mean and 95% confidence intervals. Values of P<0.05 were considered statistically significant. The null hypothesis of no association between prevalence of disease and age group, cultural group, total household income level, and highest education level was tested usingtest. We measured the association between disease determinants as explanatory variables and the defined AGI cases as the outcome variable, defined as odds ratios (ORs), using multivariable logistic regression. For comparison of average means between age groups and gender, the two-tailed P-value from linear regression was used.

Ethical approval

Ethical approvals were granted by China National Center for Food Safety Risk Assessment's Ethical Board. All data collected including the names, addresses, and telephone numbers of the participant were kept confidential. Each participant was asked to read and sign a consent form that informed about the purpose of the survey before the questionnaire was administered.

Results

Sample and response rates

In total, 58,320 interviews were completed in the period between April 2014 to March 2015. Among these, 56,704 (97%) valid responses were obtained.

AGI occurrence

At least one episode of acute gastroenteritis was reported by 2.3% (95% CI: 1.9-2.8%) of respondents in the four weeks before the interview, corresponding to a rate of 0.3 (95% CI: 0.23-0.3) episodes per person per year. The prevalence was higher in summer months (Figure 2). The mean duration of illness was 11.3 hours (95% CI: 3.5-14.5). Half of the respondents seeked medical care (49.8%; 95% CI: 43.9-55.6). Nearly half (47.0%; 95% CI: 42.4-51.6%) of the patients who seeked medical care were taking some type of medication; 17.6% (96% CI: 14.4-21.4%) reported taking anti-diarrhoeal medication.

Although there were some differences in the prevalence of AGI in some age groups, particularly in the populagion 15-24 years of age (Figure 3), results showed there were no significant differences in the incidence of AGI between males and females. The incidence was higher among children below 5 years (Figure 3). Results of multivariate analysis showed that occupation of the main earner, and traveling history were significantly associated with acute gastroenteritis (Table 1).

For 17.4% (95% CI: 14.2-21.2%) of those with AGI, they or a member of their family took time off work due to the diarrhea episode. The median number of days off was two, and the mean was 2.7 days.

Socio-demographic characteristics of AGI

Estimates of the 4-week and annual incidence of AGI in China with specific demographic characteristics are presented in Table 1. There was no significant difference in the incidence of AGI between males and females (0.26 vs 0.31). Except for the traits of age groups mentioned above, the overall incidence of AGI was high in Han nationality than in Other nationality (0.29 vs 0.08, P=0.537). The prevalence of AGI in the north of China was slightly lower than the rate in the south (0.23 vs 0.21, P=0.097). There was no significant difference in the incidence of AGI between Urban and Rural residence and household income.The tendency of incidence seemed highest in preschool children and declined with the increase of educational levels, however differences were not significant. There was a borderline significant difference in incidence of AGI between participants with blue

collar jobs and with white collar jobs (0.28 vs 0.45 p=0.053). The incidence of AGI was significantly higher in participants who had travelled within two weeks than in those who had not (0.89 vs 0.27). Respondents living in a household with two persons were significantly less likely to have experienced AGI than individuals living alone. The prevalence of AGI varied by proviences, with the highest in Gansu (0.41, P<0.001), and the lowest in Beijing (0.10, P<0.001).

Table 1. Incidence estimates and determinants for acute gastrointestinal illness (AGI) in China, 2014-2015 (weighted) (n= 56,704). Statistically significant values are highlighted in bold.

Determinants	Sample size	No. of AGI cases (unweighted)	4-week incidence	Annual incidence#	95% CI*	OR	95% CI	P value
Total	56,704	1,134	2.16	0.28	(0.23-0.34)	-	-	-
Gender								
Male (n= 28047)	28,047	547	1.96	0.26	(0.19-0.32)	1.07	0.94-1.22	0.298
Female (n= 28657)	28,657	587	2.36	0.31	(0.22-0.40)	Ref.	Ref.	Ref.
Age								
<5	1,493	44	2.93	0.38	(0.22,0.55)	**0.61**	**(0.44,0.85)**	**0.003**
5-14	2,777	55	1.46	0.19	(0.10,0.30)	1.03	(0.76,1.41)	0.844
15-24	3,431	66	2.49	0.33	(0.17,0.50)	1.06	(0.79,1.41)	0.713
25-44	14,870	318	2.34	0.3	(0.21,0.40)	Ref.	Ref.	Ref.
45-64	22,323	426	1.8	0.23	(0.17,0.30)	1.15	(0.98,1.35)	0.085
≥65	11,810	225	2	0.26	(0.17,0.36)	1.12	(0.93,1.35)	0.233
Ethnicity								
Han	55,210	1098	2.22	0.29	(0.23,0.35)	1.127	(0.77,1.65)	0.537
Other	1,494	36	0.58	0.08	(0.01,0.15)	Ref.	Ref.	Ref.
Geographical								
North	28,075	555	1.8	0.23	(0.15,0.32)	1.12	(0.98-1.27)	0.097
South	28,629	579	2.4	0.31	(0.24,0.38)	Ref.	Ref.	Ref.
Residence								
Urban	26,178	505	2.65	0.23	(0.15,0.32)	1	(0.88, 1.14)	0.982
Rural	30,526	629	1.81	0.31	(0.24,0.38)	Ref.	Ref.	Ref.
Education								
Preschool children	1900	49	2.41	0.31	(0.18,0.45)	**0.72**	**(0.52,1.00)**	**0.052**
Illiterate	4065	96	2.24	0.29	(0.12,0.48)	0.95	(0.72,1.25)	0.696
Primary school	13301	286	1.89	0.25	(0.17,0.33)	1.01	(0.82,1.24)	0.913
Middle school	18388	340	1.74	0.23	(0.14,0.33)	**1.22**	**(1.00,1.49)**	**0.055**
High school	10579	196	2.25	0.29	(0.16,0.43)	1.16	(0.93,1.45)	0.19
Undergraduate and above	8,471	167	3.14	0.41	(0.27,0.55)	Ref.	Ref.	Ref.
Occupation								
While collar job	7,402	175	3.49	0.45	(0.27,0.66)	Ref.	Ref.	Ref.
Blue collar job	17,624	377	2.14	0.28	(0.17,0.38)	**0.82**	**(0.68,1.00)**	**0.053**

Others	31,678	582	1.85	0.24	(0.19,0.30)	1.08	(0.94,1.25)	0.281
Household income								
<20,000 RMB/person	28,822	617	1.82	0.24	(0.17,0.31)	Ref.	Ref.	Ref.
20,000–50,000RMB/person	17,347	351	3.01	0.39	(0.27,0.53)	1.01	(0.88,1.17)	0.864
>50,000 RMB/person	5,270	92	2.16	0.28	(0.14,0.43)	1.17	(0.92,1.48)	0.205
Non-reported	5,265	74	1.95	0.25	(0.12,0.38)	**1.38**	**(1.07,1.78)**	**0.015**
No. of persons in household								
1	7,382	122	2.53	0.33	(0.17,0.53)	Ref.	Ref.	Ref.
2	19,689	426	2.75	0.36	(0.24,0.48)	**0.8**	**(0.64,1.00)**	**0.046**
3	16,188	317	1.93	0.25	(0.16,0.35)	0.88	(0.70,1.10)	0.27
≥4	13,445	269	1.94	0.25	(0.17,0.34)	0.88	(0.70,1.12)	0.3
Travel within two weeks								
Yes	1,001	36	6.81	0.89	(0.39,1.46)	Ref.	Ref.	Ref.
No	55,701	1092	2.08	0.27	(0.22,0.33)	**0.41**	**(0.30,0.50)**	**<0.001**
Non-reported	1	-	-	-	-	-	-	
Province								
Beijing	9,885	131	0.73	0.1	(0.05,0.15)	Ref.	Ref.	Ref.
Jilin	5,906	167	3.04	0.4	(0.24,0.56)	**0.48**	**(0.37, 0.62)**	**<0.001**
Shanghai	8,407	149	1.62	0.21	(0.14,0.28)	**0.73**	**(0.57, 0.95)**	**0.018**
Jiangsu	6,948	187	3.58	0.47	(0.31,0.63)	**0.47**	**(0.37, 0.59)**	**<0.001**
Henan	5,433	63	1.14	0.15	(0.07,0.22)	1.06	(0.77, 1.46)	0.717
Guangdong	5,745	108	1.99	0.26	(0.16,0.36)	**0.66**	**(0.50, 0.86)**	**0.003**
Sichuan	7,529	135	2.25	0.29	(0.20,0.39)	**0.72**	**(0.55, 0.94)**	**0.014**
Gansu	6,851	194	3.15	0.41	(0.21,0.64)	**0.54**	**(0.42, 0.69)**	**<0.001**

* CI: Confidence interval

Annual incidence specified as episodes per person-year

Symptoms, healthcare, and impact of AGI

Among the 1,134 cases, 1,122 (98.9%) reported suffering from diarrhoea, 238 (21%) reported suffering from vomiting and 226 (19.9%) cases experienced both symp-toms. Of the 1,122 cases with diarrhoea, 16 (1.4%) had bloody diarrhoea. Respiratory

symptoms were reported by 10.4% of all the cases, usually not associated with intestinal disease. The information on the duration of illness, presence of concurrent symptoms and recourse to healthcare is reported in Table 2. The average duration of illness was 46.4 hours. Children in the 0–4 year group had a significantly higher fever rate (39.5 %) than other age groups ($p < 0.001$). On the worst day of symptoms, cases reported diarrhoea anaverage of 4.2 times (range 3–16 times) and vomiting anaverage of 2.4 times (range 1–11 times).

Table 2. Proportions and average means for associated factors, care seeking and treatment of acute gastrointestinal illness cases in China, by age and gender (n= 948)

	Age group (years)							P value for age*	Male	Female	P value for gender*
	Total	0-4	5-14	15-24	25-44	45-64	65-				
Diarrhoea (%)	98.94	97.67	97.87	98.28	98.87	99.42	98.94	0.283	99.11	98.79	0.624
Vomiting (≥1 times/day) (%)	20.95	39.53	36.17	22.41	22.26	17.44	17.02	**<0.001**	18.4	23.28	0.066
Bloody diarrhoea (%)	1.39	2.38	0	0	2.29	0.58	2.15	0.665	0.89	1.84	0.225
Fever (>38°C) (%)	11.85	39.53	29.79	6.9	10.94	9.88	7.45	**<0.001**	11.97	11.74	0.912
Respiratory symptoms(%)	10.36	27.91	12.5	6.9	8.3	10.17	10.11	0.173	11.5	9.31	0.27
Stool sample (%)	11.88	15.63	3.57	20	8.65	11.11	17.74	0.408	8.7	14.67	0.09
Outpatients (%)†	36.65	74.42	59.57	34.48	39.62	28.86	32.98	**<0.001**	35.7	37.53	0.561
Hospitalized (%)	4.02	0	0	5	4.76	4	6.35	0.059	1.84	5.95	0.066
Work absenteeism (%)	13.21	9.3	14.89	15.52	20.08	11.5	6.38	**0.001**	12.22	14.11	0.394
Medication taken (%)	78.69	95.35	85.11	72.41	75.85	76.61	82.98	0.838	78.44	78.9	0.863
Medication prescribed (%)	42.72	68.29	57.5	42.86	47.76	35.5	37.82	**<0.001**	42.78	42.67	0.978
Diarrhea medication(%)	45.6	69.23	35.56	34.48	45.95	43.15	50.54	0.557	46.22	45.04	0.719
Antibiotics medication (%)	44.75	25.64	66.67	44.83	46.54	44.35	41.62	0.315	44.65	44.83	0.954
Painkiller medication(%)	5.12	5.13	8.7	8.62	6.59	2.69	5.46	0.089	5.52	4.76	0.604
Antipyretic medication (%)	2.84	15.79	6.52	5.17	3.49	1.2	0.55	**<0.001**	2.53	3.11	0.6
Mean duration of using medication (hours)	46.43	49.95	35.92	31.1	45.63	42.47	n.a.	0.497	43.56	49.03	0.061
Mean duration of symptoms (hours)	42.19	50.11	37.52	35.19	41.39	38.49	n.a.	0.068	40.92	43.37	0.398
Mean duration of hospitalisation (hours)	121.71	n.a.	n.a.	72	115.2	156	108	0.814	56	139.64	0.151
Mean duration of work absenteeism (days)	2.47	n.a.	1.84	1.44	2.1	3.13	n.a.	**0.001**	2.36	2.56	0.572
Mean duration before seeing doctor (hours)	15.36	15.56	12.61	10.1	16.1	13.56	19.82	0.218	15.5	15.24	0.897

The healthcare-seeking behaviour of AGI cases, medication taken by cases, and the source of the medicine are reported in Table 3. 36.7% of all the cases took outpatient services,while 4% were hospitalized. Outpatient services-seeking behaviour varied by age; the percentage of service-taking for AGI was highest (74.4%) in children aged <5 years. 11.9% of all the cases reported providing a stool sample for laboratory testing. In total, 78.7% of all the cases took medication for AGI. Nerlay half (44.8%) of all cases have taken antibiotics, while 5.1% reported taking pain killers and 2.8% antipyretics. Only 42.7% reported that the medication was prescribed by a doctor.

Table 3. Distribution of medical institutions utilized by acute gastroenteritis cases.

Hospitals	Outpatients		Hospitalized	
	n=346	%	n=14	%
Grades of hospital				
Tertiary hospital	26	7.51	0	0.00
Secondary hospital	48	13.87	8	57.14
Primary hospital	81	23.41	5	35.71
Other hospital	191	55.20	1	7.14
Types of hospital				
General hospital	113	32.66	10	71.43
Children's hospital	4	1.16	0	0.00
Chinese medicine hospital	12	3.47	2	14.29
Other hospital	217	62.72	2	14.29
Classification of hospital				
Provincial and ministerial hospital	6	1.73	0	0.00
City hospital	31	8.96	1	7.14
County hospital	28	8.09	4	28.57
Community health center	110	31.79	6	42.86
Health service station	130	37.57	0	0.00
Private hospital	9	2.60	3	21.43
Individual clinic	31	8.96	0	0.00
Other hospital	1	0.29	0	0.00

Discussion

We estimated the magnitude and distribution of AGI in the community in China using a large-scale population-based study. Our results showed that the prevalence of AGI in the population was 2.3%, corresponding to an incidence of 0.3 episodes per person per year. In other words, our study suggests that one in every three Chinese residents suffers from AGI every year. This was the first survey provide nationwide representative estimates of the prevalence and incidence of AGI in China.

Applying the synchronized interviewing cycle and the same questionnaire, this survey covered not only north and south representative provinces in China, but also provinces representing the northwest (Gansu province) and southwest (Sichuan province), thus providing national representative data on the incidence and distribution of AGI in the population. We applied a face-to-face methodology similar to what has been used in other stucies [12, 13]. Similarly to those studies, we achieved a

high average response rate of 97.2% when compared to telephone-administered surveys conducted in most developed countries. The high response rate was not only determined by the face-to-face interviewing, but also greatly benefited from cooperative street residents' committee from selected residential district or villages.

Seasonality and geography

The results showed a seasonal distribution of AGI during the study period that is in line with the normally expectation- of high incidence of AGI in summer and low incidence in winter. The data showed it's peak in sping and summer, and lower incidence in autumn and late winter, but relative high in early winter. The variation is likely to reflectthe seasonal variation in infections with viral enteric pathogens in colder months as seen in other studies [14–17]. China is so large that temperatures and other meteorological factors typical of different seasons vary by province during the same period. For example, when the southern region is in summer, the northen region is in early sping, and in topography descends from the west to the east. As a result, the seasonality of AGI of bacterial origin is not synchronized. An analysis stratified by province and season would be needed to clarify such variations.

Determinants

We did not observe significant differences in the likelihood of having AGI in individuals with different leves of education, with different levels of income, or living in urbanized or rural areas. Travelling within two weeks was a significant risk factor, which is in accordance to what seen elsewhere [18].

Healthcare utilization

Care seeking behavior and utilization of healthcare services was high in all age groups. Half of survyed individuals that reported AGI went to primary and lower health care institutions for medical care, which represents a higher rate of seeking medical care than estimated by other countries such as the United States (19%) [18], Ireland (19.5%) [19], Canada (20.4%) [20], Australia (19.5%) [21] and Denmark (12%) [15], Cuba (17.1%-38.1%) [22] and Argentina (26%) [12]. It remains to be investigated if this disproportion is caused by the attention to disease, the attitude towards medicine., different medical insurance systems or differences in healthcare systems. The collection rate of biological samples in this survey was 14.3%, which is close to Canada (14.4%) [20] and Ireland (14.9%) [19], but lower than Australia (18.4 %) [21] and the United States (21.1%) [18]. These results showed that the attention of hospitals in China to investigating the causes of AGI still needs to be improved, and suggest that the central and local governments should increase awareness and investment to improve the sampling rate of patients' and the rate of laboratory diagnistics, so as to better grasp the etiology of acute gastroenteritis.

The hospitalization rate of AGI in our survey was 7.9%, suggesting a high proportion of severe cases of AGI in China. This index was not included in the previous domestic survey [7].

Nearly 80% of cases were treated with drugs, among which 62% use antibiotics, a much higher proportion estimated in other countries (US: 8.3%, Ireland: 5.6%, Canada: 3.8%, Australia: 3.6%, Italy: 6.5% Argentina: 7%, Cuba: 6.5-18.9%) [12, 14, 18–20]. Oversuse or misuse of antimicrobials may lead to antimicrobial resistance, an important public health concern globally. These estimates suggest that there is still a long way to go to popularize the legal knowledge of the scientific use of antibiotics in China.

Domestic comparison

The estimated incidence of AGI in China of 0.28 (95%CI: 0.23-0.34) episodes per person was lower than the rate of 0.56 (95% CI: 0.56-0.57) episodes per person per year estimated by the previous survey conducted between 2010 to 2011 [7]. However, they were similar to the estimation of 0.31 episodes per person per year calculated by reviewing scientific literature [23]. The

differences in the estimates of the different surveys may be explained by several factors. First, differences in the selection of provinces in the survey design, since China has great population diversity, which may also be reflected in diarrhea incidence and risk factors. All the provinces selected by the previous survey were southern provinces. On the contrary, our study took place in eight provinces that represent all the traditional seven regions of China [24]. Second, in the past several years, the Chinese government has continuously improved the food safety regulation systems, developed innovative regulation mechanisms, established a structure for developing food safety standards and successfully dealt with intentional food safety issues [25]. Risk communication was also enhanced. As examples, many ministries and departments jointly organized the Food Safety Awareness Week and Open Day. Several activities based on data generated from greatly improved foodborne disease surveillance since 2011 were also implemented. In 2013 alone, 120,000 supervision staff, more than 4,000 experts and scholars, and 35 million employees participated in activities. Hundreds of media issues nearly 20,000 news reports and over 300, 000 micro-blogging topics [25]. These activities have also had an impact on public awareness and engagement in food safety practices. The overall food safety status has improved steadily, and may be reflected in the burden of diarrheal diseases.

International comparison

Several cross-sectional surveys have been conducted in other countries to estimate the prevalence and distribution of AGI. In America [26–38], Europe [2, 39–47], Oceania[48, 49], Asia [50] and Africa [51].

The estimated incidence of AGI in China is comparable to similar retrospective studies conducted in Sweden and France, which reported 0.31 and 0.33 episodes of AGI each year, respectively, in spite of slightly different case definitions and recall periods. It is also similar to estimates of prospective follow-up studies in The Netherlands (0.28) (ranging from 0.42 to 1.66 episodes/person-year) [52]. However, it is lower than observations in almost all the similar cross-sectional studies conducted in other countries or regions, no matter what interviewing methods they used, and higher than rate from England and Wales (0.19) [53]. Nevertheless, comparisons between countries need to consider the varying case definitions, interviewing and sampling methods, and general differences in populations.

Our study used criterion for the identification of AGI recommended by an international collaboration focusing on burden of foodborne illnesses [54]. However, most studies, unlike ours, used a telephone survey; some of them used random digit dialing techniques or modified version to selectparticipants [14, 15, 17, 55]. Other possible explanations for the differences in AGI incidence include cultural aspects and likelihood to answer questions openly. Chinese people are not used to talk about their health status in front of strangers, no matter if in public or in private, especially in big cities like Beijing Shanghai. Furthermore, our survey had a very high response rate. With the help of social workers in resident's committees or villager's committees, almost all the selected household participated, and we had a response rate of 97%. In contrast, the response rate in other countries was below 70%, but there is a possibility that people who have AGI recently are more inclined to respond. Other explanations for differences in reported incidence of diarrhea may include differences in risk factors such as food consumption and preparation habits, food contamination, or environmental factors.

Limitations and strengths

In this survey, the samples were weighted and standardized to make the survey sample representative. However, there are still some biases in the survey: the young and middle aged labor force in rural areas worked in the cities, while the young and middle aged labor force in cities work in the daytime; this may have resulted in more elderly people in the sample population, In addition, the selection of survey sites failed to give full consideration to China's western minority areas, such as Tibet and Xinjiang. At the same time, some groups of group-life accommodation (such as inpatients in hospitals, elderly people in nursing homes, students in long-term accommodation, prisoners in prisons and officers and soldiers in barracks) were not covered. This might have introduced selection bias. Furthermore, our study suffered from the limitations of all cross-sectional surveys. Its results reflect only real time data from the survey sample, and is difficult to make causal inferences.

Impact

Our estimates provide evidence on the incidence of AGI in the population. Due to underdiagnosis and underreporting, such data are not available from public health surveillance. However, it is crucial to demonstrate the true burden of diarrheal diseases in the population. This burden is not only of a health nature, but also social and economic. Fo example, our estimates demonstrated that at least 17% of respondants or caretakers with AGI loss a mean 3 days of work due to the illness. If extrapolated to the population, this equates to approximately 1.5 million working days loss due to AGI annually. Together with healthcare costs, this represents a substantial burden nationally. When combined with evidence on the contribution of different causative agents for the overall incidence of AGI, these estimates will form the basis to estimate the burden of foodborne diseases in China.

Abbreviations

AGI: Acute gastrointestinal illness; CDC: Centers for Disease Control and Prevention; CI: Confidence interval; REF: References; OR: Odds ratio; SAS: Statistics Analysis SystemS

Declarations

Ethics approval and consent to participate

Ethical approvals were obtained from the China National Center for Food Safety Risk Assessment's Ethical Board & Ethical approval number 2013-01. The study which has no interventions and treatment measures was in Accordance with *Measures for the Ethical Review of Biomedical Research Involving Humans* issued by the Ministry of Health All participants gave written informed consent to participate in the study. All data collected including the names, addresses, and telephone numbers of the participant were kept confidential. Each participant was asked to read and sign a consent form that informed about the purpose of the survey before the questionnaire was administered.

Consent for publication

Not applicable

Availability of data and materials

All data generated or analyzed during this study are included in this article

Competing interests

The authors declare that they have no competing interest

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Authors' contributions

Jikai Liu: Writing-Introduction, partial Discussion, and partial Result. Baozhang Luo: Data curation and statistics, Funding acquisition, Writing-Methodology and Visualization. Yijing Zhou: Writing: partial Result, Investigation. Xiaochen Ma: Data curation, Resources, Investigation, and Writing - review. Junhua Liang: Resources, Data curation, Investigation, and Writing-partial Discussion. Xianglai Sang: Data curation, Resources, Investigation, and Writing - review. Le Lv Data curation, Resources, Investigation, and Writing - review. Wen Chen: Data curation, Resources, Investigation, and Writing - review. Pengyu Fu: Data curation, Resources, Investigation, and Writing - review. Hong Liu: Survey and questionnaire design. Data curation, Supervision. Shiqi Zhen: Data curation, Supervision. Resources, Investigation. Chao Wang: Data collection and curation and Resources, Investigation. Yangbo Wu: Data collection and curation and Resources, Investigation. Qiong Huang: Data curation, Resources, Investigation, and Writing - review Xiaocheng Liang: Data curation, Supervision. Resources, Investigation. Guangda Bai: Data curation, Supervision. Resources, Investigation. Zhen Lan: Data curation, Supervision. Resources, Investigation. Shufang Zhang: Data curation, Supervision. Resources, Investigation. Ning Li: Validation. curation, supervision. Yongning Wu: Curation, Supervision.Yunchang Guo: Conceptualization, Project administration, Funding acquisition. Sara M. Pires: Writing - review & editing.

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Figures

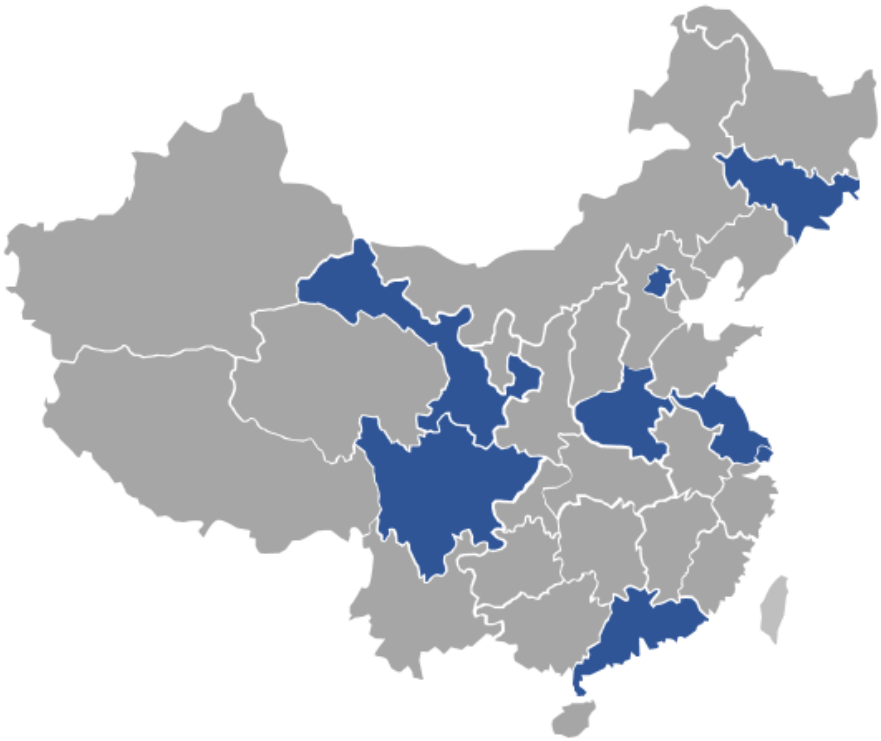

Figure 1

Distribution of survey sites of the population-based retrospective face-to-face acute gastrointestinal disease survey, corresponding to provinces or municipalities in mainland China selected stratified random sampling method.

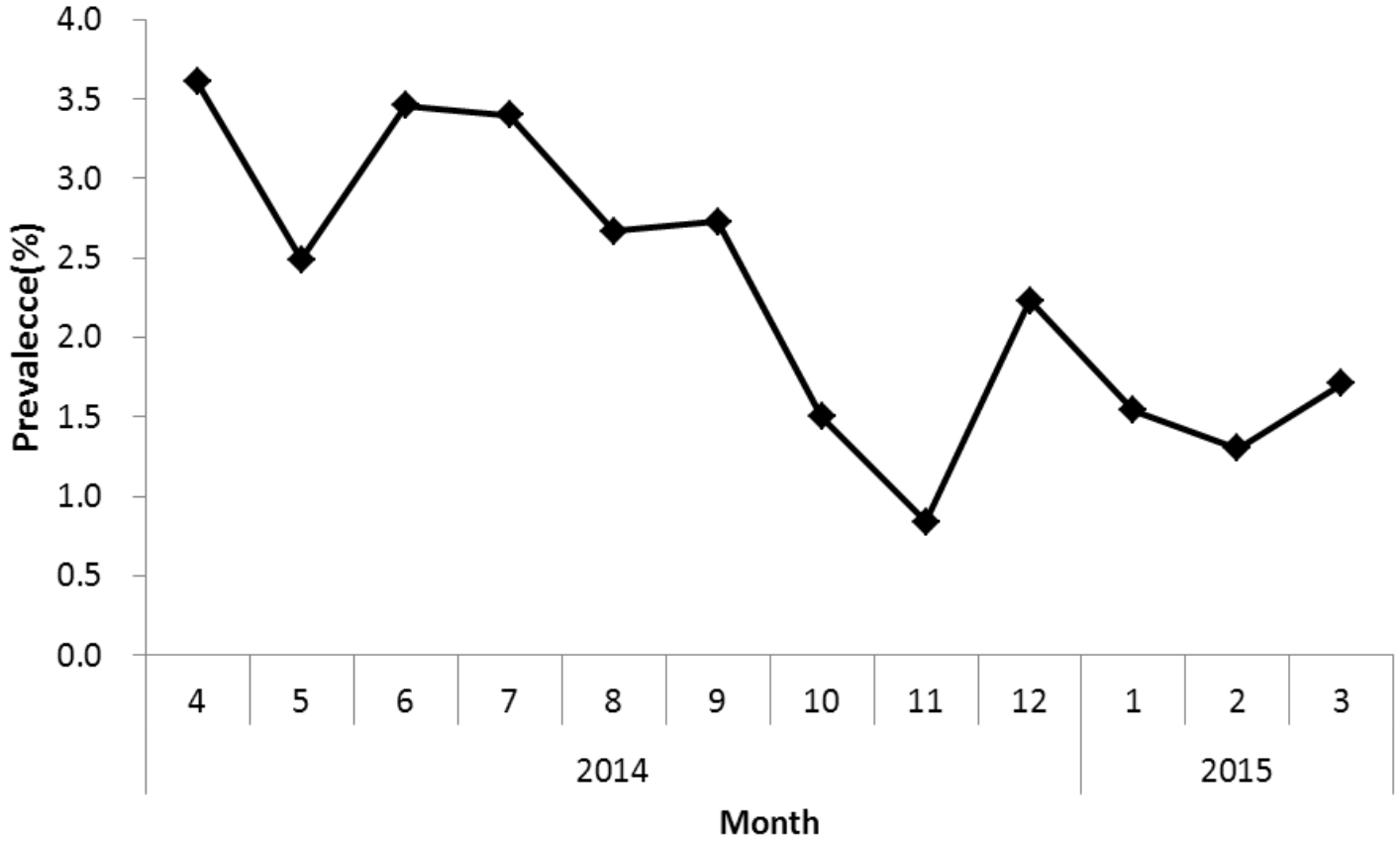

Figure 2

Prevalence of acute gastronenteritis in the overall population by month, 2014-2015.

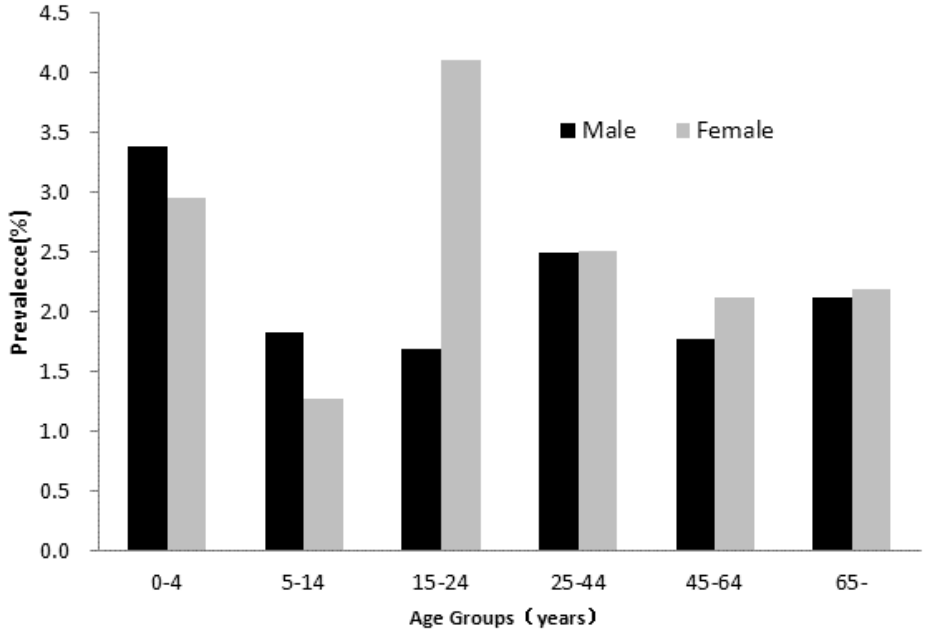

Figure 3

Prevalence of acute gastrointests in mainland China, by age and gender.