



한국 단일기관 응급실을 방문한 소아환자에서 급성위장염 발생과 지역 기온의 상관관계

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Correlation between the occurrence of acute gastroenteritis in children and regional temperature at a tertiary hospital emergency department in Korea

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Purpose: Several studies have investigated the association between acute gastroenteritis (AGE) and regional temperatures. We aimed to investigate the correlation between the occurrence of AGE and regional temperature in Korean children.

Methods: We reviewed the clinical characteristics of children aged 18 years or younger with AGE, defined according to the International Statistical Classification of Diseases, 10th Revision codes, who visited a Korean tertiary hospital emergency department (ED) between 2006 and 2016, and compared the children who were discharged from the ED and those who were hospitalized. Data on temperature in Seoul, Korea during the period were obtained from the Korea Meteorological Administration. Subsequently, we assessed correlations between the monthly mean numbers of the children with AGE and monthly mean temperature using Pearson's correlation analysis.

Results: A total of 31,931 children with AGE visited the ED. Vomiting was the most common manifestation (62.0%). Fever, chills, cough, and sputum were more frequent in the hospitalized children ($P < 0.05$). Hospitalization rate was highest (2.7%) and monthly mean temperature was lowest (-2.4°C) in January. We observed negative correlations between the monthly mean numbers of the children with AGE and the monthly mean temperature (for ED visit, $r = -0.845$; for hospitalization, $r = -0.923$).

Conclusion: Children with AGE tend to visit the ED, and undergo hospitalization during the cold weather. This finding could help the guardians to expect the occurrence of AGE, and physicians to facilitate the allocation of resources for emergency medicine in winter.

Key words: Association; Child; Epidemiology; Gastroenteritis; Korea; Temperature

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Introduction

Acute gastroenteritis (AGE) is a common disease of childhood, affecting children several times per year. Thus, associated losses of time and costs are high¹⁻³. Because the occurrence of this entity is known to be influenced by regional temperature⁴⁻⁶, this regional

temperature-associated difference in incidence of AGE may appear in Korean children with AGE as well, but insufficient research has been performed on it.

A seasonal assessment of the number of children with AGE who visit the emergency department (ED) may help the guardians to expect the entity, and physicians to facilitate the allocation of resources for emergency medicine in appropriate seasons. Studies regarding the association between the occurrence of AGE due to *Campylobacter* spp. and regional temperature showed conflicting results^{7,8}. To our best knowledge, no authors reported the association in the Korean children.

We aimed to investigate the correlation between the occurrence of AGE and regional temperature in children who visited a Korean tertiary hospital ED.

Methods

1. Study design and setting

This retrospective chart review included children aged 18 years or younger with AGE who visited the Severance Hospital ED in Seoul, Korea, between 2006 and 2016. The ED provided care to approximately 20,000 children in 2016. AGE was defined according

to the International Statistical Classification of Diseases and Related Health Problems, 10th Revision codes for AGE (A09). We excluded children having similar symptoms attributed to other causes. The study was approved by the Institutional Review Board (IRB No. 4–2018–0036).

2. Data collection

Clinical characteristics, including age, gender, and clinical manifestations (fever, chills, cough, sputum, rhinorrhea, poor oral intake, anorexia, nausea, vomiting, constipation, diarrhea, and abdominal pain), were collected and compared between the children who were discharged from the ED and those who were hospitalized. We investigated the correlations between the occurrence of AGE (monthly mean numbers of the children with AGE who visited the ED, and of those who were hospitalized) and regional temperature (monthly mean temperature in Seoul during the study period) in the ED. Data on the latter variables were obtained from the Korea Meteorological Administration⁹ (Appendix 1).

3. Statistical analysis

Clinical characteristics of the discharged and

Table 1. Clinical characteristics of the children with acute gastroenteritis who visited the emergency department

Variable	Total (N = 31,931)	Discharge (N = 31,293)	Hospitalization (N = 638)	P value
Age, y	3.7 ± 3.5	3.8 ± 3.5	2.4 ± 2.8	< 0.001
Boys	17,630 (55.2)	17,281 (55.2)	349 (54.7)	0.793
Fever	9,425 (29.5)	9,216 (29.5)	209 (32.8)	0.040
Chills	1,097 (3.4)	1,058 (3.4)	39 (6.1)	0.018
Cough	5,257 (16.5)	5,126 (16.4)	131 (20.5)	0.003
Sputum	3,127 (9.8)	3,049 (9.7)	78 (12.2)	0.028
Rhinorrhea	5,263 (16.5)	5,143 (16.4)	120 (18.8)	0.068
Poor oral intake	458 (1.4)	457 (1.5)	1 (0.2)	0.956
Anorexia	984 (3.1)	963 (3.1)	21 (3.3)	0.489
Nausea	8,227 (25.8)	8,092 (25.9)	135 (21.2)	0.016
Vomiting	19,791 (62.0)	19,426 (62.1)	365 (57.2)	0.030
Constipation	508 (1.6)	497 (1.6)	11 (1.7)	0.640
Diarrhea	10,771 (33.7)	10,542 (33.7)	229 (35.9)	0.168
Abdominal pain	12,223 (38.3)	12,012 (38.4)	211 (33.1)	0.016

Values are expressed as mean ± SD or number (%).

hospitalized children were compared using the chi-square tests. Correlations between the monthly mean numbers of children and regional temperature were analyzed using Pearson's correlation coefficients (r). All statistical analyses were performed using SPSS software version 23.0 (IBM Co., Armonk, NY). A $P < 0.05$ was considered statistically significant.

Results

1. Clinical characteristics

A total of 31,931 children with AGE visited the ED. The clinical characteristics of the children are shown in Table 1. Most data were available over approximately 90%, except poor oral intake, anorexia, and constipation (available in 20%–70%). Vomiting was the most common manifestation, followed by abdominal pain, diarrhea, and fever. The hospitalized children showed more frequent fever, chills, cough and sputum, compared to those discharged.

2. Correlation between the occurrence of AGE and regional temperature

Fig. 1 presents the biannual trends in the numbers of children with AGE who visited the ED and regional temperatures. The monthly mean temperatures between 2006 and 2016 and numbers of the children are presented in Fig. 2. A positive correlation ($r = 0.857$) was observed between the

number of children who visited the ED and the number of those who were hospitalized. However, these numbers of children exhibited negative correlations (for ED visit, $r = -0.845$; for hospitalization, $r = -0.923$) with the monthly mean temperature. Hospitalization rate was highest (2.7%) and monthly mean temperature was lowest (-2.4°C) in January.

Discussion

Our study found negative correlations between the occurrence of AGE and regional temperature in a Korean tertiary hospital ED. In addition, a positive correlation was observed between the number of children with AGE who visited the ED and the number of those who were hospitalized. This was the first study to investigate the correlation between the monthly mean numbers of children with AGE and regional temperatures in Korea.

In our current study, vomiting (62.0%) was the most common manifestation of AGE, whereas constipation (2.2%) was least common. Other frequent symptoms included diarrhea, abdominal pain, and fever. The hospitalized children showed more frequent manifestations suggestive of respiratory virus infection, including fever, chills, cough, and sputum. To the best of our knowledge, there is no study comparing symptoms of respiratory virus infection with those of AGE, but it is possible that the occurrence of coinfection due to respiratory viruses have increased in winter^{10,11}. In addition,

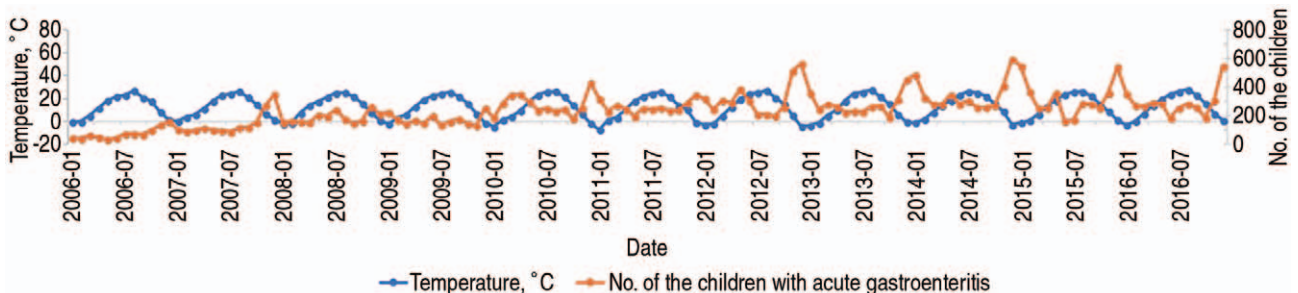


Fig. 1. Biannual trends in the numbers of children with acute gastroenteritis who visited the emergency department and regional temperatures in Seoul, Korea between 2006 and 2016.

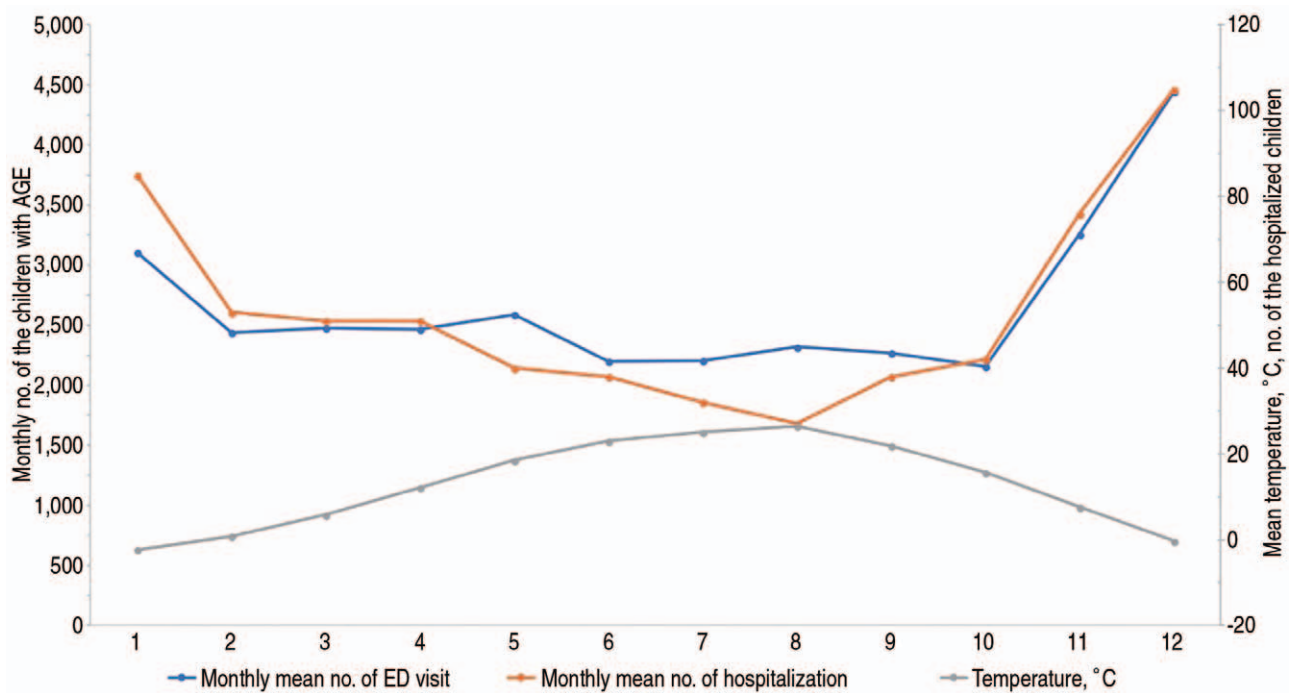


Fig. 2. Negative correlations between the monthly mean numbers of the children with AGE and the monthly mean temperatures (for ED visit, $r = -0.845$; for hospitalization, $r = -0.923$). Notably, monthly mean numbers of the children with AGE who visited the ED, and of those who were hospitalized were higher in January, November, and December. AGE: acute gastroenteritis, ED: emergency department.

having these various symptoms can affect the physicians' decisions on hospitalization. Hence, decision-making on patient disposition in such cases may need laboratory and imaging work-ups.

The study children with AGE tended to visit the ED, and undergo hospitalization in winter, which are associated with cold weather. This finding contrasts with the higher incidence of food poisoning during warmer seasons, implying that AGE is not due to food poisoning. Although the exact causes of AGE were unknown due to the lack of available stool or blood test results, these cases might have been attributable to rotavirus and norovirus, which are known to be prevalent in winter^{12–14}. The frequency of AGE in summer also has decreased owing to the population education on food poisoning, such as handwashing.

This study had some limitations of note. The results may not be easily generalizable due to the single center study design. Some study children resided outside Seoul, and thus the observed correlations

may not be fully reflective of the real world. Moreover, some factors besides the regional temperature may contribute to the occurrence of AGE. The low availability of some manifestations, such as a poor oral intake, might affect the results. Finally, decisions on hospitalization were made at the discretion of the ED physicians, rather than according to precise criteria.

In conclusion, many children with AGE may visit the ED, and undergo hospitalization during the cold weather. This finding could help the guardians to expect the occurrence of AGE, and physicians to facilitate the allocation of resources for emergency medicine in winter.

Conflicts of interest

No potential conflicts of interest relevant to this article were reported.

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Appendix 1. Monthly mean temperature in Seoul during the study period^{a)}

Mo	2006		2007		2008		2009		2010		2011		2012		2013		2014		2015		2016	
	Temp	No.*	Temp	No.*	Temp	No.*	Temp	No.*	Temp	No.*	Temp	No.*	Temp	No.*	Temp	No.*	Temp	No.*	Temp	No.*	Temp	No.*
1	-0.2	45	0.4	106	-1.7	155	-2	225	-4.5	185	-7.2	319	-2.8	323	-3.4	361	-0.7	487	-0.9	547	-3.2	353
2	0.1	43	4	89	-1.2	162	2.9	171	1.4	285	1.2	229	-2	245	-1.2	246	1.9	329	1	368	0.2	273
3	5.2	62	6.1	98	7.3	159	6	145	4.3	347	3.6	273	5.1	311	5.1	281	7.9	280	6.3	254	7	268
4	11.6	50	11.4	114	14.1	154	12.7	167	9.5	350	10.7	246	12.3	291	10	264	14	282	13.3	256	14.1	292
5	18.4	35	18.1	101	17.7	206	19.1	150	17.2	298	17.9	197	19.7	385	18.2	224	18.9	346	18.9	360	19.6	287
6	21.8	45	23.2	97	21.5	197	22.4	198	23.4	238	22	252	24.1	310	24.4	230	23.1	284	23.6	162	23.6	185
7	23.1	74	24.2	87	25.1	243	24.3	136	25.8	251	24.6	244	25.4	208	25.5	227	26.1	307	25.8	171	26.2	257
8	27	74	26.5	117	25.3	179	25.7	160	26.5	231	25.8	257	27.1	210	27.7	265	25.2	259	26.3	285	28	283
9	21.1	70	21.5	119	22	150	21.8	178	21.8	245	21.8	236	21	198	21.8	269	22.1	260	22.4	284	23.1	259
10	17.9	100	15.1	155	16.1	166	16	146	14.5	180	14.2	240	15.3	260	15.8	193	15.6	272	15.5	256	16.1	188
11	8.4	136	6.7	271	7.6	165	6.9	130	6.5	254	10.7	291	5.5	516	6.2	314	9	409	8.9	361	6.8	311
12	1.4	160	1.8	350	1.1	212	-1	253	-1.3	430	-0.9	344	-4.1	563	-0.2	454	-2.9	596	1.6	541	1.2	544

Temperatures are expressed as ° C.

* No. refers to the number of the children with acute gastroenteritis who visited the emergency department.