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ORIGINAL RESEARCH

Self-Medication with Antibiotics Among Children in China: A Cross-Sectional Study of Parents' Knowledge, Attitudes, and Practices

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Background: Self-medication with antibiotics (SMA) among children is a common practice in low-income and middle-income countries, which has accelerated antibacterial abuse.

Objective: This study aimed to estimate the prevalence and associated factors of SMA among children in China, including parents' knowledge, attitudes, and practices towards antibiotic use.

Methods: A cross-sectional study based on a structured questionnaire survey of parents was conducted in Nantong between July and September 2020. A total of 1699 respondents participated. Information on participants' demographic and family characteristics, knowledge, attitudes, and practices towards antibiotics use was collected. Hierarchical binary logistic regression was used to examine the predictors of SMA among children.

Results: Among 1699 participants, 23.31% practiced SMA to their children in the past year. Cough (59.6%) was the most common symptom leading to self-medication and penicillins (85.4%) were the most commonly used drugs. Hierarchical regression indicated that parents with higher level of antibiotic knowledge scores (OR=1.163, 95% CI: 1.067–1.268) and buying antibiotics without a prescription from pharmacy (OR=1.475, 95% CI: 1.097–1.983) were more likely to practice SMA to their children both in urban and in rural areas. Storing antibiotics at home resulted in an increased likelihood of self-medication in urban areas but not in rural areas. In addition, there was also a higher probability of non-prescribed antibiotics in children without chronic diseases (OR=1.959, 95% CI:1.072–3.578).

Conclusion: The prevalence of SMA in children is high in China. Higher knowledge scores and practices of buying and storing non-prescribed antibiotics behaviors increased parents' antibiotic self-medication in their children. Practical and effective education intervention for children's rational use of antibiotics is urgently strengthened.

Keywords: antibiotic, self-medication, children, China, antibiotic knowledge, attitude

Introduction

Self-medication with antibiotics (SMA) is the use of medicines by individuals on the basis of their own experience without consulting a doctor.[1] Antibiotics without prescriptions are easily available in China, which may lead to unnecessary utilization and adverse outcome, especially for bacterial resistance.[2] A large number of studies revealed that caregivers dispensing antibiotics to children without prescriptions was a common practice worldwide, particularly in low- and middle-income countries due to the lack of drug regulatory regimes.[1,3] A meta-analysis with 57 studies indicated that the prevalence of SMA among children was 24% worldwide,[4] with higher prevalence in the Middle

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East at 34%, Africa 22%, Asia 20%, and South America at 17%, while the lower prevalence in Europe at 8%.[4] No-prescription antibiotic use in children is an important public health issue and increasing concern in China, but few studies focus on SMA in children aged 7 to 14 years. Most studies have focused on non-prescribed antibiotic use in children aged under 5 years old from underdeveloped provinces in China.[5,6] A recent cross-sectional study among 4608 parents from 7 regions of China indicated that the prevalence of SMA in children aged 6 to 11 years (65.95%) was higher than those in children aged 3 to 5 years (27.69%),[7] also highlighting that drug safety among children remains a serious public health problem. Thus, non-prescription antibiotics use in children aged 5 years should be further studied.

The rate of SMA among children is fairly high in China,[8] and variations among different regions in children's antibiotic utilization are great. Children in less developed provinces were more likely to be treated with antibiotics indiscriminately or unnecessarily by their caregivers.[6] A previous study conducted in three Chinese cities in 2018 showed SMA prevalence among children at 60.6% in Xi'an, 50.1% in Changsha, and 28.2% in Shanghai.[9] However, a study in central China showed that the rate of SMA among children was 14.32%.[5] A national survey among children under age 12 in China conducted in 2022 indicated that parents living in Northern China are associated with the odds of self-medication.[7] However, few studies of parents' SMA behaviors among children were reported in developed provincial areas in eastern China. A study on antibiotic utilization in Chinese children suggests further studies should be more focused on rural children's rational antibiotic use.[10] The risk of SMA was 3.7 times higher for parents who lived in rural areas in Uganda.[11] However, a study conducted in Tanzania showed that the prevalence of SMA among the rural and urban respondents was similar.[12] Hence, the rural and urban differences in the prevalence and predictors of SMA among children were worthy of further study.

Parents, as the primary caregivers for their children's medication management, play an important role in SMA among children. Parents' level of knowledge and attitude towards medication safety greatly impacts their children's self-medication behaviors.[7] Self-medication can be useful if used properly with sufficient information about usage, requiring widespread knowledge of antibiotic use and rational drug use.[1] Insufficient and inconsistent knowledge and attitudes toward antibiotic use are factors driving inappropriate SMA.[13] Chinese parents were more likely to practice SMA with worse knowledge.[13] However, a study in Sri Lanka indicated that people with better knowledge of antibiotics were more likely to SMA.[14] Moreover, keeping antibiotics at home was also pervasive in China.[15] A previous study conducted in China indicated that parents who reserved antibiotics at home or purchased antibiotics without a prescription were more likely to administer antibiotics to their children without medical advice.[5] To sum up, the role of parents' knowledge in SMA among children had no consistent results.

The primary aim of this study was to investigate the prevalence of SMA among children aged 7 to 14 in China and to explore the relationship between parents' KAP towards antibiotic use and SMA behaviors among children, as well as compare their differentiate effects in urban and rural areas.

Materials and Methods

Study Design and Setting

A cross-sectional study was conducted in a rural and an urban district in Nantong city, Jiangsu Provinces in eastern China, from July to September 2020. As the indicator of economic status, the gross domestic profit (GDP) of Jiangsu Province ranked second of 31 provinces in mainland China in 2020. Nantong city located in Yangtze River Delta economic region is one of most developed city in Jiangsu province. Despite a rapid of economical development, a rural district has poorer quality of healthcare facilities and lower density of pharmacy, compared with an urban district. We used a primary school-based clustered sampling based on geographical location. Two schools in each district were selected by random numbers and stratified according to geographic locations.

Participants and Data Collection

The survey was conducted at classrooms after parents meeting. Participants were eligible to be included if they: (1) being a parent whose child aged 7 to 14 years was studying at school; (2) making routine decisions on their children's

medication; (3) being a parent who can read and write in Chinese; (4) having no visual or hearing disorder. Participants with a medical background such as doctors, pharmacists and nurses, were excluded from this study.

Data Interviewers were recruited from Nantong University and received training in investigation skills and research ethics in the School of Public Health. Before the investigation, a detailed introduction to study purpose, significance, privacy safety, and consent form was informed to all potential participants. Respondents were required to self-complete questionnaire with their written informed consent within 20 min. Finished questionnaires were collected by interviewers on the spot. A total of 1920 participants were included in this study, and 1699 valid questionnaires were obtained, culminating in an effective response rate of 88.49%.

Development of Questionnaire

The questionnaire used in the current study was developed from previous studies[9,16–21] and consulted with multi-disciplinary experts working in respiratory, pharmacy, pediatrics, and public health fields, who evaluated the face and content validation of the questionnaire. A pilot study was carried out to address any ambiguity in the questions and acceptability of the participants among 20 min among 50 respondents. The final questionnaire consists of three parts: 1) basic characteristics of children and parents; 2) parents' non-prescription antibiotic use in children in the past year; 3) parents' knowledge, attitudes, and practices towards antibiotics use.

Measures

Dependent Variables

The dependent variable of this study was antibiotic self-medication among children, which was defined as antibiotics that had been administered to their children without a physician's prescription in the past year. This was measured by an affirmative response (Yes) to the following question,[9,19] "Have you administered your child antibiotics without a prescription in the past year?", with the answer of "Yes" or "No", coding 1 and 0. If respondents reported "Yes", more detail information was explored. Further questions with multiple responses (eg the often reasons, the often self-perceived symptoms, and which types of antibiotics for SMA) were assessed.

Independent Variables

Knowledge

Based on previous studies[9,17,19,21] and experts' advice, parental knowledge of antibiotic use was measured by five items, including questions such as "Antibiotics have no effect on viral flu, "Intravenous therapy may not necessarily be better than oral therapy", and others, with an answer of "True", "False", and "Not sure". The answers were scored as 1 for a correct response and 0 for an incorrect response or uncertain response. The total knowledge score was calculated by summing up the scores for each item, with a higher score indicating a higher level of antibiotic knowledge. Cronbach's alpha in the present study was 0.667, indicating a good internal consistency reliability.

Attitudes

According to previous research,[9,17,18,21] parental attitudes of antibiotic self-medication were measured by four items. The items included questions such as "It is necessary to read the drug instructions carefully before using antibiotics", "I will not increase or decrease the drugs on your own when use antibiotics", "It is necessary to observe the adverse reactions after using antibiotics" and "I will withdraw drug immediately after occurring adverse reactions", with an answer of "True", "False", and "Not sure", coding from 1 to 0. A total score of attitude was calculated by summing item scores, with higher scores presenting better antibiotic attitudes. The Cronbach's alpha in our study was 0.602.

Practices

The practices of parental antibiotic use behaviors consisted of two items,[9,21] "bought non-prescribed antibiotics from pharmacy in the past year", and "stored antibiotics at home in the past year". The response was recorded using "yes" or "no".

Control Variables

Control variables included basic characteristics of children and parents. Children variables included gender, age, medical insurance, self-rated health, and chronic disease, while parent characteristics also covered educational level, occupation, residential location, self-rated household income, and whether having a doctor relative.

Statistical Analysis

All statistical analyses were conducted using SPSS 26.0. Descriptive analysis was conducted to the characteristics of the sample, and chi-square test was used to examine the relationship between parental knowledge, attitudes, and practices (KAP) towards antibiotic use and SMA to their children. Hierarchical Logistic regression models were used to explore the potential predictors of SMA among children. In these models, parents' SMA among children was dependent variable, parental knowledge and attitude scores towards antibiotics use, and the practices of buying and storing non-prescribed antibiotics behaviors were predictive variables, basic characteristics of children and parents as control variables in all the models. Model 1 only explored the relationship between the basic characteristics and parental SMA. Model 2 examined parental knowledge scores of antibiotic use towards SMA in children's behaviors. On the basis of Model 2, Model 3 further tested the relationship between parental attitude scores of antibiotic use and SMA behaviors. Based on Model 3, Model 4 examined associations between the practices of buying and storing antibiotics behaviors and parental SMA. All statistical tests were two-tailed, with α set at 0.05.

As additional analyses, we repeated logistic regression models to further explore the differentiate effects of KAP scores to parental SMA behaviors in rural and urban areas.

Results

Participant Characteristics

The basic characteristics of participants are presented in Table 1. Of the 1699 participants, nearly half (49.1%) of the children were female, with an average age of the children was 10.79±1.66 years. Only 5.5% of children had chronic diseases. Approximately 29.5% of their father and 27.2% of their mother having bachelor degree or higher. 50.6% of them lived in urban setting and 36.6% had a doctor relative.

Table 1 Basic Characteristics of Participants (N=1699)

Variables	Overall		Self-Medication				p-value
	(n=1699)		Yes (n=396)		No (n=1303)		
	n	%	n	%	n	%	
Child characteristics							
Gender							0.073
Male	856	50.9	186	21.7	679	79.3	
Female	834	49.1	210	25.2	624	74.8	
Age							0.566
7	33	1.9	4	12.1	29	87.9	
8	132	7.8	28	21.2	104	78.8	
9	241	14.2	64	26.6	177	73.4	
10	338	19.9	75	22.2	263	77.8	
11	290	17.1	75	25.9	215	74.1	
12	385	22.7	89	23.1	296	76.9	
13	236	13.9	52	22.0	184	78.0	
14	44	2.6	9	20.5	35	79.5	
Having chronic diseases							0.047
No	1605	94.5	382	23.8	1223	76.2	
Yes	94	5.5	14	14.9	80	85.1	

(*Continued*)

Table 1 (Continued).

Variables	Overall		Self-Medication				p-value
	(n=1699)		Yes (n=396)		No (n=1303)		
	n	%	n	%	n	%	
Parent-reported health							0.695
Good	1330	78.3	316	23.8	1014	76.2	
General	343	20.2	74	21.6	269	78.4	
Bad	26	1.5	6	23.1	20	76.9	
Parents characteristics							
Father's occupation							0.760
Civil servants	46	2.7	11	23.9	35	76.1	
Medical workers	34	2.0	12	35.3	22	64.7	
Technicians	299	17.6	73	24.4	226	75.6	
Business or service	257	15.1	56	21.8	201	78.2	
Workers	475	28.0	110	23.2	365	76.8	
Farmers	243	14.3	55	22.6	188	77.4	
Others	345	20.3	79	22.9	266	77.1	
Mother's occupation							0.313
Civil servants	21	1.2	7	33.3	14	66.7	
Medical workers	50	2.9	16	32.0	34	68.0	
Technicians	165	9.7	47	28.5	118	71.5	
Business or service	342	20.1	72	21.1	270	78.9	
Workers	411	24.2	93	22.6	318	77.4	
Farmers	307	18.1	68	22.1	239	77.9	
Others	403	23.7	93	23.1	310	76.9	
Father's education							0.762
Primary school and below	128	7.5	26	20.3	102	79.7	
Junior high school	622	36.6	141	22.7	481	77.3	
High school	448	26.4	109	24.3	339	75.7	
University and above	501	29.5	120	24.0	381	76.0	
Mother's education							0.758
Primary school and below	166	9.8	35	21.1	131	78.9	
Junior high school	615	36.2	141	22.9	474	77.1	
High school	456	26.8	105	23.0	351	77.0	
University and above	462	27.2	115	24.9	347	75.1	
Home location							0.577
Urban	863	50.8	206	23.9	657	76.1	
Rural	836	49.2	190	22.7	646	77.3	
Having a doctor relative							0.456
Yes	621	36.6	151	24.3	470	75.7	
No	1078	63.4	245	22.7	833	77.3	
Self-rated household income							0.326
High income	92	5.4	19	20.7	73	79.3	
Medium income	1345	79.2	307	22.8	1038	77.2	
Low income	262	15.5	70	26.7	192	73.3	

Previous Practice Regarding SMA Among Children

Among 1699 participants, 23.31% of parents self-medicated their children with antibiotics in the last year. The rate of SMA among children in the urban area was 23.9%, and in the rural area it was 22.7%. The incidence of SMA among children with chronic diseases was higher than those without chronic diseases (Table 1).

Among 396 respondents who had ever SMA behaviors, 36.4% of them gave antibiotics to their children for 1 time, 49.2% for 2–3 times and 14.4% for more than 4 times (see Table S1). In terms of information source for antibiotic use, most parents used antibiotics to treat their children according to the drug instructions (76.4%), followed by pharmacist recommendations (19.8%), previous medication experience (2.8%) and other (1.0%) (See Table S2).

Figure 1 demonstrates the type of antibiotics used, penicillins (85.4%, 338/396) were the most frequently used, followed by Cephalosporins (74.7%, 296/396), Macrolides (54.3%, 215/396), Quinolones (22.7%, 90/396), Sulfonamides (9.8%, 39/396), and other (0.8%, 39/396) (See Table S3). The main symptoms of antibiotic use were cough (59.6%, 236/396), followed by cold (51.8%, 205/396), throat pain (41.9%, 166/396), fever (37.4%, 148/396), diarrhea (18.4%, 73/396), bronchitis (16.2%, 64/396), and pneumonia (6.8%, 27/396) (Figure 2).

Knowledge, Attitudes, and Practices on Antibiotic Use

As shown in Table 2, the average knowledge score was 1.85±1.47. Only 12.9% of parents thought that antibiotics did not have effects on viral flu. 56.2% of the parents were able to recognize that there was no direct link between the antibiotic effect and the dosage. There was a significant difference in the incidence of SMA in children among parents' knowledge scores.

More than 90% of parents thought that it was necessary to read the instructions carefully before using antibiotics. 61.4% of the parents considered that they would not increase or reduce the dose of antibiotics by themselves. The average attitude score was 3.18±0.94. There was a significant difference in the incidence of SMA in children among parents' attitude scores.

30.0% of parents did not store antibiotics at home and 33.7% had not bought antibiotics from a pharmacy without a prescription in the past year. The practices of both storing and buying antibiotics were more common among parents who had SMA among children.

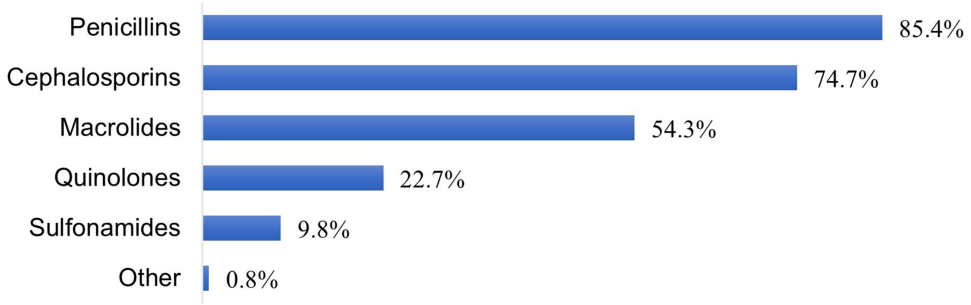

Figure 1 Most commonly used antibiotic for self-medication among children (N=396).

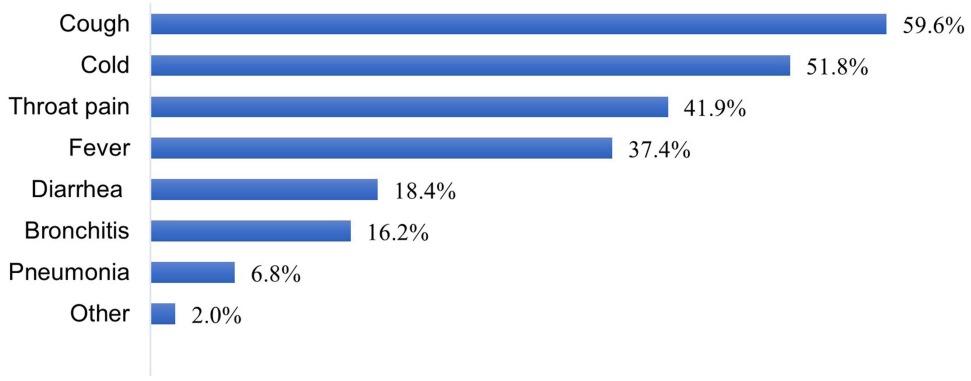

Figure 2 Most commonly symptoms of antibiotic self-medication among children (N=396).

Table 2 Parents' Knowledge, Attitudes, and Practices of Antibiotics Use (N=1699)

Items	Overall (n=1699)		Self-Medication				p-value
			Yes (n=396)		No (n=1303)		
	Proportion		Proportion		Proportion		
	n	%	n	%	n	%	
Knowledge							
Antibiotics have no effect on viral flu. (Yes)	220	12.9	66	24.2	154	11.8	0.012
The more expensive the antibiotic, the effectiveness may not necessarily be better. (Yes)	715	42.1	180	45.5	535	41.1	0.121
The larger the dosage of antibiotics, the effect may not necessarily be good. (Yes)	954	56.2	241	60.9	713	54.7	0.031
Using multiple antibiotics is not necessarily better than using only one. (Yes)	934	55.0	247	62.4	687	52.7	0.001
Intravenous therapy may not necessarily be better than oral therapy. (Yes)	323	19.0	90	22.7	233	17.9	0.031
Knowledge scores (Mean±SD)	1.85±1.47		2.08±1.49		1.78±1.45		0.004
Attitudes							
It is necessary to read the drug instructions carefully before antibiotics use. (Yes)	1549	91.2	360	90.9	1189	91.3	0.834
I will not increase or decrease the drugs on your own when using antibiotics. (Yes)	1044	61.4	214	54.0	830	63.7	0.001
It is necessary to observe the adverse reactions after using antibiotics. (Yes)	1272	74.9	284	71.7	988	75.8	0.099
I will withdraw drug immediately after occurring adverse reactions. (Yes)	1543	90.8	365	92.2	1178	90.4	0.287
Attitudes scores (Mean±SD)	3.18±0.94		3.08±0.93		3.21±0.94		0.022
Practices							
Bought antibiotics from pharmacy without a prescription. (No)	572	33.7	50	12.6	522	40.1	<0.001
Stored antibiotics at home. (No)	510	30.0	76	19.2	434	33.3	<0.001

Factors Associated with SMA Among Children

Table 3 presents the outcome of hierarchical logistic regression models for exploring the potential predictors of SMA among children. In Model 1, the occupation of mothers of business or service workers (OR=0.602, 95% CI:0.381–0.950) is a predictor of SMA among children. It is based on controlling for demographic variables. Model 2 showed that parents' antibiotic knowledge scores (OR=1.146, 95% CI:1.055–1.244) were significantly positively associated with SMA among children. Model 3 showed that antibiotic knowledge scores (OR=1.165, 95% CI:1.072–1.266) were significantly positively correlated with SMA among children, and antibiotic attitude scores (OR=0.822, 95% CI:0.727–0.930) were SMA among children. Model 4 showed that antibiotic knowledge scores (OR=1.163, 95% CI:1.067–1.268), buying (OR=4.304, 95% CI:3.099–5.977) and storing antibiotics (OR=1.475, 95% CI:1.097–1.983) were significantly positively correlated with SMA among children, and antibiotic attitude scores (OR=0.864, 95% CI:0.759–0.983) were significantly negatively correlated with children's self-medication. In addition, children without chronic diseases (OR=1.959, 95% CI:1.072–3.578) and occupation of mothers of business or service workers (OR=0.575, 95% CI:0.357–0.927) are predictors of SMA among children.

Additional Analysis

We found consistent results in additional regression analysis presented in Table 4, parents with higher knowledge scores and purchasing antibiotics from pharmacy without prescriptions were more likely to give their children antibiotics without prescriptions in both urban and rural areas. These findings highlighted that there are robust associations among parents' antibiotic knowledge and purchasing medicines behaviors without prescriptions and children's antibiotics utilization. However, storing antibiotics at home behaviors was only related to children's self-medication in urban areas but not for rural areas, which may account for higher rate of storing antibiotics at home in urban areas (71.8%) than those in rural areas (68.1%).

Table 3 Hierarchical Regression Analysis of Knowledge, Attitudes, and Practices Towards SMA

Variable	Control Group	Reference Group	Model 1		Model 2		Model 3		Model 4	
			OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Antibiotic knowledge score	–	–			1.146	**1.055–1.244****	1.165	**1.072–1.266*****	1.163	**1.067–1.268****
Antibiotic attitude score	–	–					0.822	**0.727–0.930****	0.864	**0.759–0.983***
Buying antibiotics from pharmacy	Yes	No							4.304	**3.099–5.977*****
Storing antibiotics at home	Yes	No							1.475	**1.097–1.983***
Gender	Male	Female	0.812	0.646–1.020	0.803	0.638–1.010	0.798	0.634–1.005	0.801	0.631–1.017
Age	–	–	1.007	0.939–1.080	1.014	0.946–1.088	1.019	0.949–1.093	1.024	0.952–1.102
Physical condition	Good	Bad	0.870	0.335–2.261	0.829	0.318–2.159	0.831	0.318–2.173	0.984	0.364–2.660
	General		0.805	0.304–2.131	0.794	0.300–2.107	0.777	0.292–2.068	0.850	0.309–2.338
Chronic disease	No	Have	1.792	0.992–3.237	1.846	**1.020–3.343***	1.789	0.987–3.241	1.959	**1.072–3.578***
Father's occupation	Other	Civil servants/ Medical workers/technicians	0.962	0.620–1.492	0.988	0.635–1.537	0.943	0.605–1.472	0.971	0.609–1.547
	Farmers		1.106	0.556–2.202	1.188	0.595–2.373	1.165	0.583–2.325	1.220	0.605–2.461
	Workers		1.060	0.676–1.663	1.092	0.695–1.715	1.082	0.688–1.703	1.128	0.707–1.801
	Business or service workers		0.967	0.628–1.488	1.026	0.664–1.583	1.035	0.670–1.598	1.065	0.679–1.672
Mother's occupation	Other	Civil servants/ Medical workers/technicians	0.710	0.440–1.144	0.739	0.457–1.195	0.737	0.455–1.193	0.643	0.387–1.068
	Farmers		0.567	0.280–1.149	0.588	0.289–1.196	0.589	0.290–1.196	0.528	0.256–1.087
	Workers		0.611	0.362–1.032	0.638	0.377–1.081	0.652	0.384–1.105	0.609	0.353–1.052
	Business or service workers		0.602	**0.381–0.950***	0.620	**0.392–0.980***	0.626	**0.395–0.990***	0.575	**0.357–0.927***
Father's education	Primary school and below	University and above	0.971	0.461–2.046	1.057	0.499–2.237	1.034	0.488–2.191	0.936	0.426–2.055
	Junior high school		1.134	0.691–1.862	1.146	0.697–1.884	1.145	0.696–1.884	1.155	0.686–1.942
	High school		1.238	0.817–1.877	1.265	0.833–1.920	1.261	0.829–1.917	1.234	0.801–1.902
Mother's education	Primary school and below	University and above	0.929	0.464–1.861	0.949	0.473–1.907	0.891	0.442–1.796	1.073	0.517–2.229
	Junior high school		0.966	0.581–1.609	1.014	0.608–1.691	0.980	0.586–1.637	1.107	0.651–1.883
	High school		0.947	0.619–1.449	0.961	0.628–1.472	0.967	0.630–1.483	1.020	0.656–1.584
Home location	Urban	Rural	1.003	0.730–1.378	0.983	0.714–1.352	0.986	0.717–1.355	1.025	0.736–1.428
Having a doctor relative	Yes	No	1.053	0.824–1.346	1.015	0.793–1.301	1.040	0.811–1.334	1.034	0.799–1.338
Self-rated household income	–	–	1.232	0.982–1.544	1.226	0.977–1.539	1.253	0.998–1.572	1.223	0.967–1.546

Notes: The bold text means $p<0.05$. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Table 4 Predictors of SMA in Urban and Rural Areas

Variable		Reference Group	Urban		Rural	
			OR	95% CI	OR	95% CI
Antibiotic knowledge scores	–	–	1.178	**1.050–1.322****	1.175	**1.023–1.351***
Antibiotic attitude scores	–	–	0.941	0.763–1.161	0.846	0.710–1.008
Purchasing antibiotics from pharmacy	Yes	No	5.776	**3.551–9.396*****	3.476	**2.199–5.495*****
Storing antibiotics at home	Yes	No	1.788	**1.133–2.821***	1.385	0.924–2.076

Notes: All the models controlled covariates, including gender, age, physical condition, chronic disease, parent-reported health, father's occupation, mother's occupation, father's level of education, mother's level of education, having a doctor relative, self-rated household income. The bold text means $p<0.05$. *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Discussion

This study is one of the few studies on SMA among children aged 7–14 years in eastern China. The prevalence of SMA among children aged 7 to 14 years in urban and rural areas was similar, with a rate of SMA of 23.31%. Two schools per district were selected at random, which ensured equality of the sample population among urban and rural areas. The consequences of our survey could represent children's antibiotics use in developed provincial areas in eastern China. Our findings were comparable to a national survey of the prevalence of SMA among children conducted in China (24.21%).[7] However, the rate of SMA among children in other regions of China is much higher than in the eastern region. A survey of 3558 participants from three cities in eastern, central, and western regions of China showed that the prevalence of non-prescription use of antibiotics for children was 48.2%.[9] Moreover, a study conducted in vaccination clinics in two rural Chinese counties indicated that 62% of the parents had given their children antibiotics without a prescription.[21] Compared to developed countries (3% −19% rate of self-medication of antibiotics),[18] the prevalence of antibiotic self-medication in China was still high.[22] Exposure of young children to antibiotics was high in low-income and middle-income countries, with an average of 24.5 antibiotic prescriptions for children from birth to age 5.[23]

Parents' antibiotic knowledge scores were associated with more SMA among children. Our study suggested that parents with higher overall scores of antibiotic knowledge tended to carry out self-medication for their children in both rural and urban areas. This may be attributed to their confidence in using antibiotics appropriately. This is consistent with a previous survey in Sri Lanka, which indicated that those with better knowledge of the appropriate use of antibiotics were more likely to self-medicate.[14] A British study once reported that people who had better understandings and attitudes towards antibiotics were more likely to self-medicate.[19] Nonetheless, a survey of community pharmacy staff conducted in Sri Lanka revealed that higher levels of knowledge about antibiotics were associated with lower probabilities of self-medication.[24] This may be due to differences in the survey participants, where pharmacy staffs have more comprehensive understanding of antibiotics compared to ordinary consumers, leading to more cautious use of antibiotics. Thus, improving parents' comprehensive knowledge of the rational use of antibiotics may reduce the rate of SMA. Meanwhile, our data also suggested that a higher total score of antibiotic attitudes among parents was associated with a lower likelihood of their children engaging in SMA. This could be explained by the result of a study regarding antibiotic use, with the association being stronger between knowledge and attitudes and weaker between knowledge and practices.[25] The knowledge level and attitudes of parents towards drug safety significantly impact their children's rational use of medications.[7] Even if parents have correct knowledge about antibiotics or a higher education, the practice is not always appropriate.

Parents' antibiotic use practices also have a significant positive association with SMA among children. In our study, majority parents stored antibiotics at home and bought antibiotics without any prescriptions. In urban areas, storing antibiotics at home was associated with more SMA among children, but in rural areas, antibiotic storage was not a predictor in SMA. This may be due to the fact that parents in urban areas can buy antibiotics from pharmacies more easily than in rural areas. Thus, parents in urban areas are more likely to store antibiotics at home. In line with previous studies,[15,22,26] the more antibiotics stored at home, the more probabilities to take self-medication of antibiotics to children. There are two main sources of leftover antibiotics for children: previous prescriptions and pharmaceutical

purchases.[15] Pharmacies were the main source of information for self-medication.[27] Antibiotics are easily available to the general public in China from pharmacies without physician prescriptions because pharmacies can be found everywhere around China. Our data showed that parents attached great importance to the drug instructions, but recommendations from friends or relatives and pharmacy staff also influenced caregivers' decisions.[28,29] The loose drug regulatory framework accelerates the SMA behaviors.[30] Therefore, strengthening the sales management of antibiotics and regulating the purchase behavior through prescriptions are necessary. Meanwhile, it is also essential to train pharmacy staff to improve their service capacity and undertake health education for customers or patients.

In addition, upper respiratory tract infections (colds, fever, coughs, sore throats, etc.) were the most common causes of antibiotic use in our study, which is consistent with the existing literature.[1,31–33] This implies that individuals were accustomed to using antibiotics to treat various common low-level diseases. Besides, our study revealed that amoxicillin was the most frequently used type of antibiotics, which is consistent with previous studies.[34,35] However, in contrast to our results, a study indicated that ciprofloxacin was the most commonly used antibiotic in Pakistan.[32] This may be due to the wide variation in the types of antibiotics used by different geographical settings and national income levels. Our study also indicated that parents were more likely to practice SMA for their children who did not have chronic conditions, contrary to a study in Mexico.[36] This may be due to the fact that parents in Nantong were cautious to treat their children with chronic diseases while considering their children's physical conditions.

Our study has a few limitations. Firstly, this study was a cross-sectional study, and it is difficult to determine the causal relationship between KAP and non-prescribed antibiotics use. Secondly, self-administrated questionnaire in our study only included some contents of the knowledge, attitudes, and practices towards antibiotics. Parents' self-medication behaviors in the past year evaluated inevitably had recalling bias to some extent. In view of the above two reasons, the results may be underestimated or overestimated. Thirdly, these study settings were only sampled in a rural and a urban district in one city in eastern China, so the findings were not representative of other areas in eastern China and could not be extrapolated.

Implication

Multi-system cooperation and long-term efforts should be strengthened to improve antibiotic rational use among children in China. Mass media, schools, and hospitals may increase health interventions to augment parents' knowledge of antibiotics use including the basic concepts of antibiotics, guidelines of antibiotics use and potential harms of self-medication, especially for rural residents. Furthermore, prescription-only on antibiotics sales should be more stringent implemented at community pharmacies and more exact prescribed dispensing in health institutions. Finally, pharmacists should be trained to enhance their pharmaceutical service skills and knowledge of appropriate use with antibacterial drugs in community pharmacies.

Conclusion

The prevalence of antibiotic self-medication among children aged 7–14 years in both rural and urban districts was high in eastern China. We revealed higher levels of knowledge score, the practices of buying antibiotics at pharmacy and storing antibiotics at home related to increased non-prescribed antibiotic use among children. Therefore, public antibiotics literacy is also vital and should be improved through multiple approaches. It is also necessary to strengthen regulations in the antibiotic market and restrict sales of antibiotics to physician's prescriptions.

Abbreviations

SMA, self-medication with antibiotics; GDP, Gross Domestic Product; KAP, knowledge, attitude, practice.

Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Ethics Approval and Consent to Participate

This study was approved by the Ethics Committee of Nantong University. All respondents were aware of the purpose of this study and consented to participate in the survey. Data were collected anonymously. This study was performed in accordance with the Declaration of Helsinki.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising, or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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