

Epidemiology of diarrhea among young children: a questionnaire-based study in Taiwan

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Background and purpose: Acute diarrhea is the most common pediatric illness in Taiwan, despite the considerable improvements in hygiene. The aims of this study were to evaluate the epidemiology of diarrhea among children younger than 5 years in Taiwan, and to analyze the epidemiological changes since 1985.

Methods: A questionnaire survey was conducted from January 2007 to June 2007, which targeted children in hospital outpatient clinics in different parts of Taiwan. Parents of children younger than 5 years were invited to complete the questionnaire.

Results: 1200 questionnaires from North, Central, South, and East Taiwan were completed. The overall incidence of diarrhea was 55.78%. The incidence of diarrhea increased with age, from 15.45% among infants younger than 6 months to 82.22% of children aged from 4 to 5 years. There were no differences among the different regions of Taiwan. Most children experienced diarrhea during winter (37%) and spring (29%), which is compatible with the rotavirus season. Eighty five percent of children had less than 2 episodes of diarrhea each year.

Conclusions: This study demonstrated the possible epidemiological features of acute diarrhea among children younger than 5 years in Taiwan. The children's ages and the seasonal distribution of diarrhea coincided with the pattern of rotavirus gastroenteritis seen in hospital-based studies. Since 1985, the frequency of diarrhea has reduced, and the peak age of diarrhea is older.

Key words: Child, preschool; Diarrhea; Epidemiology; Infant; Questionnaires; Rotavirus

Introduction

Diarrhea is one of the most common acute illnesses among children, both in developing and developed countries. Children younger than 5 years are estimated to experience 1 to 5 episodes of acute diarrhea per person-year [1]. Mortality due to diarrhea in children has been greatly reduced by a clean water supply and adequate fluid supplement. However, the morbidity remains high. According to the study by Xu, performed in 1985, diarrhea was associated with 10% to 20% of all hospital admissions among children in Taiwan [2]. A database from the United States in 2006 showed that diarrhea was associated

with 13% of all hospital admissions among children, with an estimated cumulative incidence of 1 in 23 to 27 diarrhea-related hospital admissions by the age of 5 years [3]. In Taiwan, the database from the National Health Insurance (NHI) during 2002 to 2005 showed a mean of 46,000 hospital admissions per year due to diarrhea among children younger than 5 years. With the improved standard of hygiene in Taiwan, bacterial diarrhea has decreased during the past 2 decades. Instead, viral diarrhea is now the most common cause of diarrhea among children. A 2-year active surveillance study of diarrhea among children younger than 5 years in Taiwan showed that rotavirus was detected in 45.9% of children who were admitted to hospital [4]. The purposes of this recall study were to evaluate the prevalence of diarrhea among children younger than 5 years in Taiwan, and to analyze the epidemiological change since 1985.

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Methods

From January to June 2007, a questionnaire-based study was conducted in Taiwan, which included 5 major medical centers in each part of Taiwan (National Taiwan University Hospital, Taipei; Chang Gung Memorial Hospital, Taoyuan; Veterans General Hospital, Taichung; Chang Gung Memorial Hospital, Kaohsiung, and Tzu Chi General Hospital, Hualien). Parents or caregivers of children aged younger than 5 years were invited to answer a questionnaire while they visited the outpatient departments of these hospitals.

Sample size

According to the data of the Ministry of the Interior, Taiwan, the population of children younger than 5 years in Taiwan in 2006 was approximately 1,290,000. The sample size was based on 1% of the pediatric population younger than 5 years in each part of Taiwan, so 1200 children and questionnaires were required. The study population was divided into 4 groups, according to their place of residence (North, 40%; Central, 25%; South, 27%; and East, 2.5%).

Questionnaire design

The children's demographic data, including age, sex, and residence were recorded. The questions included:

- Have your children had experience of acute diarrhea?
- How often did they experience diarrhea?
- Which month did they get the most severe diarrhea episode?

Table 1. Demographic data of children with diarrhea.

Characteristic	No. of patients	Diarrhea-positive No. of patients (%)
Sex		
Boys	616	362 (58.76)
Girls	584	308 (52.73)
Age		
<6 months	123	19 (15.45)
6-12 months	159	73 (54.91)
1-2 years	370	196 (52.97)
2-3 years	256	152 (59.37)
3-4 years	157	119 (75.80)
4-5 years	135	111 (82.22)
Region		
North Taiwan	480	277 (57.70)
Central Taiwan	360	205 (56.94)
South Taiwan	300	148 (49.33)
East Taiwan	60	38 (63.33)
Total	1200	670 (55.83)

- How many times have your children been admitted to hospital due to acute diarrhea?

Definition

Diarrhea was defined as the passing of 2 or more liquid or semi-liquid stools, or was diagnosed on the basis of the clinical history provided by the caregivers [4].

Statistical analysis

Data analysis was conducted using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA). Chi-squared test was used to evaluate the significance of difference between regions. A *p* value of <0.05 was considered to be significant.

Results

Patients' characteristics

1200 questionnaires were completed from January to June 2007. The age distribution, region of distribution, and the number of children experiencing diarrhea are summarized in Table 1.

Age, region and seasonal distribution

Among the 1200 children aged younger than 5 years, 670 (55.83%) had experienced at least 1 episode of acute diarrhea. The rate increased by age, from 15.45% among infants younger than 6 months to 82.22% among children aged between 4 and 5 years (Table 1). The overall prevalence of diarrhea differed according to region, with 58% of children in North Taiwan having experienced diarrhea, 57% in Central Taiwan, 49% in South Taiwan, and 63% in East Taiwan. Children from East Taiwan had more diarrhea than the other regions, but this was not statistically significant (*p* = 0.061). There was evidence of seasonal variability, with 37.3% of episodes of the most severe diarrhea occurring during January and March. The second seasonal peak was October to December (29%), followed by 20% for April to June and 14% for July to September.

Diarrhea-related hospital admission

The rate of diarrhea-related hospital admission was 24.6% (165 patients) among those who experienced diarrhea and 13.7% for all children. By the age of 5 years, 34% of children who had experienced diarrhea had been admitted to hospital for a diarrhea-related illness.

Frequency of diarrhea

568 parents or caregivers answered this question. 273 children (48%) experienced less than 1 episode of

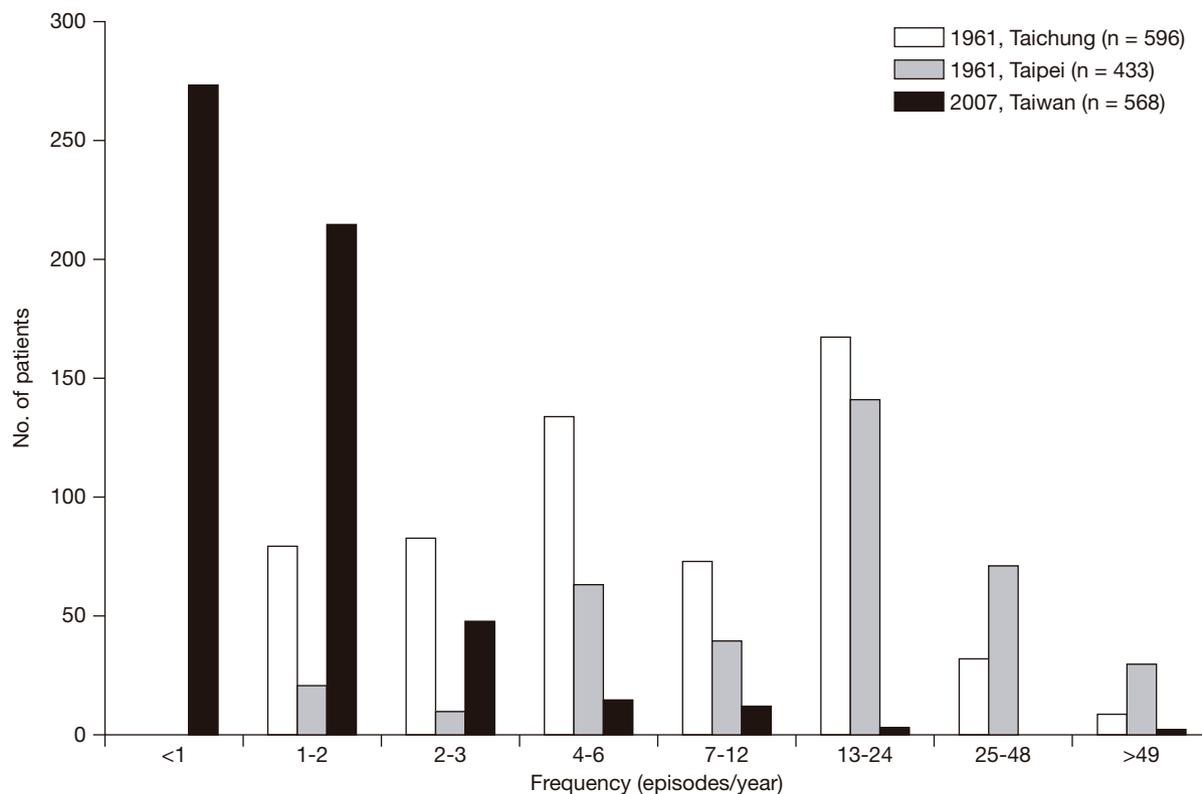


Fig. 1. Comparison of the frequency of diarrhea among children in Taiwan in 1961 and 2007.

diarrhea per year and 214 (37%) had 1 to 2 episodes per year. The frequency of diarrhea among young children was compared with that reported by Pong et al in 1961 (Fig. 1) [5].

Discussion

Diarrhea is one of the most common diseases throughout the world. According to the World Health Report in 2002, diarrhea is one of the top 3 infectious diseases associated with mortality, secondary to lower respiratory tract infection and acquired immunodeficiency syndrome. In developing countries, diarrhea is so common that most people have many episodes during childhood. Rotavirus is the leading cause of diarrhea-associated mortality among young children, and has been estimated to cause more than 600,000 deaths worldwide annually. It has been estimated that all children have had at least 1 episode of rotavirus infection by the age of 5 years [6]. However, this may not be the case in developed countries, as shown by seroepidemiology data in Taiwan [7].

It is thought that most children develop symptomatic diarrhea after their first exposure to rotavirus. In developing countries, children are exposed to rotavi-

rus at a young age. By the age of 2 years, nearly 90% of children have had at least 1 episode of rotaviral diarrhea [8]. Ninety percent of children with diarrhea who are younger than 5 years are cared for at home, less than 10% seek medical advice, and less than 1% are admitted to hospital [6]. Rotavirus is estimated to represent 8% of children with diarrhea cared for at home. However, 18.8% and 21.3% of episodes of diarrhea in children seeking medical advice and being admitted to hospital, respectively, are rotavirus related [6]. This situation highlights the severity and importance of rotavirus disease.

Rotavirus infection has been reported to be responsible for 30% to 50% of all diarrhea-related morbidity among children younger than 5 years in the United States, and for more than 50% of diarrhea-related hospital admissions during the winter peak [9]. A similar epidemiological pattern was found in Taiwan. A 2-year prospective surveillance study performed from 2001 to 2003 demonstrated a 43% rotavirus-related gastroenteritis rate among children younger than 5 years who were admitted to hospital [4]. An 18-month active surveillance study in Taichung performed from 2005 to 2006 showed a 14% rotavirus-related gastroenteritis rate among children

younger than 5 years in outpatient clinics. To evaluate the disease burden of rotavirus disease in Taiwan, information on the background diarrhea pattern among young children may provide useful information about the true incidence of diarrhea in Taiwan. The database of the NHI system may also provide some information on gastroenteritis of any cause. However, the problems of overdiagnosis, misdiagnosis, and multiple outpatient visits will limit its usefulness for epidemiological study.

During the 1940s, 10% to 20% of children with diarrhea required hospital admission, and the mortality rate ranged from 5% to 45%. The mortality rate was higher in summer (10% to 24%) than in winter (0% to 9%), which may have been due to a higher rate of bacterial infection, including cholera [2]. In 1961, Pong et al studied 433 parents from Taipei and 596 parents from Taichung by questionnaire, and found that two-thirds of children had experienced more than 1 episode of diarrhea per month in North Taiwan (Fig. 1) [5]. Bacterial diarrhea was still more common than viral infection during the 1980s [10]. Rotavirus is now the leading cause of diarrhea among children, and represents more than 40% of diarrhea in children admitted to hospital. The improvements in socio-economic status, hygiene, and medical care during the past 2 decades has changed the epidemiology of diarrhea in Taiwan. A rotavirus vaccine was licensed in 2006, which is likely to further change the pattern of pediatric diarrhea in the future.

This study was designed to evaluate the epidemiology of diarrhea among young children in Taiwan, and to compare with that of the 1960s and 1980s. Studies of diarrhea published since the 1990s have focused on children admitted to hospital. This recall study was designed to evaluate the overall experience of diarrhea among children younger than 5 years, including those cared for at home, by the outpatient service, or in hospital. Parents may not remember an experience of mild diarrhea, but a first rotavirus illness would be sufficiently severe to disturb their daily lives. Viral diarrhea, especially rotavirus, mainly occurred in a cluster during winter, and may be endemic every other year in Taiwan (Centers for Disease Control [CDC] in Taiwan surveillance data). The data from this study showed that 55.83% of children younger than 5 years in Taiwan had experienced at least 1 episode of acute diarrhea, and the prevalence increased by age (Table 1). Many children had their first experience of diarrhea between the ages of 6

months and 2 years, while only a small proportion of infants younger than 6 months had experienced diarrhea (15.45%). By the age of 5 years, the prevalence of diarrhea was 82.22%. Mild and transient diarrhea of any cause could easily be forgotten by parents and the true rate of diarrhea among children is likely to be underestimated.

As it is likely that rotavirus contributes to the etiology of severe diarrhea, these data were compared with those available before 2000 in Taiwan. Lin et al enrolled 209 children with diarrhea treated in hospital in North Taiwan and found that 91 children (43.5%) had diarrhea caused by rotavirus infection, and 65% were younger than 1 year [11]. A 5-year retrospective study of 429 children with rotavirus gastroenteritis in North Taiwan during 1993 to 1997 showed that 43% were younger than 6 months [12]. Rotavirus therefore affected young infants in Taiwan before 2000, similar to developing countries. The epidemiology of rotavirus infection is now similar to that of well-developed countries such as Japan [13], Hong Kong [8], Singapore, and the United States. Compared with Taiwanese data from 1983, it is clear that the peak incidence of rotaviral diarrhea has changed to an older age group (Fig. 2) [11,12]. Improved hygiene, decreased birth rate and number of children in a family, increased rate of breast feeding, and infectious control awareness in hospitals may all have contributed to the change in age at first incidence.

Xu demonstrated a summer peak of pediatric diarrhea in Taiwan during 1939 and 1948 [2]. In this study, the peak season was in winter, and was likely to be due to a rotavirus endemic, which is similar to other developed tropical countries [14]. The active surveillance system of outpatient clinics by the CDC of Taiwan shows that winter diarrhea is endemic every other year, which is also compatible with the rotavirus activity in hospitals.

The number of episodes of diarrhea in this study is considerably less than that in other studies. Pong et al found that more than one-third of children experienced a least of 1 episode of diarrhea per month (36.1% in Taichung, 65% in Taipei) [5]. In this study, a different pattern of diarrhea was found (Fig. 1). Only 10% of children had more than 1 episode of diarrhea per month. Most children did not have severe diarrhea, and 85% of them experienced less than 2 episodes per year.

There has been a dramatic change in the epidemiological pattern of diarrhea since 1939, including the peak age, seasonality, etiology, and frequency. Rota-

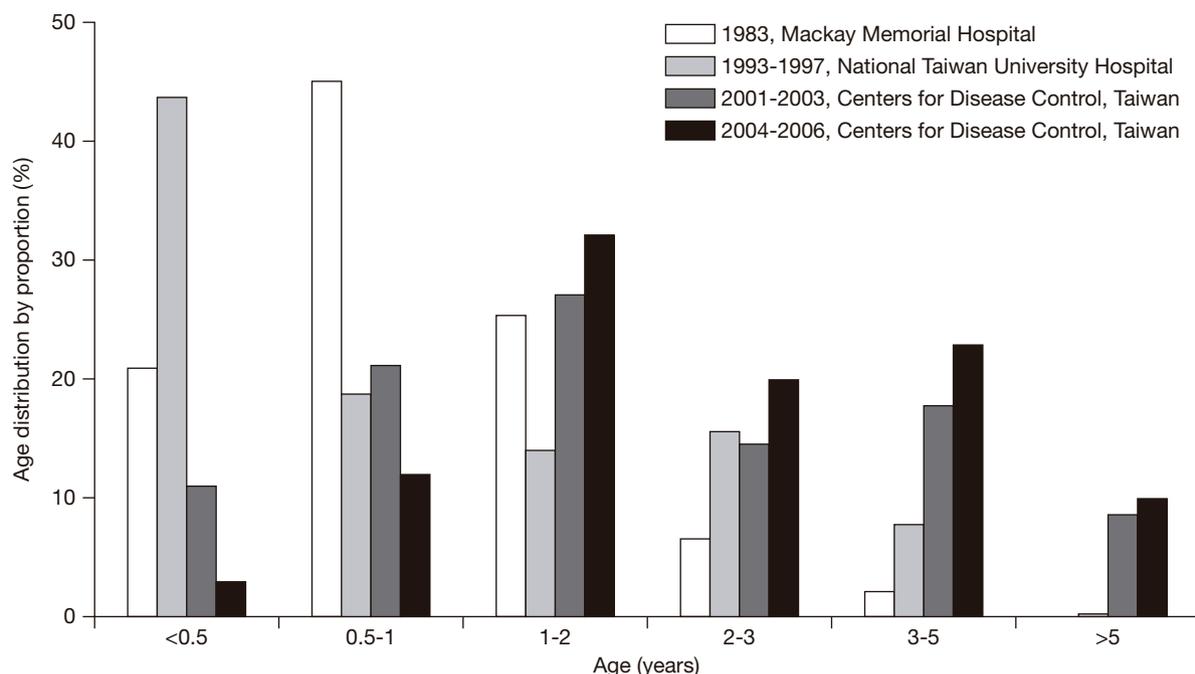


Fig. 2. Comparison of age distribution of rotavirus gastroenteritis in Taiwan by year of study.

virus is now the leading cause of diarrhea among children who need medical care, but this may change after the introduction of the rotavirus vaccine in Taiwan. The CDC in the United States estimated that rotavirus-related diarrhea among young children may account for 10% to 20% of outpatient clinic visits [6]. This data is similar to the active surveillance study from 2005 to 2006 in central Taiwan (PY Chen, unpublished data). Active surveillance data from the Asian Rotavirus Surveillance Network during 2001 to 2003 [4] and the study of Lu et al, who combined the diarrhea data from the NHI and 3 large-scale hospitals in northern Taiwan [15], found that rotavirus accounted for 33% to 43% of diarrhea-related hospital admissions. Therefore, the vaccine could be expected to reduce the hospital admission rate among children younger than 5 years to 4.5% to 5.9%. There were no documented rotavirus-related deaths during this period.

The currently available data on diarrhea and rotavirus in Taiwan are mainly hospital based. This pilot study shows the pattern and epidemiology of diarrhea and rotavirus disease in Taiwan in the community. There were some limitations to this study. First, this was a recall study, and episodes of mild diarrhea could be forgotten by parents, which would lead to underestimation of the true incidence of diarrhea. Second, some of the questionnaire respondents were not the principal caregivers (grandparents or baby-sitters), and

may not have understood the questionnaire. Third, the sample size was not sufficiently large to avoid bias. Fourth, the study was performed mainly in hospital-based outpatient clinics, which may not adequately reflect the true experience of diarrhea among young children. A large-scale randomized prospective study of diarrhea may provide valuable information on the true epidemiology and disease burden of diarrhea and rotavirus in Taiwan.

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