


BMJ Open Low acuity paediatric emergency visits under single-payer universal health insurance in Taiwan, 2000–2015: a population-based repeated cross-sectional design

I-Anne Huang ^{1,2,3} Yiing-Jenq Chou,³ I-Jun Chou,^{2,4} Yu-Tung Huang,⁵ Jhen-Ling Huang,⁵ Tang-Her Jaing,^{2,4} Chang-Teng Wu,^{2,4} Hsiang-Ju Hsiao,^{1,2} Nicole Huang⁶

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For numbered affiliations see end of article.

Correspondence to

Dr Nicole Huang;
syhuang@ym.edu.tw

ABSTRACT

Objectives Emergency services utilisation is a critical policy concern. The paediatric population is the main user of emergency department (ED) services, and the main contributor to low acuity (LA) ED visits. We aimed to describe the trends of ED and LA ED visits under a comprehensive, universal health insurance programme in Taiwan, and to explore factors associating with potentially unnecessary ED utilisation.

Design and setting We used a population-based, repeated cross-sectional design to analyse the full year of 2000, 2005, 2010 and 2015 National Health Insurance claims data individually for individuals aged 18 years and under.

Participants We identified 5 538 197, 4 818 213, 4 401 677 and 3 841 174 children in 2000, 2005, 2010 and 2015, respectively.

Primary and secondary outcome measures We adopted a diagnosis grouping system and severity classification system to define LA paediatric ED (PED) visits. Generalised estimating equation was applied to identify factors associated with LA PED visits.

Results The annual LA PED visits per 100 paediatric population decreased from 10.32 in 2000 to 9.04 in 2015 (12.40%). Infectious ears, nose and throat, dental and mouth diseases persistently ranked as the top reasons for LA visits (55.31% in 2000 vs 33.94% in 2015). Physical trauma-related LA PED visits increased most rapidly between 2000 and 2015 (0.91–2.56 visits per 100 population). The dose–response patterns were observed between the likelihood of incurring LA PED visit and either child's age (OR 1.06–1.35 as age groups increase, $p < 0.0001$) or family socioeconomic status (OR 1.02–1.21 as family income levels decrease, $p < 0.05$).

Conclusion Despite a comprehensive coverage of emergency care and low cost-sharing obligations under a single-payer universal health insurance programme in Taiwan, no significant increase in PED utilisation for LA conditions was observed between 2000 and 2015. Taiwan's experience may serve as an important reference for countries considering healthcare system reforms.

Strengths and limitations of this study

- This is the first study showing trends in low acuity emergency visits among children under a single-payer system in Asia.
- The study traced a nationwide population of all children aged 18 and below in Taiwan in multiple years.
- The use of a robust claims database and Paediatric Emergency Care Applied Research Network classification system allowed this study to distinguish diagnoses leading to low acuity paediatric emergency department visits.
- Unfortunately, due to data limitations, measurements of some important variables such as residential location and parental socioeconomic status may not be precise, which may lead to under-estimation or over-estimation of the findings.
- The nature of this observational trend analysis does not warrant any causal inferences.

INTRODUCTION

The high costs of emergency medical services and overcrowding of emergency departments (EDs) make the increasing number of ED visits a serious concern.^{1–5} It would be expected that the recent global movement towards expansion of health insurance coverage would result in improved access to primary care or preventative services, thus reducing hospital ED visits. However, other studies have suggested the opposite may occur,^{6–10} where the expansion and comprehensiveness of health insurance coverage may, on the other hand, increase the utilisation of hospital ED.^{11–14} Due to the pervasive phenomenon of moral hazard in health insurance, whether comprehensive health insurance coverage may exacerbate potentially unnecessary ED utilisation has become a

critical policy concern.^{15–17} In March, 1995, Taiwan implemented a universal health insurance programme for all of its residents. The National Health Insurance (NHI) programme in Taiwan has been renowned for its universality, comprehensiveness and easy access to ambulatory care.¹⁸ Hence, Taiwan serves as an ideal setting to investigate whether offering a universal and comprehensive health insurance coverage may lead to increasing inefficiency or potentially unnecessary ED visits over time.

Unnecessary ED visits, which are defined as ED visits amenable to intervention by ambulatory care due to low acuity (LA),^{19 20} have been analysed to estimate inefficiency or waste in emergency care systems.^{2 4 14 21} Since the 1990s, several studies have conducted investigations into preventable ED visits.^{19 20 22} The concerns regarding adverse consequences of LA visits are that LA ED visits may worsen ED overcrowding; thus affecting the quality of ED care,^{23 24} and adding to the inefficiency in healthcare delivery by levying excessive cost on health systems.^{20 24} Studies have revealed an increasing trend of ED utilisation in many countries with different healthcare systems,^{4 5 14 21 25 26} but only a few have investigated changes in LA ED over time.^{2 11 27} Although single-centre and multi-centre studies have estimated that 20%–65% of paediatric ED (PED) visits are likely to be classified as LA,^{2 15 28 29} none of these studies specifically focused on the changes in LA PED visits in the paediatric population over time. The paediatric population is the main user of ED services²⁷ and a main contributor to LA ED visits. Therefore, it is critical to gain a better understanding of the changes in potentially unnecessary ED visits among paediatric populations and associated influencing factors. More importantly, conducting this investigation in Taiwan, where a universal and comprehensive health insurance programme is implemented, may shed light on the debate between expansion of health insurance and excessive LA ED visits in the paediatric population.

We aimed to demonstrate the changes in the utilisation of emergency medical services and potential LA ED visits among the paediatric population under a single-payer universal health insurance programme in Taiwan from 2000 to 2015. More specifically, we explored clinical and non-clinical factors associated with LA ED visits among the paediatric population.

METHODS

Study design and data sources

This study was conducted using a population-based repeated cross-sectional design. The NHI claims data from 2000, 2005, 2010 and 2015 in Taiwan were obtained to evaluate the changes in the population rates of paediatric emergency medical services over time. Updated annually, the NHI database contains enrollment files and claims data, which provide comprehensive information on beneficiaries, such as demographic characteristics, socioeconomic status (SES), dates of medical services (outpatients, inpatients and ED visits), diagnosis International

Classification of Diseases (ICD) codes, medical expenditures, type of provider sought and registry for catastrophic illness. Before data were released for research, personal identifiers were encrypted to ensure confidentiality. The Institutional Review Board stated that informed consent is not needed.

Setting and participants

In total, 5 538 197, 4 818 213, 4 401 677 and 3 841 174 individuals aged 18 years and below were identified in 2000, 2005, 2010 and 2015, respectively. The ambulatory care and hospital ED visits of these individuals were included for analysis. ED visit records with missing diagnoses, residential locations or provider information data were excluded. ED visits made by children and adolescents who had a long-existing, severe disease, such as type I diabetes, end-stage renal disease, cancer, certain autoimmune diseases and certain congenital disorders, among others, were excluded. The flowcharts of the sample selection process are shown in the online supplemental materials. The NHI programme was implemented on 1 March 1995 and offered all Taiwanese residents comprehensive health insurance coverage, which includes ambulatory care, inpatient care, emergency care, prescription drugs, dental care and Chinese medicine services. During the study period, more than 99% of the population were enrolled, and 93% of healthcare providers were contracted with the NHI programme.³⁰ The NHI programme covers diagnostic tests and medically necessary procedures used in emergency medical departments for all beneficiaries.³¹ Only a modest copayment (approximately US\$15 per visit) is required.³⁰ Paediatric subpopulations with low SES or health-related issues are exempted from this copayment obligation when accessing ED services.³⁰

Variables

Low acuity PED visits

We adopted an ICD-based diagnosis grouping system (DGS) and severity classification system (SCS) for classifying PED visits and defining LA PED visits in our study. The DGS and SCS, developed by the Paediatric Emergency Care Applied Research Network (PECARN), allow comprehensive identification of nearly all diagnoses (>95%) and approximate severity of ED visits.^{32 33} The SCS, a diagnosis-based severity scoring tool, was used to classify PED visits into one of five severity levels (1=lowest severity to 5=highest severity) based on the diagnosis of the condition provided within a single PED visit with the highest severity.³³ LA PED visits were defined as PED visits with a SCS score of 1 or 2. The PED visits with a SCS score of 3 or above, with a following admission within 3 days, and of adolescents with a long-existing, severe diseases, were defined as non-LA PED visits.

Child and family characteristics

Children's age, gender, SES, timing of PED visit (Sunday/holiday) and health status were recorded. Children's age was categorised into five categories

(<1, 1–4, 5–9, 10–14, 15–18 years). SES was inferred by linking the patient identifier and birth date to the NHI enrolment files, and was defined by parental insurable wage, which was constructed as a categorical variable. High SES was defined as parents whose insurable wages were among the top 25% of parental wages, middle SES was inferred as the middle 50%, low SES was the bottom 25%. The last group were the families below the poverty line, who received premium subsidies from the government. The timing of PED visits was classified as weekday or weekend/holiday according to the calendar year. Weekend was defined as Sundays only, as many clinics and hospitals in Taiwan offer regular outpatient or ambulatory care sessions on Saturdays. Admission within 1 year of PED visit was used as a proxy to reflect children's health status.

Area characteristics

We defined children's residential location as where they were enrolled in the NHI programme, relating to the 369 townships in Taiwan. Township-level data were obtained from an open public government website³⁴ and from the Taiwan Medical Association.³⁵ Area characteristics, such as medical resources and area income, were recorded. We trichotomised all townships into high-income, middle-income and low-income groups according to their median household incomes. Outpatient resources were defined as the number of physicians per square kilometre in each township. We categorised townships into three categories: low (<2 physicians/km²), medium (2–10 physicians/km²) and high (>10 physicians/km²). We also defined PED resources as the number of hospitals offering emergency medical services per square kilometre in each county and recorded these in tertiles. The 22 counties were classified as having low, medium or high levels of ED resources.

Statistical methods

We estimated LA PED and PED visits per 100 population per calendar year and calculated specific rates for each child, family and area characteristics. Due to the declining birth rates from 2000 to 2015, we presented the changes of our rate estimates in 2000, 2005, 2010 and 2015 after standardisation using the 2015 population structure. We examined the changes in the rate of LA PED visits between 2000 and 2015 and the proportional difference was calculated. A Joinpoint test was used for trend analyses. We further assessed the top 10 most common diagnoses of LA and non-LA PED visits in 2000 and 2015 according to the DGS developed by PECARN.

Univariate and multivariate analyses were performed to identify factors associated with LA PED visits in 2015. Due to the hierarchical nature of the data, generalised estimating equations (GEE) were applied. Two levels were identified: visits and townships. Sensitivity analyses were conducted by including either patient-level or hospital-level data. The results remained robust and the intraclass

correlations for patient and hospital levels were low. Therefore, we presented the two-level model (visit and area levels) in the main results. The analyses were adjusted for robust standard errors. Statistical significance levels of 0.05, 0.01 and 0.001 were chosen. All statistical analyses were performed using the SAS V.9.4 statistical software (SAS Institute).

RESULTS

We identified 5 538 197 children enrolled in the NHI program in 2000, and 3 841 174 children in 2015. A low fertility rate persisting in Taiwan over the past two decades has led to an apparent decrease in the paediatric population. Child demographics, SES and health status were similar between the 2 years (table 1). The sex ratio was also similar between the 2 years, with a male to female ratio of 1.08 for both years. In terms of area characteristics, a higher proportion of children resided in areas with high or middle outpatient resources in 2015, compared with 2000. Despite the decrease in the number of hospitals offering emergency medical services (489 in 2000, compared with 318 in 2015), the spatial distribution of PED resources in relation to children remained relatively similar.

After standardisation using the 2015 population structure, the annual LA PED visits per 100 population decreased from 10.32 in 2000, to 9.04 in 2015 (12.40%); whereas the PED visits per 100 population increased from 23.80 in 2000, to 29.07 in 2015 (22.14%; figure 1). This indicated that, although the PED utilisation rate increased sizably under the NHI programme in Taiwan from 2000 to 2015, the LA PED rate did not follow this increasing trend. A decreasing trend in LA PED visit rates was observed across most of the individual and area subgroups, except for the adolescent population. Compared to 2000, the LA PED utilisation increased by 30% and 24% among children and adolescents aged 10–14 (4.57 in 2000 vs 5.95 in 2015), and 15–18 years (5.71 in 2000 vs 7.08 in 2015), respectively. Overall, the decline for girls was higher than that for boys (15% vs 12%, respectively; figure 2).

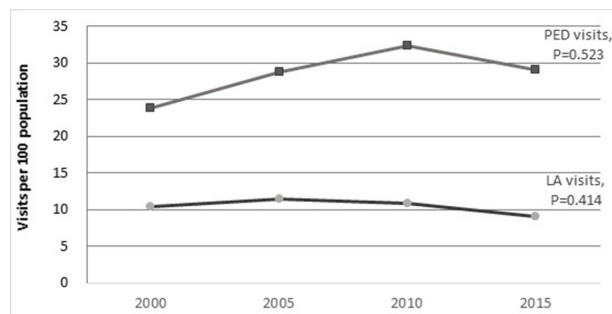
The top five most common diagnosis categories in LA and non-LA PED visits in 2000 and 2015 are presented in table 2. The top five major groups comprised more than 85% LA PED visits in 2000, and 90% in 2015. Infectious ears, nose and throat (ENT) conditions, and dental and mouth diseases persistently ranked as the most common reasons for LA PED visits from 2000 to 2015, although their rate and proportion decreased over the study period (5.79–2.89 visits per 100 population; 55%–32% of LA PED visits in 2000–2015, respectively). Of the other four disease categories, trauma-related LA PED visits (ie, contusions and abrasions or strains and sprains) increased most rapidly (9%–28% of LA PED visits; 0.91–2.56 visits per 100 population in 2000 and 2015, respectively).

Table 1 Characteristics of Taiwanese children by individual and area factors in 2000 and 2015

Characteristics	Year	
	2000	2015
	No. (%)	No. (%)
Total children population (n)	5 538 197	3 841 174
<i>Individual factors</i>		
<i>Age group, year</i>		
<1	288 396 (5)	190 765 (5)
1–4	1 148 242 (21)	802 627 (21)
5–9	1 547 149 (28)	925 524 (24)
10–14	1 526 336 (28)	1 103 896 (29)
15–18	1 028 074 (19)	818 362 (21)
<i>Gender</i>		
Female	2 659 305 (48)	1 839 854 (48)
Male	2 878 892 (52)	2 001 320 (52)
<i>Parental income level</i>		
High	1 402 597 (25)	935 574 (24)
Middle	2 783 810 (50)	1 974 459 (51)
Low	1 298 153 (23)	811 164 (21)
Below poverty line	53 637 (1)	119 977 (3)
<i>Admission within 1 year before PED visit</i>		
No	5 272 383 (95)	3 629 391 (94)
Yes	265 814 (5)	211 783 (6)
<i>Area level factors</i>		
<i>Area income</i>		
High	3 706 983 (67)	2 528 172 (66)
Middle	1 286 602 (23)	846 430 (22)
Low	544 612 (10)	466 572 (12)
<i>Outpatient resources area</i>		
High	2 151 271 (39)	1 702 841 (44)
Middle	1 499 660 (27)	1 072 082 (28)
Low	1 887 266 (34)	1 066 251 (28)
<i>PED resources area</i>		
High	1 175 495 (21)	766 138 (20)
Middle	2 845 737 (51)	2 060 460 (54)
Low	1 516 965 (27)	1 014 576 (26)

PED, paediatric emergency department.

The top five most common disease categories of non-LA PED visits were somewhat different from those of the LA PED visits. Systemic and neurological diseases were ranked among the top five categories, along with trauma, gastrointestinal diseases and respiratory diseases. All non-LA PED visit rates of these top five categories increased during the study period. The largest increase

**Figure 1** Trends of population visit rates of paediatric emergency department (PED) visits and low acuity (LA) PED visits, 2000–2015.

was observed for systemic (1.80–6.04 visits per 100 population from 2000 to 2015, respectively) and gastrointestinal diseases (1.59–4.62 visits per 100 population from 2000 to 2015, respectively).

The GEE results indicated that after adjusting for other covariates, a dose–response pattern was observed between children’s age and the likelihood of incurring an LA PED visit in 2015. The older the child, the more likely it was that their ED visit was of LA (table 3). The ED visits made by boys were more likely to be for an LA reason than those made by girls (OR=1.06, CI=1.05–1.07, $p<0.0001$). Children who had been admitted to hospital in the previous year were less likely to visit the ED for an LA reason (OR=0.78, CI=0.77–0.79, $p<0.0001$). A dose–response relationship was also observed between family SES and LA-PED visits. The ED visits of children from poorer families were more likely to be LA-PED visits.

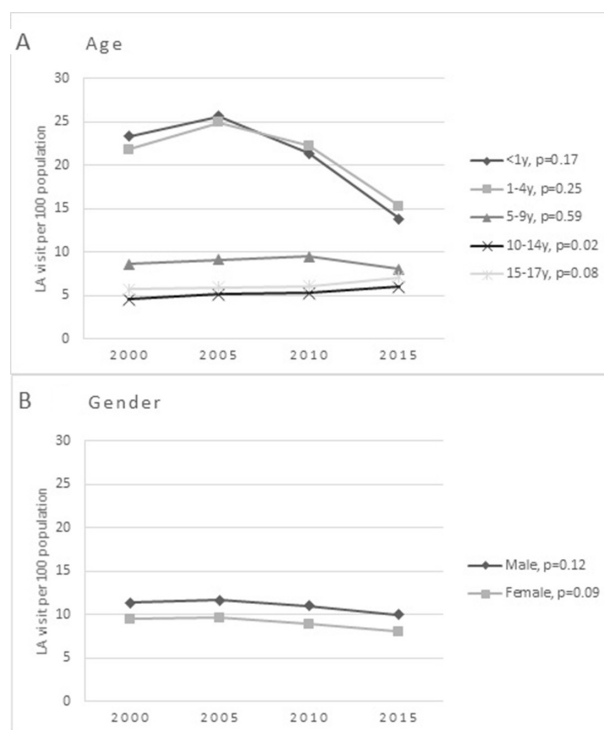
**Figure 2** Trends of population visit rates of low acuity (LA) visits, by age and gender.

Table 2 Most common diagnoses in low acuity paediatric emergency department (LA PED) and non-LA PED visits per 100 population (% of each diagnostic group among LA PED visits or non-LA PED visits), 2000 and 2015

Major group diagnoses	2000	2015
	Numbers per 100 population (% among LA PED visits)	Numbers per 100 population (% among LA PED visits)
LA PED visits		
ENT, dental and mouth diseases	5.79 (55.31)	2.89 (31.94)
Infectious mouth and throat disorders (tonsillitis, pharyngitis)	2.68 (25.60)	1.43 (15.86)
Infectious nose and sinus disorders, including URI	2.62 (25.08)	0.98 (10.90)
Gastrointestinal diseases	1.58 (15.13)	1.61 (17.80)
Gastroenteritis	1.29 (12.35)	1.44 (15.97)
Other gastrointestinal diseases (constipation)	0.27 (2.61)	0.13 (1.42)
Trauma	0.91 (8.68)	2.56 (28.31)
Contusions and abrasions (external, of any body part)	0.64 (6.09)	2.12 (23.41)
Strains and sprains (extremities)	0.09 (0.87)	0.20 (2.20)
Respiratory diseases	0.40 (3.87)	0.52 (5.71)
Infectious respiratory diseases (acute bronchitis)	0.39 (3.71)	0.43 (4.78)
Allergic, immunologic and rheumatologic diseases	0.36 (3.41)	0.72 (7.99)
Allergic, immunologic and rheumatologic diseases (urticaria)	0.36 (3.41)	0.72 (7.99)
	Numbers per 100 population (% among non-LA PED visits)	Numbers per 100 population (% among non-LA PED visits)
Non-LA PED visits		
Trauma	2.93 (21.54)	3.68 (18.39)
Lacerations, amputations and uninfected foreign bodies (external)	1.87 (13.77)	2.17 (10.81)
Brain and skull trauma	0.63 (4.62)	0.80 (4.02)
Fractures and dislocations (extremities)	0.19 (1.40)	0.37 (1.86)
Systemic states	1.80 (13.25)	6.04 (30.13)
Fever	1.40 (10.33)	5.14 (25.65)
Gastrointestinal diseases	1.59 (11.68)	4.62 (23.07)
Other gastrointestinal diseases (dyspepsia, impaction of intestine)	0.89 (6.58)	0.54 (2.72)
Gastroenteritis (gastritis)	0.62 (4.57)	1.08 (5.41)
Abdominal pain	0.002 (0.01)	1.95 (9.75)
Vomiting	0.003 (0.02)	0.98 (4.89)
Respiratory diseases	1.39 (10.22)	2.29 (11.43)
Infectious respiratory diseases (bronchopneumonia, bronchiolitis, pneumonia)	0.93 (6.87)	1.12 (8.07)
Asthma	0.40 (2.95)	0.49 (2.47)
Neurologic diseases	0.33 (2.40)	0.76 (3.8)
Headache	0.16 (1.14)	0.29 (1.43)
Seizure	0.03 (0.24)	0.24 (1.20)

ENT, ears, nose and throat; URI, upper respiratory infection.

Furthermore, the PED visits on Sundays or holidays, when ambulatory care services were generally unavailable, were more likely to be of LA. In terms of area characteristics, ED visits occurring in high-income areas were more likely to be of LA (OR=1.07, CI=1.01–1.14, $p=0.0289$). A U-shape relationship was found between PED resources and the likelihood of LA PED visits, as PED visits occurring in areas with middle-level of PED resources offering

PED services 1–2 hospitals per 100 square kilometres were less likely to be of LA.

DISCUSSION

This study had several important findings. First, under the comprehensive universal insurance coverage in Taiwan from 2000 to 2015, we observed an increasing

Table 3 Multilevel regression of low acuity PED visits among PED visits, 2015

Model	Low acuity PED visits among PED visits	
	OR (95% CI)	P value*
<i>Individual level factor</i>		
Age group, year		
<1	Reference	
1–4	1.06 (1.04–1.08)	<0.0001*
5–9	1.12 (1.09–1.15)	<0.0001*
10–14	1.32 (1.29–1.35)	<0.0001*
15–18	1.35 (1.32–1.39)	<0.0001*
Gender		
Female	Reference	
Male	1.06 (1.05–1.07)	<0.0001*
Admission within 1 year before PED visit		
No	Reference	
Yes	0.78 (0.77–0.79)	<0.0001*
Parental income level		
High	Reference	
Middle	1.02 (1.00–1.03)	0.0117*
Low	1.06 (1.04–1.08)	<0.0001*
Below poverty line	1.21 (1.17–1.25)	<0.0001*
Sunday/Holiday		
No	Reference	
Yes	1.18 (1.16–1.19)	<0.0001*
<i>Area level factors</i>		
Area income level		
High	1.07 (1.01–1.14)	0.0289*
Middle	0.97 (0.92–1.03)	0.3103
Low	Reference	
PED resources		
High	1.07 (0.99–1.16)	0.094
Middle	0.89 (0.85–0.93)	<0.0001*
Low	Reference	
Outpatient resources		
High	0.94 (0.88–1.01)	0.4207
Middle	0.98 (0.93–1.03)	0.0697
Low	Reference	

*Significance.

PED, paediatric emergency department.

trend in PED utilisation, but a decreasing trend in LA PED visits. Consistent with the findings in other countries,^{14 21} we found that the PED utilisation increased over time. Changing morbidity patterns among children, with a rapid growth in fever, abdominal pain and trauma, may have increased ED utilisations among children, since

many advanced diagnostic tests, and some equipments, are not readily available in primary care settings (eg, imaging for abdominal pain and trauma, urine testing, rapid influenza testing, chest X-ray or blood testing for fever). Increasing international demand for acute medical services and diagnostic rate or intervention trends in the PED may explain the need for non-LA PED services.^{6 8 14 36–38}

Unlike in other countries,^{21 25 39} LA or potentially unnecessary ED utilisation has not concurrently increased over time in Taiwan. During the study period, the reduced need for ED in LA conditions in Taiwan may have resulted from improved access to ambulatory care; likely due to the NHI copayment exemption policies for disadvantaged children, as well as an increased supply of physicians in primary care setting. Although the NHI copayment exemption policy also exempts young children's copayments when using ED services, our findings suggest that such a policy has not led to an increased overuse of emergency medical care over time among the paediatric population. In addition, regular influenza vaccination programmes for children, as well as amendment of school policies to enforce sick absences and mask wearing ever since the SARS epidemic, may have cut down the transmission of mildly infectious ENT, dental and mouth diseases.³⁶ This change in morbidity may have reduced children's needs for LA ED visits relating to mildly infectious ENT conditions, as well as dental and mouth diseases.

Furthermore, injuries are leading causes of mortality and morbidity in youth in Taiwan, particularly in adolescents.³⁷ A substantial increase in both PED and LA PED visits due to trauma from 2000 to 2015 has reiterated this long-standing and increasingly serious health hazard for Taiwanese youth. Contusions and abrasions (relating to any external body part trauma) were found to be the leading reason for LA PED visits. Similarly, lacerations, amputations and uninfected foreign bodies (relating to any external trauma) have also been a leading cause of non-LA PED visits over time. The high injury susceptibility among adolescents, particularly male teens, may help to partially explain the increasing trends in both PED and LA PED visits among adolescents during the study period, as well as the significantly higher likelihood of LA PED visits among males and adolescents.^{37 38 40} More importantly, these findings highlight the importance and urgency of injury prevention in Taiwanese youth.

Nevertheless, the analysis of leading causes of PED and LA PED visits in the paediatric population reveals that, unlike in the USA and other developed countries,^{27 28 41} gastroenteritis, abdominal pain or vomiting conditions have consistently remained as leading causes of LA PED and non-LA PED visits, respectively. More precautionary efforts are needed to enhance vaccination, hand hygiene, food safety and environmental protection measures for reducing such morbidities.

Consistent with the literature,^{28 42} our study demonstrated that children from socioeconomically

disadvantaged families were more likely to use ED services for LA conditions. This finding suggests that, although the NHI programme and the copayment exemption policies have substantially removed financial barriers to primary care for children, other factors, such as health literacy, and non-financial barriers may have also influenced parent's care seeking behaviours for their children's ailments. Socioeconomically disadvantaged parents lack sufficient capability or information to assess the severity of illnesses, or lack the time flexibility to seek care from ambulatory care providers during regular office hours. Therefore, the ED becomes the most convenient source of care for these populations. Similarly, the unavailability of ambulatory care services on Sundays and holidays has also contributed to the higher likelihood of using ED for LA conditions among children and adolescents.

In terms of area characteristics, paediatric ED visits occurring in more resource-rich areas, including high income areas or areas with richer paediatric emergency care resources, were more likely to be for LA conditions. One plausible explanation is that these more resource-rich areas tend to have more advantageous resources, such as transportation and information, which may lead to higher healthcare utilisation among children.⁸ For example, expediency has been identified by patients as the primary influencing factor for seeking care from the ED.²² Studies showed that people living in higher socio-economic areas had 1.04–1.32 times higher likelihood to use ED for low acuity conditions.²⁷ High PED resources may induce unnecessary LA PED visits, arising from hospital shopping or moral hazard behaviour. The lowest likelihood of incurring ED visits for low acuity conditions in Taiwan was found to be 1–2 hospitals offering PED services per 100 square kilometres.

Our study has several limitations. First, due to data limitations, the exact residential location of the child was unavailable, and instead, the NHI enrollment location of the child was used as a proxy for his or her residential location. Thus, misclassification bias may possibly lead to an overestimation of the effects of high-resource or income areas. However, prior validation studies have suggested that over 90% of children under 15 years who obtain coverage from their parents co-habit with at least one of their parents, and thus have the same enrollment location.⁴³ Second, due to the lack of more precise information on parental SES, the insurable wage of one parent was used to assess the relationship between child's SES and likelihood of LA PED visits. Under the NHI programme in Taiwan, children are normally enrolled through the parent with a lower insurable wage to save premium costs. Therefore, using this insurable wage information may not be a full reflection of child's SES. Further studies with more comprehensive measures of SES may help to clarify this relationship. Third, due to the limitations inherent in the claims data, several relevant variables, such as the time of day, health literacy, transportation availability and parent or physician perceptions of need for care, were not included in analyses. Fourth, as this study was an

observational trend analysis, we were unable to draw any causal inference based on our descriptive results.

Overall, this study is the first nationwide population-based assessment of PED and LA PED utilisation among children and adolescents under a single-payer universal health insurance programme over time in Taiwan. Despite a comprehensive coverage of emergency care and low cost-sharing obligations for the covered services, surprisingly, we did not observe a significant increase in ED utilisation for LA conditions over time from 2000 to 2015. Easy access to outpatient care and a rich supply of primary care clinics may have helped to reduce the utilisation of ED for discretionary care in Taiwan. Taiwan's experience may serve as an important reference to countries considering healthcare system reforms. More importantly, the analysis of the causes of ED visits suggests that more policy and preventive efforts are needed to address injury prevention, hygiene and food safety, in order to further improve the health of Taiwanese youth.

Author affiliations

¹Pediatrics, Chang Gung Memorial Hospital, Keelung, Taiwan

²College of Medicine, Chang Gung University, Taoyuan, Taoyuan, Taiwan

³Institute of Public Health, National Yang-Ming University, Taipei, Taiwan

⁴Department of Pediatrics, Chang Gung Children's Hospital, Taoyuan, Taiwan

⁵Center for Big Data Analytics and Statistics, Chang Gung Memorial Hospital, Taoyuan, Taiwan

⁶Institute of Hospital and Health Care Administration, National Yang-Ming University, Taipei, Taiwan

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ORCID iD

I-Anne Huang <http://orcid.org/0000-0001-8570-7723>

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