Public Health 182 (2020) 102–109

Contents lists available at ScienceDirect

Public Health

journal homepage: www.elsevier.com/locate/puhe

Original Research

# Urban-rural disparity of preventive healthcare utilisation among children under the universal health insurance coverage in Taiwan: a national birth cohort analysis

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ARTICLE INFO

*Article history:*
Received 25 July 2019
Received in revised form
18 January 2020
Accepted 14 February 2020
Available online 1 April 2020

*Keywords:*
Low birth weight
Child
Rural health services
Healthcare disparities
Cohort studies

ABSTRACT

*Objective:* In the context of universal health insurance coverage, this study aimed to determine whether urban–rural inequality still exists in preventive health care (PHC) amongst children in Taiwan.
*Study design:* Prospective cohort study.
*Methods:* A total of 184,117 mothers and their children born in 2009 were identified as the study cohort. The number of children born in urban, satellite and rural areas was 40,176, 57,565 and 86,805, respectively. All children were followed for 7 years, before which a total of seven times PHC were provided by Taiwan's National Health Insurance (NHI) programme. Ordinal logistic regression models were used to associate urbanisation level with the frequency of PHC utilisation. Stratified analyses were further performed in accordance with the children's birth weight and the mothers' birthplace.
*Results:* Children from satellite areas had higher utilisation for the first four scheduled PHC visits. Children living in urban areas received more PHC for the fifth and sixth scheduled visits. Compared with those from rural areas, children in satellite areas exhibited a small but significant increase in odds in PHC utilisation, with a covariate-adjusted odds ratio (aOR) of 1.04 and 95% confidence interval (CI) of 1.02–1.06. By contrast, no significant difference was observed between rural and urban areas (aOR = 1.01). Further stratified analyses suggest more evident urban–rural difference in PHC utilisation amongst children with low birth weight and foreign-born mothers.
*Conclusions:* Given a universal health insurance coverage and embedded mechanisms in increasing the availability of healthcare resources in Taiwan, a slight urban–rural difference is observed in PHC utilisation amongst children. Hence, sociodemographic inequality in utilisation of PHC still exists. This issue should be addressed through policy intervention.


## Introduction

Preventive health care (PHC) plays a crucial role in children's health through the early detection of health problems. The children's PHC programme of Taiwan, also known as well-child visits, provides scheduled primary immunisations and health checkups for physical, developmental and behavioural problems; it also offers counselling to caregivers.[1] Regular health checkups for children

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https://doi.org/10.1016/j.puhe.2020.02.011
0033-3506/

have been effective in reducing neonatal and infant mortality, decreasing the likelihood of hospitalisation and improving children's health.[2–4] Despite all these benefits, the utilisation rate of health checkups varies worldwide. In the USA, for example, 58.9% of children took recommended well-child visits in 2007–2008.[5] An Australian survey conducted in 2012–2013 showed that 70.3% of parents with children aged under 6 months and 48.6% of parents with children aged 3–5 years reported that they regularly visit child and family health nurses.[6] In Taiwan, the utilisation rate of PHC for children under 7 years was approximately 70% in 2002 and increased to 78.3% in 2015.[3]

Disparity in healthcare utilisation in urban and rural areas amongst children has been reported in previous studies. The determinants of such disparity can result from inadequate healthcare resources, low socio-economic status of families, lack of insurance coverage, poor health literacy of parents and negative attitude towards health checkup in rural areas.[7,8] Previous studies have shown an evident urban–rural variation in morbidity and mortality amongst children from developing countries;[9,10] meanwhile, disparity still exists in health problems between urban and rural areas amongst children from developed countries. These health problems include hospitalisation due to physical abuse, emergency department reliance, drug-related poisoning and underdiagnosis of obesity, which are more prevalent in children living in rural areas than in urban areas.[11–14] Although well-child visit can play varying roles in different countries, reducing the gap in PHC utilisation between urban and rural areas is expected to effectively improve the disparity in children's health problems.

Health insurance coverage is a pivotal factor that determines whether a baby will use PHC.[1] The low insurance coverage in rural areas may result from the poor socio-economic status of people from such areas.[15] The government of Taiwan launched its universal health insurance coverage in 1994, and over 99% of Taiwan residents have been insured since 2009.[16] The present study aimed to determine if urban–rural disparity in PHC utilisation still exists in Taiwan after nearly two decades of universal health insurance coverage.

## Methods

### *Data source*

The data analysed in this study included Taiwan's national birth notification (BN), national health insurance database (NHID) and parents–child pair dataset (PCPD). BN includes various pieces of information about mothers, including personal identification number (PID), birthday, birthplace, delivery date and residential city district/township at the time of delivery. BN also includes information regarding gestational week and birth weight for each live birth. NHID comprises various subdatasets, including beneficiary registry (BR) and inpatient/outpatient medical claims. BR includes the demographic characteristics, insurance premium and PID of each individual covered by Taiwan's National Health Insurance (NHI) programme. NHID covers claim data for nearly all (>99%) Taiwanese residents.[16] To ensure the accuracy of claim data, the National Health Insurance Administration (NHIA) performs quarterly expert reviews on a random sample for every 50 to 100 ambulatory and inpatient claims (NHIA, 2018), and the information available from NHIA is considered complete and accurate.[17]

To obtain the link between newborns and their parents, we used PCPD to identify parental PIDs for each newborn. By linking PCPD and BN, we determined the gestational weeks and birth weight of each newborn. In addition, paternal age at the time of delivery can be obtained through the link between PCPD and BR. The various datasets and the study variables derived from these datasets are illustrated in Appendix A. We also used the national death registry (DR) to identify newborns that died under the age of 7 years and were unable to complete the seven PHC visits provided by the NHI programme.

The current study protocol was approved by the Institutional Review Board of National Cheng Kung University Hospital (No. B-ER-107-014). Access to the aforementioned databases was approved by the Health and Welfare Data Science Centre (HWDSC) of the Ministry of Health and Welfare. To guard the data, the data management and statistical analyses involved in this study were conducted on-site at HWDSC.

### *Study design*

This work is a nationwide cohort study of all neonates born in 2009, who were followed up until the age of 7 years. We initially identified 186,044 newborns from BR in 2009. After excluding the newborns whose mothers' PIDs were not found in BN ($n = 37$) and whose mothers' residential city district/township was missing ($n = 509$), 185,498 children were left in the study cohort. We further excluded children who died during follow-up (i.e. prior to the age of 7 years) ($n = 954$). A total of 184,544 children were finally included in the current analysis.

### *Level of urbanisation*

On the basis of the information regarding the residential city district/township of a mother at the time of delivery, we classified maternal residential area into different urbanisation levels: rural, satellite and urban areas. The classification scheme for determining urbanisation level was proposed by Liu et al. who categorised all 316 city districts and townships in Taiwan into seven clusters in accordance with population density, proportion of residents with college or higher education levels, percentage of elderly (>65 years old) people, proportion of the agricultural workforce and number of physicians per $10^5$ people.[18] In this study, we regarded the most and second most urbanised clusters as 'urban' and 'satellite' areas, respectively, and the remaining ones as 'rural' areas.[19]

### *PHC services*

In addition to the treatment-oriented medical care provided by the NHI programme, the Health Promotion Administration (HPA) of the Ministry of Health and Welfare also provides every child with seven PHC services before his or her 7th birthday. PHC services include primary regular physical examinations, dental checkup, assessment of physical and mental development and screening for various disorders, such as hearing loss, inherited metabolic disorders and ophthalmological problems.[3] Regular PHC is expected to increase the probability of early detection of certain disorders, and thus, provide timely referrals for clinical treatment. These services are directly provided by paediatricians under contract with the NHI programme.

Every child may receive PHC service when he or she reaches the ages of 0–2 months (1st), 2–4 months (2nd), 4–10 months (3rd), 10 months to 1.5 years (4th), 1.5–2 years (5th), 2–3 years (6th) and 3–7 years (7th). The utilisation of PHC service during the aforementioned periods can be identified from the medical order codes in NHID, which were IC11/IC71, IC12/IC72, IC13/IC73, IC15/IC75, IC16/IC76, IC17/IC77 and IC19/IC79, respectively.

### *Covariates*

A number of parental and children's characteristics were considered, including paternal and maternal ages at the time of delivery, birth weight and mother's birthplace. Birth weight was classified as normal birth weight (NBW, ≥2500 g), low birth weight (LBW, 1500–2499 g) and very low birth weight (VLBW, <1500 g).

Paternal and maternal ages were categorised as <18, 18 to <25, 25 to <35 and ≥35 years. Maternal birthplace was grouped under 'otherwise' if a mother was not a native-born Taiwanese.

### *Statistical analysis*

Sociodemographic characteristics were compared amongst children with maternal residential city district/township in rural, satellite and urban areas. We used a Chi-squared test to compare the differences of discrete variables and Student's *t*-test to compare continuous variables. The prevalence of PHC utilisation was calculated by dividing the total number of utilisation by the study's children with the total number of children. A Chi-squared test was also performed to compare the prevalence of PHC utilisation at each scheduled visit amongst children living in rural, satellite or urban areas.

We used an ordinal logistic regression model to estimate the odds of higher PHC utilisation in association with urbanisation level and various covariates. Crude odds ratio (OR), adjusted OR and their corresponding 95% confidence intervals (CIs) were estimated from the regression coefficients derived from the ordinal logistic regression. We tested the assumption of proportional odds for the ordinal logistic regression model and determined that the assumption holds.[20] All data management and analyses were performed using statistical software SAS for Windows (version 9.4; SAS Institute, Cary, NC). A *P*-value of 0.05 or less was considered statistically significant.

## Results

Table 1 shows and compares the characteristics of the study's children in rural, satellite and urban areas. A higher number of boys were reported in the three study groups. The prevalence of LBW children was higher in rural areas (8.09%) than in satellite (7.62%) and urban (7.64%) areas. Most mothers had given birth at the age of 25–34 years (72%–74%). Mothers under 18 years old were slightly more common in rural areas (0.65%) than in satellite (0.35%) and urban (0.25%) areas. Similarly, fathers in rural areas were slightly younger. Approximately 6.03% of the study's children had foreign-born mothers, with higher prevalence amongst children from rural areas (7.07%) than from satellite and (5.39%) urban (5.64%) areas.

Fig. 1 compares PHC utilisation for each scheduled visit amongst the three study groups. Within-group and between-group variations were observed in utilisation rate. In all three study groups, the 1st scheduled visit was associated with the lowest utilisation rate, and the 3rd and 4th scheduled visits tended to have higher rates. In addition, whilst the difference in utilisation rate was small between satellite and urban areas, children from rural areas tended to have lower utilisation rates for most of the scheduled visits. The detailed information about utilisation and comparison amongst the study groups are presented in Appendix B.

Table 2 provides the crude and covariate-adjusted ORs of the high utilisation of PHC services in association with urbanisation level and various covariates. Compared with children living in rural areas, those from satellite areas had significantly higher odds of utilising PHC service (adjusted OR: 1.04, 95% CI: 1.02–1.06). Such significantly elevated OR, however, was not observed amongst children from urban areas. Apart from lower urbanisation, a number of covariates were also associated with significantly lower utilisation, including lower birth weight (adjusted OR: 0.85, 95% CI: 0.82–0.88 for LBW; adjusted OR: 0.20, 95% CI: 0.18–0.22 for VLBW), younger parents [adjusted OR: 0.72, 95% CI: 0.61–0.88 for mothers <18 years; adjusted OR: 0.51 (95% CI 0.33–0.78) and 0.85 (95% CI 0.81–0.89) for fathers <18 years and 18–24 years, respectively] and foreign-born mothers (adjusted OR: 0.64, 95% CI: 0.62–0.67).

We assessed the potential effect modification by each covariate and noted significant ($P < 0.05$) interactions of urbanisation level with birth weight and maternal birthplace. We then performed stratified analyses in accordance with the two effect modifiers. The

**Table 1**
Comparison of characteristics among study subjects with different residential levels of urbanisation.

| Characteristics | Level of urbanisation | | | | | | *P*-value |
|---|---|---|---|---|---|---|---|
| | Rural | | Satellite | | Urban | | |
| | *n* | % | *n* | % | *n* | % | |
| Gender | | | | | | | 0.13 |
| Male | 45,350 | 52.24 | 29,787 | 51.74 | 20,824 | 51.83 | |
| Female | 41,454 | 47.76 | 27,777 | 48.25 | 19,352 | 48.17 | |
| Birthweight | | | | | | | <0.01 |
| Normal | 79,782 | 91.91 | 53,181 | 92.39 | 37,106 | 92.36 | |
| Low | 6434 | 7.41 | 4005 | 6.96 | 2801 | 6.97 | |
| Very low | 588 | 0.68 | 378 | 0.66 | 269 | 0.67 | |
| Mean ± SD | 3066.6 | 450.59 | 3079.5 | 447.71 | 3086.5 | 452.39 | <0.01 |
| Maternal age (yrs) | | | | | | | <0.01 |
| <18 | 564 | 0.65 | 201 | 0.35 | 100 | 0.25 | |
| 18–24 | 13,880 | 15.99 | 5031 | 8.74 | 3037 | 7.56 | |
| 25–34 | 62,499 | 72.00 | 42,396 | 73.65 | 29,526 | 73.49 | |
| ≥35 | 9861 | 11.36 | 9936 | 17.26 | 7513 | 18.70 | |
| Mean ± SD | 29.41 | 4.63 | 30.89 | 4.45 | 31.22 | 4.39 | <0.01 |
| Paternal age (yrs) | | | | | | | <0.01 |
| <18 | 52 | 0.06 | 6 | 0.01 | 3 | <0.01 | |
| 28–24 | 5356 | 6.17 | 1704 | 2.96 | 940 | 2.34 | |
| 25–34 | 56,795 | 65.47 | 34,832 | 60.52 | 23,765 | 59.15 | |
| ≥35 | 24,601 | 28.36 | 21,022 | 36.52 | 15,468 | 38.50 | |
| Mean ± SD | 32.48 | 5.35 | 33.72 | 5.05 | 34.03 | 5.05 | <0.01 |
| Mother's birthplace | | | | | | | <0.01 |
| Taiwan | 80,670 | 92.93 | 54,461 | 94.61 | 37,912 | 94.36 | |
| Otherwise | 6134 | 7.07 | 3103 | 5.39 | 2264 | 5.64 | |
| Total | 86,804 | 47.04 | 57,564 | 31.19 | 40,176 | 21.77 | |

[a] Normal birthweight: ≥2500g, low birthweight: 1500–2499g, very low birthweight: <1500g.
[b] Based on $\chi^2$ or Student's *t* test.
[c] Inconsistence between total number and summation of specific numbers for some variables was due to missing data.

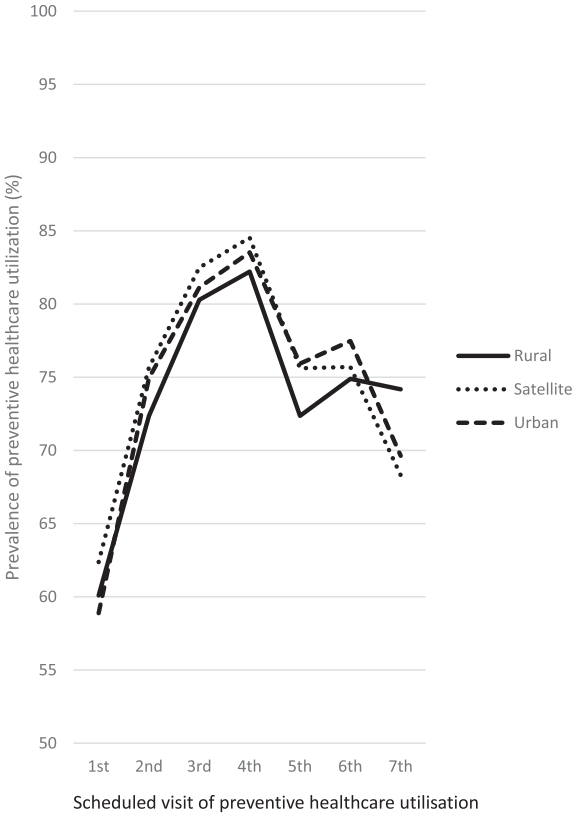


**Fig. 1.** Graphic illustration of urbanisation level specific prevalence of preventive healthcare visit for each scheduled visit at age 0–6 years.

urban–rural difference in OR of high PHC utilisation was only significant amongst LBW infants and those with foreign-born mothers. Amongst LBW infants, satellite (adjusted OR: 1.09, 95% CI: 1.01–1.18) and urban (adjusted OR: 1.17, 95% CI: 1.08–1.27) areas were associated with a significantly higher adjusted OR of PHC utilisation, with a significant trend. A similar trend was observed amongst VLBW children (corresponding adjusted OR = 1.09 and 1.22, $P = 0.13$) and those with foreign-born mothers (adjusted OR = 1.09 and 1.19, $P < 0.01$), as shown in Table 3.

## Discussion

Only a slight urban–rural difference in PHC utilisation was observed amongst young children in the context of universal health insurance coverage in Taiwan. However, urban–rural difference was more evident in certain segments of children's population, including children with lower birth weight and foreign-born mothers. In addition, some sociodemographic characteristics were associated with lower PHC utilisation, including lower birth weight, younger or older parents and foreign-born mothers.

The small disparity across different urbanisation levels noted in our findings slightly differs from observations made in other countries that frequently do not have universal health coverage. A US study reported a covariate-adjusted difference of 12.2% in well-child visit adherence ratio in favour of children from metropolitan statistical areas (MSAs) compared with those living in non-MSA areas in 2007–2008.[5] Although this US study determined that the utilisation of well-child visits increased through years 1996–98 to 2007–08, the increase was smaller in uninsured subgroups than in insured ones. In the uninsured children population, the increase in adherence ratio was from 4.8% to 32.0%; by contrast, the increase was from 9.7% to 56.6% during the same period amongst publicly insured children and from 14.6% to 63.6% in the privately insured

**Table 2**
Odds ratio of higher frequency of preventive healthcare utilisation in association with level ofurbanisation and other sociodemographic characteristics.

| | Total number of preventive healthcare utilisation | | | | | | | | Crude estimate | | | Adjusted estimate | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | OR[a] | 95% CI[a] | *P* | OR[a] | 95% CI[a] | *P* |
| Level of urbanisation | | | | | | | | | | | | | | |
| Rural | 1554 | 2403 | 3799 | 6233 | 10,506 | 17,284 | 24,094 | 20,931 | Ref. | | | Ref. | | |
| Satellite | 785 | 1322 | 2162 | 3752 | 6873 | 11,988 | 17,082 | 13,600 | 1.06 | 1.04–1.08 | <0.01 | 1.04 | 1.02–1.06 | <0.01 |
| Urban | 549 | 995 | 1556 | 2654 | 4825 | 8498 | 12,025 | 9074 | 1.02 | 1.00–1.04 | 0.05 | 1.01 | 1.00–1.04 | 0.21 |
| Gender | | | | | | | | | | | | | | |
| Male | 1514 | 2394 | 3837 | 6632 | 11,728 | 19,749 | 27,618 | 22,489 | Ref. | | | Ref. | | |
| Female | 1374 | 2326 | 3680 | 6007 | 10,476 | 18,021 | 25,583 | 21,116 | 1.02 | 1.00–1.03 | 0.06 | 1.02 | 1.00–1.04 | 0.02 |
| Birthweight[b] | | | | | | | | | | | | | | |
| Normal | 2451 | 4156 | 6711 | 11,365 | 20,369 | 35,050 | 49,417 | 40,550 | Ref. | | | Ref. | | |
| Low | 307 | 466 | 638 | 1092 | 1646 | 2529 | 3584 | 2978 | 0.84 | 0.82–0.87 | <0.01 | 0.85 | 0.82–0.88 | <0.01 |
| Very low | 130 | 98 | 168 | 182 | 189 | 191 | 200 | 77 | 0.20 | 0.18–0.22 | <0.01 | 0.20 | 0.18–0.22 | <0.01 |
| Maternal age (yrs) | | | | | | | | | | | | | | |
| <18 | 39 | 59 | 95 | 110 | 125 | 159 | 177 | 102 | 0.46 | 0.40–0.51 | <0.01 | 0.72 | 0.61–0.85 | <0.01 |
| 18–24 | 472 | 784 | 1123 | 1787 | 2876 | 4406 | 5703 | 4797 | Ref. | | | Ref. | | |
| 25–34 | 1769 | 3046 | 4982 | 8692 | 15,741 | 27,484 | 39,670 | 33,036 | 1.30 | 1.27–1.33 | <0.01 | 1.17 | 1.13–1.20 | <0.01 |
| ≥35 | 608 | 831 | 1317 | 2050 | 3462 | 5721 | 7651 | 5670 | 1.03 | 1.00–1.06 | 0.06 | 1.01 | 0.97–1.05 | 0.58 |
| Paternal age (yrs) | | | | | | | | | | | | | | |
| <18 | 3 | 8 | 5 | 5 | 8 | 12 | 12 | 8 | 0.35 | 0.23–0.53 | <0.01 | 0.51 | 0.33–0.78 | <0.01 |
| 18–24 | 190 | 271 | 436 | 669 | 1025 | 1568 | 2102 | 1739 | 0.76 | 0.73–0.80 | <0.01 | 0.85 | 0.81–0.89 | <0.01 |
| 25–34 | 1392 | 2530 | 4234 | 7480 | 13,571 | 23,623 | 33,915 | 28,647 | Ref. | | | Ref. | | |
| ≥35 | 1303 | 1911 | 2842 | 4485 | 7600 | 12,567 | 17,172 | 13,211 | 0.82 | 0.80–0.83 | <0.01 | 0.88 | 0.87–0.90 | <0.01 |
| Mother's birthplace | | | | | | | | | | | | | | |
| Taiwan | 2412 | 4053 | 6746 | 11,589 | 20,718 | 35,656 | 50,488 | 41,381 | Ref. | | | Ref. | | |
| Otherwise | 476 | 667 | 771 | 1050 | 1486 | 2114 | 2713 | 2224 | 0.60 | 0.58–0.62 | <0.01 | 0.64 | 0.62–0.67 | <0.01 |
| Total | 2888 | 4720 | 7517 | 12,639 | 22,204 | 37,770 | 53,201 | 43,605 | | | | | | |

[a] OR: odds ratio; CI: confidence interval.
[b] Normal birthweight: ≥2500g, low birthweight: 1500–2499g, very low birthweight: <1500g.

**Table 3**
Odds ratio of higher frequency of preventive healthcare utilisation in association with levels of urbanisation stratified by children's birthweight and birthplaces of mothers.

| | Total number of preventive healthcare utilisation | | | | | | | | aOR[a] | 95% CI[a] | *P*-value for interaction | *P*-value for trend in OR |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | | | | |
| Birthweight[b] | | | | | | | | | | | $P < 0.01$ | |
| Normal | | | | | | | | | | | | |
| Rural | 1335 | 2118 | 3364 | 5567 | 9591 | 15,963 | 22,336 | 19,508 | Ref. | | | |
| Satellite | 663 | 1171 | 1938 | 3398 | 6318 | 11,116 | 15,902 | 12,675 | 1.04 | 1.02–1.06 | | |
| Urban | 453 | 867 | 1409 | 2400 | 4460 | 7971 | 11,179 | 8367 | 1.00 | 0.98–1.02 | | $P = 0.87$ |
| Low | | | | | | | | | | | | |
| Rural | 158 | 239 | 349 | 569 | 823 | 1233 | 1671 | 1392 | Ref. | | | |
| Satellite | 82 | 118 | 174 | 305 | 497 | 806 | 1121 | 902 | 1.09 | 1.01–1.18 | | |
| Urban | 67 | 109 | 115 | 218 | 326 | 490 | 792 | 684 | 1.17 | 1.08–1.27 | | $P < 0.01$ |
| Very low | | | | | | | | | | | | |
| Rural | 61 | 46 | 86 | 97 | 92 | 88 | 87 | 31 | Ref. | | | |
| Satellite | 40 | 33 | 50 | 49 | 58 | 66 | 59 | 23 | 1.09 | 0.86–1.39 | | |
| Urban | 29 | 19 | 32 | 36 | 39 | 37 | 54 | 23 | 1.22 | 0.93–1.60 | | $P$=0.13 |
| Mother's birthplace | | | | | | | | | | | $P < 0.01$ | |
| Taiwan | | | | | | | | | | | | |
| Rural | 1284 | 2042 | 3377 | 5658 | 9690 | 16,159 | 22,689 | 19,771 | Ref. | | | |
| Satellite | 665 | 1137 | 1954 | 3480 | 6474 | 11,420 | 16,332 | 12,999 | 1.04 | 1.02–1.06 | | |
| Urban | 463 | 874 | 1415 | 2451 | 4554 | 8077 | 11,467 | 8611 | 1.00 | 0.98–1.02 | | $P = 0.63$ |
| Otherwise | | | | | | | | | | | | |
| Rural | 270 | 361 | 422 | 575 | 816 | 1125 | 1405 | 1160 | Ref. | | | |
| Satellite | 120 | 185 | 208 | 272 | 399 | 568 | 750 | 601 | 1.09 | 1.01–1.18 | | |
| Urban | 86 | 121 | 141 | 203 | 271 | 421 | 558 | 463 | 1.19 | 1.09–1.30 | | $P < 0.01$ |
| Total | 2888 | 4720 | 7517 | 12,639 | 22,204 | 37,770 | 53,201 | 43,605 | | | | |

[a] aOR: adjusted odds ratio; CI: confidence interval.
[b] Normal birthweight: ≥2500g, low birthweight: 1500–2499g, very low birthweight: <1500g.

children population.[5] Another US study observed a significant increase in well-child visit adherence by 20%, which was accompanied by a 28% reduction in the uninsured rate after the execution of the Patient Protection and Affordable Care Act.[21] Reasons that may account for the dissimilarity in findings between our study and those of others can be multifaceted, and insurance coverage may be one of the crucial issues. A lack of insurance has been associated with increased morbidity and mortality due to financial barriers to health care.[22,23] The implementation of the NHI programme in Taiwan effectively removed such financial barriers and increase the affordability of using healthcare services.[19]

Taiwan launched its NHI programme, which covers nearly all Taiwanese residents, in 1995. Such universal health insurance coverage considerably benefits several disadvantaged populations, such as children, the elderly, non-working adults and low-income individuals, who may thereafter afford to receive health care at a reasonable cost.[24] Under the policy of Taiwan's NHI programme, seven PHC visits are available to all children whose parents are only required to pay a small amount of registration fee (approximately USD 5) for each visit. PHC services are provided by general practitioners or paediatrics specialists who can obtain subsidies from the Health Promotion Administration via NHI's reimbursement.[2,25] A universal health insurance coverage may help parents with low socio-economic status eliminate financial barriers to seeking PHC services.

Apart from the affordability issue, improved accessibility through the NHI policy may be another reason that accounts for the slight urban–rural disparity in PHC utilisation by children. One of the health disparity-eliminating strategies of the NHI programme is to increase medical service supply in rural and remote areas.[26] The NHI programme implements various integrated healthcare programmes in rural Taiwan with high reimbursement, increasing physicians' incentive to practice in rural areas.[26] In addition, the local public health stations in each of the 316 city districts/townships around Taiwan also provides well-baby clinic services to parents, all of which has effectively improved healthcare resources in rural Taiwan.[3] Huang et al. analysed 5-year data since the initiation of Taiwan's NHI programme and reported that the rural–urban disparity in the rates of ruptured appendix apparently narrowed down; meanwhile, the rural–urban disparity in medical utilisation exhibited greater improvement amongst children than amongst adults.[26] To further explore the slight urban–rural difference in PHC services observed in our study, we analysed the data of two most socially deprived areas, i.e. aboriginal townships and offshore islands in Taiwan.[27,28] Table 4 shows that 5.49% and 2.03% of preschool children from aboriginal townships and off-shore islands, respectively, did not make any visit, which were higher than the figure (1.38%) for the remaining children. Moreover, only 15.19% of children from aboriginal townships completed seven visits. Meanwhile, 91.72% had at least one visit. These values were considerably lower than the corresponding figures for children from off-shore islands and other areas. The preceding analysis suggested that some subgroups of children from rural Taiwan may still receive noticeably inadequate PHC services. The considerably low PHC utilisation observed in aboriginal townships may suggest factors other than accessibility that limit PHC utilisation in aboriginal townships. This issue warrants further investigations

**Table 4**
Preventive healthcare visit in aboriginal townships and off-shore islands as compared to the other areas.

| Preventive healthcare visit | Geographic areas | | | | | |
|---|---|---|---|---|---|---|
| | Aboriginal townships | | Off-shore islands | | Others | |
| | N = 5795 | | N = 8378 | | N = 170,371 | |
| | *n* | % | *n* | % | *n* | % |
| Complete 7 visits | 880 | 15.19 | 2053 | 24.50 | 40,900 | 24.01 |
| At least one visit | 5315 | 91.72 | 8152 | 97.30 | 167,584 | 98.36 |
| No visit | 318 | 5.49 | 170 | 2.03 | 2350 | 1.38 |

because aboriginal townships and off-shore islands are considered areas with the most limited healthcare accessibility in Taiwan.

In addition, we noted that the frequencies of PHC for the 1st (1 month after birth) and 7th (3–5 years old) scheduled visits were relatively low in all the study groups. This observation could have originated from different scenarios. Low utilisation in LBW babies may be partly explained by the low overall utilisation of the 1st scheduled visit. Some LBW babies were struggling with physical prematurity and frequently receiving medical care during the 1st month after birth. Parents of LBW infants could have paid more attention to medical care than regular PHC for their babies. In addition, Taiwan's NHI subsidises the mental and physical assessments of VBLW babies in accordance with their corrected ages. However, we might have underestimated PHC utilisation for VLBW babies because the corrected age of VBLW babies was unavailable in the National Health Insurance Research Database (NHIRD).

Moreover, mothers and babies staying in postpartum care centres for 1 month-long postpartum recuperation is prevalent in Taiwan; some centres do not have contract paediatricians for PHC services. Therefore, we speculate that some babies may miss PHC for the 1st month after birth. The low utilisation of PHC for the seventh scheduled visit might have another reason. For the study birth cohort born in 2009, all PHC visits were matched to the schedules of various vaccinations, except for the 7th scheduled visit. Parents may be less motivated to utilise PHC if it is not aligned with a scheduled vaccination.[29] However, vaccinations for young children have been rescheduled in Taiwan since 2012. At present, children aged 3 years or older are scheduled to receive several vaccines before they attend elementary school at 7 years old. Thus, the utilisation rate of the 7th visit is expected to improve considerably. Policy input changes dynamically; hence, continuously monitoring PHC utilisation and regularly examining the entire system should be strongly considered by health policy makers.

Although only a slight rural–urban disparity in PHC utilisation is observed in Taiwan, considerable improvement can still be achieved, particularly in certain segments of children's population, such as LBW babies, babies with foreign-born mothers and babies from aboriginal townships. Cultural convictions may be a barrier to parents bringing their children to receive PHC.[30] A parent coach model has been reported to improve the receipt of well-child care in the US.[31] Integrating culture into service provisions may be an effective means to strengthen parents' belief in receiving PHC.[30] For example, trained aboriginal nurses or those familiar with diverse ethnic cultures may help parents perceive threats from babies' disorders and the benefits of early detection. Elevating clinical professional's self-efficacy also eliminates the barrier of PHC.[30] Delivering a multifaceted intervention for practical skills to clinical practitioners increased the frequency and quality of Healthy Kids Check in Australia.[32] We suggest that public health authorities should develop tailored information for target parents and provide useful materials about practical skills to clinical practitioners in paediatrics and obstetrics, enhancing the belief in and self-efficacy to utilise PHC of parents and clinicians.

A previous US study[1] reported that children with special needs had higher compliance rate (86.6%) to well-child visits recommended by the American Academy of Paediatrics compared with children without special needs (56.4%). Another research on preterm baby's preventive care utilisation showed an increased OR of good compliance if children's birth weight were 1500–2500 g (1.51), 1000–1500 g (1.42) or under 1000 g (1.67).[33] In contrast with the aforementioned findings, our study presented the opposite result, in which children with lower birth weight received less PHC services in Taiwan. One of the potential reasons may be related to the greater need of children with low birth weight to frequently seek curative treatments because of their generally poor health conditions. Physicians and parents may have overlooked PHC and paid more attention to treating various health disorders suffered by LBW children. In addition, a lack of norms and valid indicators for making evaluation of LBW children's development may impede physicians and parents from the optimal utilisation of PHC services.[6] Given the higher prevalence of potential developmental problems among LBW children throughout their childhood years, the utilisation of scheduled PHC services should be emphasised in LBW infants, particularly amongst those with VLBW.[34]

Mother's birthplace was another factor that was significantly associated with PHC utilisation. Children of foreign-born mothers received less PHC utilisation. The number of children of foreign-born mothers has been increasing in Taiwan. In 2017, 10% of children in elementary schools had foreign-born mothers.[35] Most foreign-born mothers were from Asian countries, particularly from China (64%) and Vietnam (19%).[36] The majority of foreign-born mothers married Taiwanese men with low socio-economic status and were reported to less likely receive proper prenatal care and health care.[37] As such, children of foreign-born mothers were likely to come from socio-economically disadvantaged families and their parents could have inadequate health literacy with regard to the importance of attending scheduled PHC services.

Apart from their roles as predictors of PHC utilisation, birth weight and maternal birthplace were found to modify the magnitude of urban–rural disparity in PHC services. For NBW children, minimal variation in PHC utilisation was observed across urbanisation levels. However, for LBW and VLBW children from urban areas, a significant increase of 17% and 22%, respectively, was noted in the OR of higher PHC utilisation. In addition, for children of foreign-born mothers in urban areas, a 9% and 19% significantly higher OR of higher PHC utilisation was observed amongst children from satellite and urban areas, respectively; but such urban–rural difference was less evident in children with Taiwan-born mothers. Certain non-financial factors may be responsible for effect modification by low birth weight and maternal birthplace. LBW children or those born to foreign mothers are believed to be associated with low socio-economic families. Rural areas are typically associated with inadequate public transportation supply, affecting more people with low socio-economic status.[38] In addition, rural healthcare workers usually face barriers to information access and distribution due to lack of funds, inadequate hardware and infrastructure problems.[39] Such limitation in disseminating health information to local people also likely affects low socio-economic families. People with high socio-economic status will find it easier to have a wide range of means of locating and accessing health information resources even if they are living in rural areas. Tailored strategies in improving the PHC visit of low socio-economic families by enhancing home visiting programmes may help reduce urban–rural disparity in PHC utilisation amongst children from low socio-economic families.[40]

Our study exhibits several strengths. First, this study was the first to use a prospective design to investigate young children's utilisation of PHC. The information was based on the latest national cohort, which may provide up-to-date information of PHC utilisation by young children in Taiwan. Second, most previous studies have attributed the urban–rural difference in health care to economic barriers. The current study was based on Taiwan's NHI,

largely eliminating affordability reasons. We found a slight association of urbanisation level with children's PHC utilisation in a setting with universal health coverage. This finding suggests the importance of health insurance policy on the utilisation of PHC services. Thirdly, we identified certain specific subgroups that are more vulnerable to urban–rural disparity in PHC utilisation. The results of the stratified analyses highlighted the need for additional attention on these subgroups whilst designing PHC programmes.

Despite the aforementioned strengths, several limitations should be noted in this study due to the use of secondary administrative datasets. First, we considered the city district/township of mothers at the time of delivery to determine the urbanisation level of residence of children aged 0–7 years. This method can be subject to misclassification if the children are not living with their mothers or if they have moved to other areas after birth. However, we do not have sufficient information to clarify this issue. Second, other factors identified as associated with PHC utilisation, such as household income, language used by parents and the health literacy of caregivers, were not considered and analysed in this study.[41,42] Incomplete consideration of these factors might have entailed confounding, at least to a certain extent, in our study.

### *Conclusion*

Urbanisation level posed only a slight influence on the PHC utilisation of children under Taiwan's universal health coverage setting. However, the urban–rural disparity in PHC utilisation was more apparent in certain segments of children's population, including LBW children and children with foreign-born mothers. Policy makers should provide additional attention to improving PHC utilisation amongst LBW children and children of younger mothers, younger/older fathers and foreign-born mothers.

## Author statements

### *Ethical approval*

This research has been approved by National Cheng Kung University Governance Framework of Human Research Ethics [project number: 107–116].

### *Funding*

This work was supported by Health Promotion Administration from Ministry of Health and Welfare in Taiwan [project number C1070310, 2018].

### *Competing interests*

None declared.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.puhe.2020.02.011.

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