Poverty Increases Type 2 Diabetes Incidence and Inequality of Care Despite Universal Health Coverage

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OBJECTIVE—The discrepancy of diabetes incidence and care between socioeconomic statuses has seldom been studied concurrently in nations with universal health coverage. We aimed to delineate whether income disparity is associated with diabetes incidence and inequality of care under a national health insurance (NHI) program in Asia.

RESEARCH DESIGN AND METHODS—From the Taiwan NHI database in 2000, a representative cohort aged ≥20 years and free of diabetes (n = 600,662) were followed up until 2005. We regarded individuals exempt from paying the NHI premium as being poor. Adjusted hazard ratios (HRs) were used to discover any excess risk of diabetes in the poor population. The indicators used to evaluate quality of diabetes care included the proportion of diabetic patients identified through hospitalization, visits to diabetes clinics, and completion of recommended diabetes tests.

RESULTS—The incidence of type 2 diabetes in the poor population was 20.4 per 1,000 person-years (HR, 1.5; 95% CI, 1.3–1.7). Compared with their middle-income counterparts, the adjusted odds ratio (OR) for the poor population incidentally identified as having diabetes through hospitalization was 2.2 ($P < 0.001$). Poor persons with diabetes were less likely to visit any diabetes clinic (OR, 0.4; $P < 0.001$). The ORs for the poor population with diabetes to receive tests for glycated hemoglobin, low-density lipoprotein cholesterol, triglycerides, and retinopathy were 0.6 (0.4–0.9), 0.4 (0.2–0.7), 0.5 (0.4–0.8), and 0.4 (0.2–0.9), respectively.

CONCLUSIONS—Poverty is associated not only with higher diabetes incidence but also with inequality of diabetes care in a northeast Asian population, despite universal health coverage.

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In Western economies, low-income populations have been found to be more likely to develop diabetes (1,2). A hazardous home environment, unhealthy behaviors, obesity, and stress are all risks contributing to a higher incidence of diabetes among poor populations (1,3,4). The discrepancy of diabetes incidence between different socioeconomic status (SES) groups has seldom been studied in developing or recently developed economies, however, especially in Asia.

In addition to their disproportionate diabetes occurrence, individuals with low SES tend to have poorer glycemic control, more diabetes complications, and higher mortality (5–7). Apart from personal vulnerability and other predisposing factors (8), lack of access to health care has been considered an important risk factor for the consequences of diabetes among the socioeconomically deprived (9). Some studies have been conducted to assess whether improved health-care access through universal or voluntary health insurance coverage can ensure quality of diabetes care across socioeconomic gradients; however, results have been inconclusive. Brown et al. (10) reported that low-income patients in managed-care health plans were less likely to receive dilated eye examinations because of the unaffordable copayment. Booth and Hux (11) found that limited access in rural areas and high out-of-pocket cost for medications and monitoring supplies might contribute to otherwise avoidable hospitalizations for low-SES patients with diabetes in the Canadian health system. Israeli studies (12,13) have reported, however, that even though low-SES people with diabetes in their government-funded health maintenance organizations may have higher rates of glycated hemoglobin (HbA_{1c}) and LDL cholesterol testing, their outcomes remain persistently worse. Although universal health care has often been advocated as a silver bullet to eliminate health disparity (14–16), few large-scale studies have demonstrated empirical effectiveness of universal health coverage in resolving health inequalities for poor people with chronic diseases such as diabetes.

In 1995, Taiwan launched a single-payer comprehensive national health insurance (NHI) program with full coverage of ambulatory care, hospitalization, laboratory tests, and prescribed medications (17). To ensure accessibility for the entire population, the government waives premiums and copayments for entitled low-income individuals, those living below the local lowest living index. This health policy for the poor population provides an opportunity to investigate the true influence of poverty on the development of

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diabetes and the equality of diabetes care. The empirical evidence from Taiwan's health system is also important for the recent global movement toward a goal of universal health coverage (15,18,19). We aimed to examine whether the risk of diabetes development in the poor is higher than that of general population in a northeast Asian country with recent economic advancement and the introduction of universal health insurance. In the same setting, we examined the impact of income status on diabetes care where there ought to be no barriers to its access.

RESEARCH DESIGN AND METHODS

Data sources and study subjects

The NHI program has been the basis of the health-care system in Taiwan since 1995. As of 2007, 98.4% of Taiwan's population of 23 million was enrolled in the NHI program. The NHI Research Database (NHIRD) is derived from this program for research purposes. From the registration and reimbursement files in the NHIRD, the Longitudinal Health Insurance Database 2000 (LHID2000) was constructed by randomly sampling from the year 2000 Registry for Beneficiaries of the NHIRD (20). There were no significant differences in the sex or age distributions or in the average insurable income between the samples in the LHID2000 and the subjects in the original NHIRD of 2000. We have studied the LHID2000 with antecedent data from 1 January 1997. To calculate incidence of type 2 diabetes, we formed an eligible cohort of 600,662 participants who were aged 20 years or older, diabetes free for at least 3 years before 2000, and registered as NHI beneficiaries on 1 January 2000. We then divided this eligible cohort into four groups according to economic status. Because the poor group was significantly outnumbered by the other groups, we used the simple random sampling (without replacement) method to select 7,596 subjects (three times the number in the poor group) from each of the three wealthier groups as the study subjects to minimize the possibility of overestimating a true difference between groups because of a large differences in the sample sizes. There were no statistical differences in the distribution of sex, age, income, and baseline comorbidity between each selected group and its original study population. Diabetic subjects identified in the four groups were further investigated with regard for quality of diabetes care.

Definition of economic status

The study subjects' economic statuses were estimated according to their insurable monthly incomes recorded in the NHI registry archives in 2000, by which the Bureau of NHI calculated the beneficiaries' premiums. Four economic categories were thereby determined: poor (n = 2,532), low income (monthly income less than Taiwan's minimum wage level in 2000 of 15,840 new Taiwan dollars [NTD], n = 89,868), middle income (monthly income 15,840–57,779 NTD, n = 478,086), and high income (monthly income at or above the highest rank of insurable income in 2000 [57,800 NTD], n = 30,176). The exchange rate from US currency to the NTD is about 1:30.

Individuals categorized as poor were recognized by the local municipal authorities as living below the local lowest living index and were entitled to receive social welfare subsidies and special NHI benefits, namely exemption from NHI premiums and copayments.

Diabetic subjects

Cases of type 2 diabetes in the period 2000–2005 were ascertained by one of the following criteria: *1*) hospitalization for diabetes-related illness (ICD-9-CM: 250.xx) or prescribed antidiabetic drugs during the admission course, *2*) at least one prescription of oral antidiabetic agents and one ambulatory visit for diabetes-related illness (ICD-9-CM: 250.xx or A181 [an abridged diabetes code used by physicians in Taiwan before 2000 for ambulatory visits]) within 1 year, or *3*)at least four ambulatory visits for diabetes-related illness within 1 year. Excluded were individuals who had diabetes diagnoses (ICD-9-CM: 250.xx or A181) or who had been prescribed antidiabetic agents in 1997–1999. Those who had a diagnosis of type 1 diabetes (ICD-9-CM: 250.x1 or 250.x3) made during the follow-up or those who were younger than 30 years of age and did not have any oral antidiabetes drugs recorded but who received insulin therapy for the first entire year after diabetes diagnosis were regarded as having type 1 diabetes, so they were also excluded (n = 175) from further analysis.

Table 1—*Demographics and outpatient visits of study subjects in different income status*

	Poor (n = 2,532)	Low income (n = 7,596)	Middle income (n = 7,596)	High income (n = 7,596)	P value
Age (years)					<0.001
<40	907 (35.8)	4,292 (56.5)	4,189 (55.1)	3,195 (42.1)	
40–49	601 (23.7)	1,136 (15.0)	1,669 (22.0)	2,479 (32.6)	
50–59	229 (9.0)	550 (7.2)	803 (10.6)	919 (12.1)	
60–69	292 (11.5)	673 (8.9)	560 (7.4)	466 (6.1)	
≥70	503 (19.9)	945 (12.4)	375 (4.9)	537 (7.1)	
Sex					<0.001
Male	1,385 (54.7)	4,173 (54.9)	3,766 (49.6)	4,614 (60.7)	
Female	1,147 (45.3)	3,423 (45.1)	3,830 (50.4)	2,982 (39.3)	
NHI registration location					<0.001
City	540 (21.3)	2,242 (29.5)	2,303 (30.3)	3,665 (48.2)	
Township	613 (24.2)	2,337 (30.8)	2,179 (28.7)	1,899 (25.0)	
Rural area	1,378 (54.4)	3,015 (39.7)	3,081 (40.6)	2,011 (26.5)	
Missing	1 (0.0)	2 (0.0)	33 (0.4)	21 (0.3)	
CCI score					<0.001
0	1,826 (72.1)	6,401 (84.3)	6,510 (85.7)	6,324 (83.3)	
1–2	427 (16.9)	759 (10.0)	730 (9.6)	844 (11.1)	
>2	279 (11.0)	436 (5.7)	356 (4.7)	428 (5.6)	
Comorbidity					
Hyperlipidemia	41 (1.6)	117 (1.5)	123 (1.6)	190 (2.5)	<0.001
Gout	59 (2.3)	113 (1.5)	98 (1.3)	129 (1.7)	0.002
Hypertension	192 (7.6)	406 (5.3)	255 (3.4)	396 (5.2)	<0.001
Outpatient visits in 2000, mean (SD)	23.9 (24.7)	15.6 (16.1)	14.0 (13.0)	13.9 (12.6)	<0.001

Data are n (%) unless otherwise indicated.

Quality of diabetes care

To evaluate promptness of diabetes identification across different income strata, we calculated the proportion of new diabetic patients who were incidentally identified as having diabetes through hospitalization. Diabetic patients who don't get prompt diagnosis until hospitalization may be less likely to receive screening for early detection or may not be sufficiently aware of diabetes-related symptoms to seek appropriate health care. The indicators used to evaluate quality of diabetes care were the percentage of diabetic patients who visited diabetes clinics and the percentage of diabetic patients with diabetes clinic visits who received annual tests for fasting glucose, HbA_{1c}, LDL cholesterol, triglycerides, creatinine, urine dipstick, urine microalbumin, and retinopathy within 1 year of the diabetes diagnosis.

Statistical analysis

The incidence rate of type 2 diabetes in the follow-up period was estimated by the number of new type 2 diabetes cases per 1000 person-years. The person-years were calculated as the time elapsed from the date of cohort entry (1 January 2000) until the date of diabetes development, withdrawal from the NHI program, or the end of follow-up (31 December 2005), whichever came first. The calculation of a 95% CI for the incidence rate was based on the assumption that the incident cases followed a Poisson distribution. We used Cox proportional hazards models to estimate adjusted hazard ratios of diabetes development in different income groups relative to the middle-income group. The proportional hazard assumption was examined by plotting the Kaplan-Meier survival curves and by testing the interaction between income levels and follow-up time. Multivariable logistic regressions were used to evaluate the association between income disparity and quality of diabetes care. The middle-income group was treated as the reference group to represent the general population. The covariates included sex, age, comorbidity, NHI registration location (city, township, and rural area), and the year of diabetes diagnosis. Comorbidities were measured by the Charlson comorbidity index (CCI) (21), and three chronic conditions, including hyperlipidemia (ICD-9-CM: 272, A182, or A189), hypertension (ICD-9-CM: 401 or A269), and gout (ICD-9-CM: 274). We defined subjects as having comorbidity if at least three NHI diagnoses were identified in 1999. Analyses were performed with SAS software, version 9.1 (SAS Institute, Cary, NC).

This study was granted ethical approval by the Institutional Review Board of the National Health Research Institutes of Taiwan.

RESULTS—Table 1 reveals demographic differences between poor and other income groups. Poor people tended to be older, live in rural areas, and suffer from more chronic diseases. They also visited outpatient clinics more frequently. As shown in Table 2, the income disparity was significantly associated with the discrepancy in type 2 diabetes incidence in both males and females. Poor people were more likely to develop type 2 diabetes during the 6-year follow-up period. Compared with the middle-income group, in the poor group the diabetes risk was 40% higher for males and 60% higher for females. To eliminate confounding effects of higher prevalence of comorbidities in the poor group, we selected healthy subjects (CCI score of 0 and no hypertension, gout, or hyperlipidemia in 1999) for subgroup analysis (model 3 in Table 2). This analysis found that among women, the poor population remained the most vulnerable group for diabetes development (HR, 2.1; 95% CI, 1.5–2.8).

Fig. 1*A* reveals that the possibility of initial diabetes identification during hospitalization was inversely related to income level. About 50% of poor people (data not shown) did not receive professional diabetes care until they developed symptoms or complications that were severe enough to require hospitalization. Compared with the middle-income group, the adjusted risks of

Table 2—*Relative incident risk of type 2 diabetes in four groups according to income level*

Income level	*n*	T2D cases	Person-years	T2D incidence per 1,000 person-years	Model 1 HR	Model 2 HR	Model 3 HR
Overall							
High income	7,596	397	43,084	9.2 (8.3–10.2)	0.9 (0.8–1.0)	0.9 (0.8–1.0)	0.9 (0.7–1.1)
Middle income	7,596	388	42,038	9.2 (8.3–10.2)	1.0	1.0	1.0
Low income	7,596	412	42,226	9.8 (8.8–10.7)	0.9 (0.8–1.1)	0.9 (0.8–1.1)	1.0 (0.8–1.2)
Poor	2,532	265	12,986	20.4 (18.1–23.0)	1.5 (1.3–1.8)**	1.5 (1.3–1.7)**	1.5 (1.2–1.9)**
Male							
High income	4,614	257	26,171	9.8 (8.7–11.1)	0.9 (0.8–1.1)	0.9 (0.8–1.1)	0.9 (0.7–1.2)
Middle income	3,766	203	20,593	9.9 (8.6–11.3)	1.0	1.0	1.0
Low income	4,173	248	22,885	10.8 (9.6–12.3)	0.9 (0.8–1.1)	1.0 (0.8–1.2)	1.0 (0.8–1.2)
Poor	1,385	152	6,894	22.1 (18.8–25.8)	1.5 (1.2–1.8)**	1.4 (1.1–1.8)*	1.3 (0.9–1.7)
Female							
High income	2,982	140	16,914	8.3 (7.0–9.7)	0.8 (0.6–0.9)*	0.8 (0.6–1.0)	0.8 (0.6–1.0)
Middle income	3,830	185	21,444	8.6 (7.4–9.9)	1.0	1.0	1.0
Low income	3,423	164	19,341	8.5 (7.3–9.9)	1.0 (0.8–1.2)	0.9 (0.8–1.2)	1.1 (0.8–1.4)
Poor	1,147	113	6,092	18.6 (15.4–22.2)	1.7 (1.3–2.1)**	1.6 (1.3–2.1)**	2.1 (1.5–2.8)**

Values in parentheses are 95% CIs. Middle income is reference population. Note that n = 2,532 in the poor group and n = 7,596 in each of the three better-off groups. Model 1 is adjusted for age and sex; model 2 is adjusted for the factors in model 1 and also for CCI score, comorbidity (hyperlipidemia, gout, and hypertension), and NHI registration location; and model 3 for healthy subjects (CCI score = 0, no hypertension, no gout, and no hyperlipidemia) is adjusted for age, sex, and NHI registration location. T2D, type 2 diabetes. *$P < 0.05$. **$P < 0.001$.

hospitalization-diagnosed diabetes for the poor, low-income, and high-income groups were 2.2, 1.3, and 0.8, respectively ($P < 0.0001$ for trend).

With regard to diabetes care, Fig. 1*B* illustrates that the income gradient is significantly related to the likelihood of clinical follow-up ($P < 0.0001$ for trend). Poor people with diabetes were less likely to have medical follow-up for their newly diagnosed diabetes. Overall, about 45% of the poor people with diabetes had not visited any diabetes clinic within 1 year of their diagnosis (data not shown). Compared with the middle-income group, the adjusted odds ratios (ORs) for ambulatory diabetes clinic visits for the poor, low-income, and high-income groups were 0.4 ($P < 0.001$), 0.8 ($P < 0.001$), and 1.2 ($P < 0.05$), respectively. On the other hand, the likelihood of outpatient visits for acute illnesses did not seem to decrease for economically disadvantaged groups. The multivariable adjusted model (Fig. 1*C*) shows no income discrepancy for access to acute illness care ($P = 0.94$ for trend).

As shown in Table 3, individuals with diabetes in Taiwan generally received fewer of the recommended diabetes tests through regular diabetes clinic visits. Fasting glucose was ordered by physicians most frequently (89–93%). Compared with the middle-income group, poor people with diabetes were less likely to obtain most of the recommended annual tests in the first year after diagnosis, especially for HbA_{1c} (OR, 0.6; $P < 0.05$), LDL cholesterol (OR, 0.4; $P < 0.001$), and triglycerides (OR, 0.5; $P < 0.05$), nor were they as likely to receive an ophthalmological examination for retinopathy (OR, 0.4; $P < 0.05$).

CONCLUSIONS—Poverty, as shown in this longitudinal study, is significantly associated with an increase in type 2 diabetes incidence, delayed diagnosis of diabetes, and inadequate diabetes care and management. Compared with those with a middle income, individuals who were poor had about a 50% higher risk of development of type 2 diabetes. The poor group outnumbered other income groups in their hospitalization-diagnosed diabetes, indicating probable delays in recognition and identification of a worsening prognosis. Moreover, poor people with diabetes were about 50% less likely to receive the recommended diabetes checkups. Overall, this population-based study demonstrates that economically disadvantaged people are more vulnerable to development of diabetes and more likely to experience inequality of care once diabetes has developed, despite universal health insurance coverage.

Similar to our findings, a growing body of studies has shown an association between low SES and increased diabetes incidence, especially in females. Limited resources in food choice (22), tendency toward obesity and physical inactivity

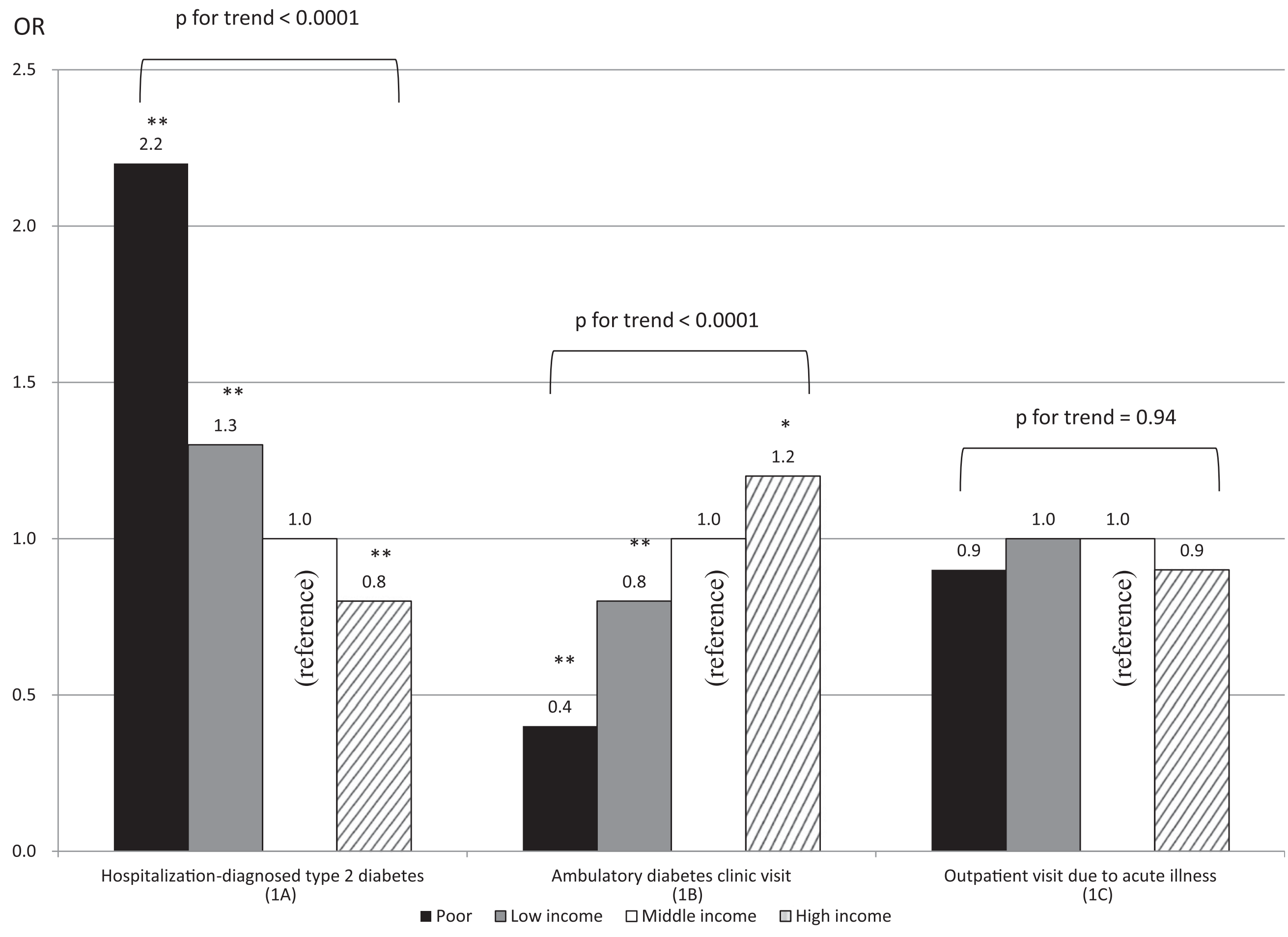

Figure 1—*Adjusted ORs of hospitalization-diagnosed type 2 diabetes* (1A), *ambulatory diabetes clinic visits within 1 year after diabetes diagnosis* (1B), *and outpatient visits for acute illnesses for diabetes patients in different income groups* (1C). *$P < 0.05$; **$P < 0.001$. *The logistic regression models have been adjusted for age, sex, CCI score, comorbidity (hyperlipidemia, gout, and hypertension), and NHI registration location.*

Table 3—*Percentage and adjusted ORs of type 2 diabetic patients receiving various diabetes checkups within 1 year after diagnoses, according to their income level*

	Poor (n = 147)			Low income (n = 283)			Middle income (n = 318)			High income (n = 324)		
Diabetes care indicator	%	OR	95% CI	%	OR	95% CI	%	OR	95% CI	%	OR	95% CI
Blood glucose monitor												
Fasting glucose	89.1	0.8	0.4–1.5	92.9	1.1	0.6–2.1	91.5	1	—	89.5	0.8	0.4–1.3
HbA_{1c}	40.1	0.6	0.4–0.9*	50.2	1.0	0.7–1.4	51.6	1	—	58.0	1.2	0.9–1.7
Lipid monitor												
LDL cholesterol	15.7	0.4	0.2–0.7**	25.4	0.8	0.6–1.2	31.1	1	—	32.1	1.0	0.7–1.4
Triglycerides	43.5	0.5	0.4–0.8*	54.8	0.8	0.6–1.1	62.0	1	—	62.4	1.0	0.7–1.5
Renal function monitor												
Serum creatinine	62.6	1.5	0.9–2.3	62.2	1.3	0.9–1.8	54.1	1	—	59.0	1.2	0.8–1.6
Urine dipstick	14.3	1.3	0.7–2.3	9.9	0.9	0.5–1.5	12.0	1	—	11.7	1.1	0.7–1.8
Urine microalbumin	4.1	0.6	0.2–1.4	7.8	1.2	0.6–2.2	7.2	1	—	6.8	1.0	0.5–1.9
Retinopathy checkup	7.5	0.4	0.2–0.9*	18.0	1.2	0.8–1.9	16.0	1	—	15.7	1.0	0.7–1.6

The logistic regression models were adjusted for age, sex, CCI score, comorbidity (hyperlipidemia, gout, and hypertension), NHI registration location, and the year of first diabetes diagnosis. For each population, n indicates those who had visited diabetes clinic within 1 year after diabetes diagnosis and % designates the number of diabetic patients receiving respective diabetes checkup divided by the number of diabetic patients who had visited diabetes clinic within the first year after diabetes diagnosis. Middle income is reference population. *$P < 0.05$. **$P < 0.001$.

(2,23), and detrimental psychosocial pressures, such as occupational stress and lack of social support (3,24), are often found to be unfavorable intermediate factors inherent in disadvantaged economic situations and serve as a link to the high incidence of diabetes. In Taiwan, the higher incidence of diabetes in the poor population could also derive from multiple risk factors, including physical vulnerability, disadvantaged environments, and risky behaviors, along with their mutual interaction (25–27).

One of our important findings is that equal access to medical care for acute illnesses in the poor group in a health system with universal insurance coverage was not mirrored by timely medical attention for diabetes diagnosis and care. Disparity of diabetes care among low-income patients is a global problem (28,29); however, the poor people in this study were entitled to waived premiums and no copayments for medical services, so their underuse of necessary diabetes care could not be solely attributed to the financial barriers identified in other studies (10,11). With regard to geographic inaccessibility to medical care facilities, this study showed no major access barrier for acute symptomatic illness in the poor population with diabetes. The high NHI participation rate of health providers (92.5% of all hospitals or clinics in Taiwan provide NHI services, including 100% of public institutions) (30) also helps to ensure accessibility for acute illness treatment. Good access to care for acute symptomatic illness, however, does not necessarily correspond with good access to care for chronic disease. Most primary care physicians in Taiwan only provide ambulatory acute care. Medical centers or regional hospitals equipped with high-tech facilities and multidisciplinary teams are thus usually the choice of patients to visit for management of chronic diseases. Unfortunately, most medical centers and regional hospitals are located in metropolitan areas, which could create a barrier of accessibility to diabetes care for those who live in rural areas. For the poor population, inaccessibility to a dedicated diabetes care is a structural obstacle to overcome, although the poor population does have good access to acute symptomatic illness management.

Furthermore, to prevent cardiovascular diseases, Taiwan's government provides a free health examination (the measurement of blood pressure, body weight, and some basic biochemical tests, such as fasting glucose, creatinine, urine dipstick test, and lipid profiles) every 3 years for those aged 40–64 years and every year for those aged ≥65 years. This government-sponsored health checkup is usually conducted by primary care physicians; according to the current study, however, it does not seem to be effective in targeting the vulnerable disadvantaged group. The failure of early detection of diabetes in the national screening program may indicate that the function of primary care physicians should be further strengthened to reduce the possibility of delayed diagnosis, especially among the poor population. Encouraging partnerships between hospitals and primary care physicians is a practical way to minimize accessibility barriers related to geographic variation. This has been shown to be effective by mobilizing hospital-based dietitians to achieve better glycemic and diet control for diabetic patients in a Taiwanese primary care setting (31).

The discrepancy in the quality of diabetes care could result from physicians' intentionally or subconsciously biased clinical management decisions owing to patients' different SES (32). Low SES could also impair mutual understanding, damage effective communication, and weaken interactive partnership between doctors and patients (33). All these influences could therefore contribute inferior quality to the diabetes process measures for the poor group.

On the other hand, patients themselves may also need to be held accountable for the delayed diagnosis of diabetes, which would usually incur clinical symptoms; however, these symptoms may be unrecognized by patients (34,35). Lack of awareness of the relevance of diabetic symptoms to the disease is common in undiagnosed diabetic patients (36) and results in delayed diagnosis and poor prognosis. Our data revealed that the disparity of diabetes care was persistent after controlling for geographic locality, indicating the association between income level and quality of diabetes care is independent of the urban or rural setting. To optimize quality of diabetes care, apart from ameliorating access to health care, diabetes-related health literacy also needs to be improved for the general populace, particularly for the economically disadvantaged. It cannot be overemphasized that individualized patient education is important to reduce disparities in self-management and health care–seeking behavior among diabetic patients according to SES. As indicated in this study, the quality of diabetes care in Taiwan falls far short of standard recommendations. Although the completeness of fasting glucose testing is high (about 90%), the annual testing rates for HbA_{1c}, LDL cholesterol, triglycerides, creatinine, urine dipstick, urine microalbumin, and retinopathy are generally low, although some improvement has been observed over time (data not shown). Suboptimal diabetes care in Taiwan was also reported by Tseng et al. (37). Because all aforementioned tests are covered by the Taiwanese NHI program and should be ordered by physicians, the lack of regular monitoring is apparently related to a paucity of professional accountability. Health providers' responsiveness to diabetes care must be promoted before we can develop effective strategies to reduce SES disparity in diabetes care.

This study has several limitations. First, because there is no laboratory information recorded in the NHI data sets, the diabetes diagnosis was not based on clinical criteria, and we did not include some important clinical confounders (e.g., BMI) in the models to assess diabetes incidence. Instead, we used a conservative method to define diabetes, but one by which the accuracy of case finding can reach 96.1% (38). Second, individual insurable income, the only socioeconomic indicator available for analysis, as used to define the SES gradient, may underestimate a subject's real income; it might also have been more appropriate to use family disposable income, occupation status, or education level to measure socioeconomic status had they been available to us. We were able to define clearly the disadvantaged, however, by identifying those in the "low-income households" entitled to be exempted from NHI premiums and copayments. We consider that the poor people in this study correctly represent those living below the local lowest living index in Taiwan. Again, lack of laboratory data in the NHI data sets prevents us from direct measurement of clinical outcomes; however, the recorded metabolic tests and referrals for retinal examination used for quality evaluation in this study constituted process measures for agreed best practice in diabetes care. The completion of these process indicators is indicative of the conduct of the required level of professional accountability.

In conclusion, we have shown that poverty is related to an increase in diabetes development in an Asian population, especially among women. Furthermore, income disparity appears to predispose people with diabetes toward receiving unequal diabetes care, which includes delayed case identification and inadequate follow-up, even in a nation with a comprehensive universal health insurance program. This study indicates that the improvement of access through comprehensive and universal health coverage is merely a start toward eliminating inequality in diabetes care, not a silver bullet. Of the multiple strategies designed to mitigate the discrepancies in diabetes care caused by the SES gradient, promoting health literacy in diabetes, minimizing geographic variation of access to diabetes care, optimizing the primary care physician's function, and reinforcing health providers' accountability are likely to be the missing steps required to ensure high-quality diabetes care in Taiwan and probably elsewhere.

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C.-C.H. designed the study and conceived the idea. C.-C.H., C.-T.H., and J.-S.C. analyzed and interpreted the data. C.-C.H. and M.L.W. drafted the article. L.C., H.-L.H., S.-J.S., C.-H.L., H.-Y.C., S.-F.S., W.-C.T., and T.C. critically revised the article for important intellectual content. C.-C.H. and J.-S.C. had final approval of the article. H.-Y.C. and S.-F.S. provided statistical expertise. C.-T.H. provided administrative and logistical support. All authors reviewed the manuscript and had final responsibility for the decision to submit for publication. C.-C.H. is the guarantor of this work and, as such, had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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