Prevalence, incidence, and mortality of PD

A door-to-door survey in Ilan County, Taiwan

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Article abstract— *Background:* The reported prevalence and incidence rates of PD were significantly lower in China than those in Western countries. People in China and Taiwan have a similar ethnic background. *Objective:* To investigate the prevalence, incidence, and mortality rate of PD in Taiwan. *Methods:* The authors conducted a population-based survey using a two-stage door-to-door approach for patients aged 40 years or older in Ilan, Taiwan. Patients were diagnosed with PD by having at least two of the four cardinal signs of parkinsonism and exclusion of seconddary parkinsonism. To identify new cases of PD after the survey, patients with negative results of parkinsonism in the first stage were matched to the information on clinical diagnosis of PD from the Bureau of National Health Insurance toward the end of December 31, 1997. All cases of PD were linked to the Taiwan mortality registration to ascertain causes of deaths until December 31, 1999. *Results:* The participation rate was 88.1% among the 11,411 contacted individuals. Thirty-seven cases of PD were identified. The age-adjusted prevalence rate of PD for all age groups was 130.1 per 100,000 population after being adjusted to the 1970 US census, assuming no cases of PD would be found among those younger than 40 years of age. Of 9972 non-PD subjects in the first screen, 15 new cases of PD were ascertained. The age-adjusted incidence rate was 10.4 per 100,000 population for all age groups. The case fatality rate of PD after a 7-year follow-up was 40.4% (21 deaths in 52 patients with PD). The relative risk of death for PD cases versus non-PD cases was 3.38 (95% CI: 2.05–4.34). The 5-year cumulative survival rate in PD cases (78.85%) was statistically lower than that in non-PD cases (92.84%). *Conclusion:* The prevalence and incidence rates of PD in Taiwan were much higher than those reported in China, but closer to those in Western countries. These results suggest that environmental factors may be more important than racial factors in the pathogenesis of PD.

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Epidemiologic surveys of PD suggest that the disease occurs worldwide.[1] The prevalence of PD varies widely in different countries.[1] Results of two large-scale door-to-door surveys conducted in mainland China reported unusually low PD prevalence rates (18 and 57 cases per 100,000 population adjusted to the 1970 US census), as compared with whites in the West.[2,3] It has been reported, however, that the prevalence rates of PD in another Chinese location, Kinmen,[4] (127 per 100,000 population adjusted to the 1970 US census) were much higher than the rates in these two surveys and closer to those in Western countries. The ethnic background of China, Kinmen and Taiwan is similar, but the standard of living is higher in Kinmen and Taiwan than in mainland China. This difference in PD prevalence between Kinmen and mainland China may result from genetic factors, environmental factors, or both. Schoenberg et al.[5] reported that blacks and whites in the same US community (Copiah County, Mississippi) have nearly the same prevalence of PD, but this is approximately five times that of Africans in Igbo-Ora, Nigeria.[6] These results suggest that environmental factors are more important than racial factors in the pathogenesis of PD. Whether it is a similar situation among the Chinese is still unexplored.

Because prevalence rates of PD were only estimated in most studies, factors accounting for the variance are sophisticated. Survival of PD may be an important factor for the variation of prevalence rates. Geographical variations in the mortality of PD may support this possibility.[7-11] Accordingly, clarification of this problem may require estimating incidence rates influenced by causal factors over prognostic factors. Nonetheless, to the best of our knowledge, few door-to-door surveys, such as one

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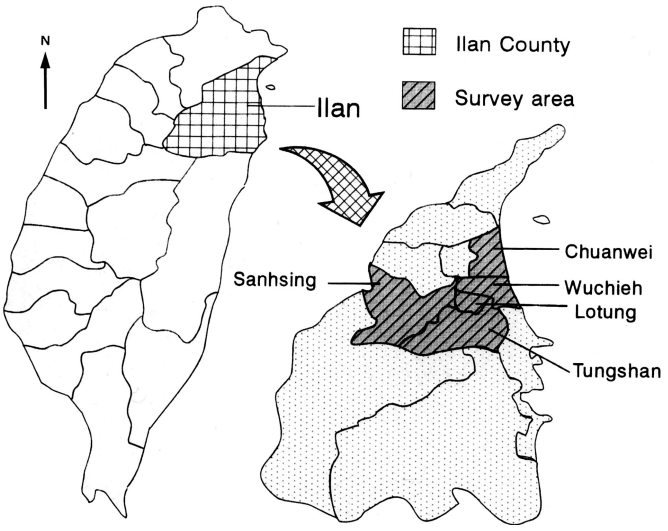

Figure 1. A map of the survey area in Ilan, Taiwan.

study in China, have reported an incidence of PD. Moreover, the survival rate from PD based on PD cases identified through a community-based survey has not been fully addressed.

The implications for estimating prevalence, incidence, and mortality rate of PD in the same study are many. The magnitude of prevalence shows the demand for medical delivery of PD. Regarding the natural history of the disease, estimation of incidence not only provides causal aspects of PD, but also enables one to estimate the average duration of survival using the ratio of prevalence to incidence (P/I). The P/I ratio provides a useful index with respect to the quality of treatment of PD.[12] The higher the P/I ratio is, the better the treatment of PD. Comparing of P/I ratios by country and period allows one to comprehend the level of treatment of PD. The assessment of mortality through door-to-door surveys enables one to examine whether the mortality rate of PD is higher than in the general population.

We conducted a door-to-door survey of PD in Taiwan to estimate PD prevalence and incidence. The average duration of PD is elucidated from the P/I ratio. Cumulative survival from PD is also investigated in this study. In addition to the above-mentioned epidemiologic profiles, we hope that the results of this survey may provide a potential clue to explain the pathogenesis in studying the development of PD.

Materials and methods. *Population description.* Ilan County, located in northeastern Taiwan, is an isolated area surrounded by high mountains and the Pacific Ocean (figure 1). Immigration and emigration in Ilan have been rather stable for more than 2 decades. The total population size was approximately 450,000.[13] To facilitate the retrieval of medical records to test the sensitivity of the stage 1 screening and confirm the final diagnosis, five townships (Lotung Chen, Chuanwei Hsiang, Tungshan Hsiang, Wechieh Hsiang, and Sanhsing Hsiang) adjacent to the only two regional hospitals in southern Ilan (Poh-Ai Hospital and St. Mary's Hospital) were selected as the target population (composed of 13,466 residents of at least 40 years of age). Taking emigration into account, a total of 11,411 residents of at least 40 years of age in 20 rural or suburban districts (Tsuen and Lii) in the five townships were randomly selected by the cluster sampling method according to household registry data on January 1, 1993. Table 1 also shows attendance rates greater than 90% for the aged subjects but slightly lower in the 40- to 49-year-old age group (82%).

Eligibility criteria. The survey covered the residents included in the list of local household registrar's office for the 20 studied districts. For household members, there were two criteria for eligibility: age of at least 40 years on the day of the screening and living in a residence at least 1 day per week or 2 months per year. Persons living in local

Table 1 *Age and sex distribution of the total population, targeted population, and participation rates in Ilan on January 1, 1993*

Age group, y	Men	Women	Both sexes
No. of total population			
0–39	32,184	29,929	62,113
40–49	2096	1876	3972
50–59	2108	1957	4065
60–69	1738	1501	3239
70–79	812	821	1633
80+	218	339	557
Total	39,156	36,423	75,579
Total (40+)	6972	6494	13,466
No. of target population			
0–39	—	—	—
40–49	1661	1579	3240
50–59	1834	1797	3631
60–69	1503	1317	2820
70–79	655	654	1309
80+	160	251	411
Total (40+)	5813	5598	11,411
No. of participants			
0–39	—	—	—
40–49	1277	1372	2649
50–59	1584	1680	3264
60–69	1334	1227	2561
70–79	620	600	1220
80+	149	215	364
Total (40+)	4964	5094	10,058
Participation rate, %			
0–39	—	—	—
40–49	77	87	82
50–59	86	93	90
60–69	89	93	91
70–79	95	92	93
80+	93	86	89
Total (40+)	85	91	88

chronic-care institution were eligible, too, if they were at least 40 years old.

General study design. Stage 1 and screening instrument. The study was conducted as a part of a large-scale comprehensive survey of neurologic disorders, including dementia, epilepsy, migraine, essential tremor, stroke, and depression, in Taiwan from January 1, 1993 to May 31, 1995.[14-18] We used a two-stage community-based survey design. In the first stage, medically unsophisticated interviewers, well-trained to ask questions in a uniform manner, visited every household in the county door-to-door. They administered an extensive questionnaire that contained census and screening items to identify residents possibly afflicted with any of the disorders. The instrument we used to screen for parkinsonism was a part of a larger one designed to detect several common neurologic disorders. Details on the overall instrument were reported elsewhere.[14,15] Its overall validity was measured in a hospital sample of 30 patients affected by parkinsonism; the sensitivity was 100%. Specificity was investigated in 30 hospital visitors free of parkinsonism and other diseases and was 87.5%. Three elements of the screening instrument addressed parkinsonism: questions regarding tremor, rigidity, and bradykinesia; a test of gait, including normal, walking on toes and heels, and tandem gait, and a check for tremor in resting, postural and action; and a direct question regarding previous diagnoses of parkinsonism. Patients who responded positively for at least one of the three elements by history or examination were forwarded to stage 2.

Stage 2 and clinical diagnosis. Ilan residents screened positive in stage 1 underwent a brief neurologic examination at a regional hospital. Board-certified neurologists from the National Taiwan University Hospital, Poh-Ai Hospital and St. Mary's Hospital performed examinations using a standardized diagnostic protocol. A structured clinical workup comprising the motor examination of the Unified PD Rating Scale,[19] a neurologic examination, and standardized history taking, was used to establish the diagnosis of parkinsonism and the classification of parkinsonism. We defined parkinsonism by four cardinal signs: resting tremor, rigidity, bradykinesia, and impaired postural reflex. Parkinsonism was diagnosed when at least two cardinal signs were presented. The subtypes of parkinsonism[20,21] were parkinsonism in vascular disease (i.e., the course of parkinsonism was abrupt onset, nonprogressive, or stepwise with a clear history of a cerebrovascular event before the illness, preferably supported by neuroimaging); drug-induced parkinsonism (i.e., after the use of neuroleptics or other antidopaminergic drugs in the 6 months before the onset of symptoms and with no history of previous parkinsonism); parkinsonism in multiple system atrophy (i.e., parkinsonism occurring in combination with a poor motor response to chronic levodopa therapy, cerebellar or corticospinal signs, or autonomic dysfunction) or progressive supranuclear palsy (i.e., parkinsonism with a vertical supranuclear gaze palsy, axial rigidity, or pseudobulbar palsy); other parkinsonism (i.e., parkinsonism secondary to severe head trauma, brain tumor, dementia, or other neurologic diseases that possibly affect the basal ganglia); and idiopathic parkinsonism (i.e., PD). PD was diagnosed by ruling out the subtypes of parkinsonism already mentioned. The staging of PD was assigned according to the Hoehn and Yahr scale.[22]

All newly diagnosed patients with definite parkinsonism were reexamined by a second neurologist. These diagnoses were reviewed in centers by the senior neurologist. In addition, they were discussed and adjudicated by a panel composed of reliability across centers.

To minimize any loss of information, our neurologists offered to examine patients in their homes. For those who refused an on-site examination, our neurologists obtained information by telephone from their family members or local physicians. Furthermore, based on the examination and the available documentation, our neurologists sought pertinent medical records to confirm or exclude the suspected disorders. We merged the master files of this survey with the disease data bank files in the two above-mentioned regional hospitals to confirm the final diagnose.

Statistical methods. Point prevalence rate was defined as the ratio of the number of disease onsets occurring on or before the day that the residents were surveyed in the stage 1 screening. The prevalence rates were estimated as the number of cases per 100,000 people on the prevalence day, January 1, 1993, for those at least 40 years of age and for the total population. The latter was estimated under the assumption that there were no patients with PD younger than age 40. In addition, the age-standardized prevalence rates (composed from the 1970 US census) were also calculated to induce comparisons with other studies. To identify new cases of PD after survey, patients with negative results of parkinsonism in the first stage were matched to information on the clinical diagnosis of PD by the International Classification Code of 332.0 from the Bureau of National Health Insurance toward the end of December 1997. Extensive chart review was performed for these matched cases to identify new PD cases that fulfilled all the above-mentioned diagnostic criteria of PD. This yielded the estimation of incidence rate of PD after being divided by person-years. All cases of PD were linked to the Taiwan mortality registration to ascertain causes of deaths until December 31, 1999. Cumulative survival rates of patients with and without PD were performed by the Kaplan–Meyer method and tested by the log-rank method.

Results. *Basic information and clinical diagnosis of PD.* According to census data for January 1, 1993, there were 75,579 residents (institutionalized and noninstitutionalized) living in five townships in Ilan comprising 20 administrative districts. Table 1 presents age- and sex-distribution for the total target population, actual population, and participants in this study. The population included 13,466 registered residents aged at least 40 years. Of these, 2055 (15.3%) were ineligible because of empty dwelling. Among the 11,411 eligible residents, 10,058 were screened in stage 1 for a response rate of 88.1%. Of the 1353 nonparticipants, 234 persons refused the interview and 1119 persons were not at home during three successive home visits. Of the 10,058 who were screened, 2385 (23.7%) were suspected to have one or more neurologic disorders and were invited to enter stage 2. In stage 2, face-to-face examinations were administered to 1916 (80.3%) by senior neurologists, 33 (1.4%) were diagnosed by reviewing their medical records, and 432 (18.1%) were con-

Table 2 *The prevalence per 100,000 and incidence per 100,000 of PD in Ilan*

	Men		Women		Both sexes	
Age, y	No. of cases	Prevalence per 100,000	No. of cases	Prevalence per 100,000	No. of cases	Prevalence per 100,000
40–49	1	78.3	0	0.0	1	37.8
50–59	4	252.5	0	0.0	4	122.5
60–69	3	224.9	11	896.5	14	546.7
70–79	4	645.2	6	1000.0	10	819.7
80+	3	2013.4	5	2325.6	8	2197.8
Total (40+)	15	302.2	22	431.9	37	367.9
Age-adjusted (40+)		299.2		423.7		357.9
Age-adjusted (for all age)		108.7		154.0		130.1
Age, y	No. of cases	Incidence per 100,000	No. of cases	Incidence per 100,000	No. of cases	Incidence per 100,000
40–49	0	0.0	0	0.0	0	0.0
50–59	2	25.4	1	12.0	3	18.5
60–69	3	45.4	3	49.6	6	47.4
70–79	3	98.1	3	102.5	6	100.2
80+	0	0.0	0	0.0	0	0.0
Total (40+)	8	32.5	7	27.8	15	30.1
Age-adjusted (40+)		30.5		27.0		28.7
Age-adjusted (for all age)		11.1		9.8		10.4

firmed free of neurologic disorders by senior neurologists by telephone interview. Four (0.2%) cases could not be traced.

Of the 1916 subjects clinically evaluated by the neurologists, 44 were diagnosed with parkinsonism. Of 465 subjects who were screened positive but could not be further examined, two were ascertained by way of medical information. This yielded another two subjects with parkinsonism. These two cases met the diagnostic criteria for PD and were previously diagnosed as having PD by neurologists. Among 46 subjects with parkinsonism, 37 (80.4%) had PD. All 37 patients with PD had two or more cardinal signs of parkinsonism; 22 (59.5%) had three or more signs; and eight (21.6%) had all four signs. In all these PD cases, 32 (86.5%) had resting tremor; 27 (73.0%) had bradykinesia; 27 (73.0%) had rigidity; and 20 (54.1%) had impaired postural reflexes. The mean duration of disease for PD cases was 2.56 ± 2.69 years (range, 6 months to 12 years). According to Hoehn and Yahr classification, there were eight (21.6%) patients in stage I, 11 (29.7%) in stage II, 12 (32.4%) in stage III, four (10.8%) in stage IV, and two (5.4%) in stage V.

Of the 37 identified patients with PD, 18 (48.6%) (eight men and 10 women) were newly identified. There was no gender difference between the newly diagnosed and previously diagnosed patients with PD ($\chi^2_{(1)} = 0.038$, $p = 0.85$). Newly diagnosed patients with PD were older than previously diagnosed patients with PD, but this was lacking a significant difference between both groups (Wilcoxon test, $Z = 1.09$, $p = 0.27$). Ten of them were 70 years of age or older in the group of newly diagnosed patients with PD. As expected, the mean duration of PD for patients previously diagnosed with PD (3.75 ± 3.26 years) was longer than that of newly diagnosed patients with PD (1.31 ± 0.9 years, Wilcoxon test, $Z = 2.8$, $p = 0.005$). Newly diagnosed patients with PD had proportionately less tremor than the ones diagnosed earlier.

Other subtypes of parkinsonism consisted of five (10.9%) cases of parkinsonism in vascular disease, one (2.2%) case of drug-induced parkinsonism, and three (6.5%) cases of other parkinsonism. None with a family history of parkinsonism were found. All five patients with parkinsonism in vascular disease had a definite history of stroke before the clinical manifestation of parkinsonism. The causal agents were neuroleptics for the patients with drug-induced parkinsonism. In the three patients with other parkinsonism, two had histories of severe head injury without operations, whereas one had a brain tumor and underwent surgical intervention before the onset of parkinsonism.

Epidemiologic profile. The crude prevalence rate of PD was estimated as 367.9 per 100,000 population aged at least 40 years (95% CI: 242.5–460.5). On the premise that no case of PD would be found among subjects younger than age 40, the age-adjusted prevalence rate for all age groups was 130.1 per 100,000 population after being adjusted to the 1970 US census.

Table 2 shows the age- and sex-specific prevalence of PD. The prevalence rates increased with age for both genders. As compared with those aged 40 to 49 years, the prevalence rates were threefold for those aged 50 to 59 years, 12-fold for those aged 60 to 69 years, 21-fold for those aged 70 to 79 years, and 60-fold for those aged at least 80 years. The prevalence rate in women was slightly higher than that in men. However, the difference was not significant ($\chi^2_{(1)} = 1.15$, $p = 0.28$).

Table 3 *Cause of death in PD in Ilan*

Cause of death	No. of cases (%)
Heart disease	7 (33.3)
Heart failure	2
Malignancy hypertension with heart disease	3
Shock, cardiac origin	2
Lung disease	5 (23.8)
Pneumonia	3
Respiratory failure	1
Tuberculosis	1
Gastrointestinal disease	3 (14.3)
Liver sclerosis	2
Upper gastrointestinal bleeding	1
Nervous system	2 (9.5)
Stroke	1
Dementia-related events	1
Malignancy	2 (9.5)
Breast cancer	1
Cervical cancer	1
Feebleness	1 (4.8)
Accidental falling	1 (4.8)
Total	21

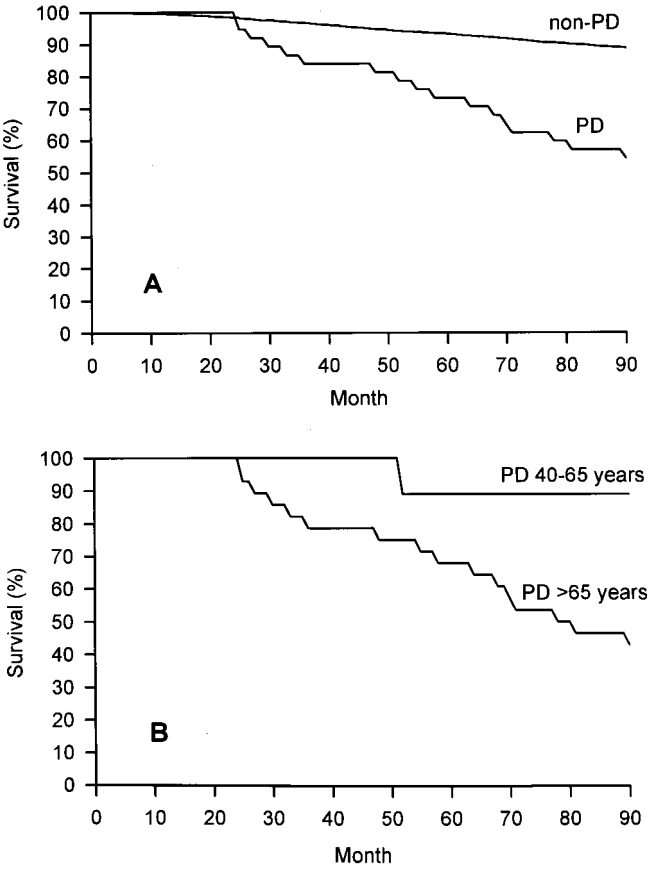

Figure 2. (A) Cumulative survival by disease status. (B) Cumulative survival by disease status and age.

Of 9972 non-PD subjects in the first screen, 15 new cases of PD (eight men and seven women) were ascertained after matched to information on clinical diagnosis of PD from the Bureau of National Health Insurance toward the end of December 1997. Total person-years was approximately 49,830 years. This yields the crude incidence rate (aged at least 40 years) of PD at 30.1 per 100,000. Assuming no patients with PD were among individuals younger than 40 years old, the age-adjusted incidence rate for all age groups was 10.4 per 100,000 population. Men had a slightly higher incidence rate of PD than women but without a significant gender difference ($\chi^2_{(1)} = 0.091$, $p = 0.36$). Annual incidence rates of PD by age showed an incremental increase, on the order of 18.5 per 100,000 for those aged 50 to 59 years, 47.4 per 100,000 for those aged 60 to 69 years, and 100.2 per 100,000 for those aged 70 to 79 years. No patients with PD were found in those younger than 50 years of age or older than 80 years of age (see table 2).

Survival of PD. The P/I ratio yields an overall average duration of approximately 12.5 years. The corresponding figures for age groups was 10.2 years for 50 to 59 years, 9.9 years for 60 to 69 years, and 8.2 years for 70 to 79. However, the average durations for those younger than 50 years of age and older than 80 years of age were not available because no patients with PD were recorded.

Of the 52 patients with PD, 21 deaths were noted after a 7-year follow-up. The case fatality rate of PD was 40.4%. Heart disease (33.3%) and lung disease (23.8%) were the leading causes for deaths of the patients with PD (table 3). Among 9957 subjects with negative results of PD, 1205 deaths were ascertained. The case fatality rate of patients without PD was 12.1%. The relative risk of death for PD against non-PD was 3.38 (95% CI: 2.05–4.34). The 5-year cumulative survival rate in (78.9%) patients with PD was significantly lower than in patients without PD (92.8%) ($\chi^2_{(1)} = 43.25$, $p < 0.0001$) (figure 2A). Patients with PD older than 65 years of age have a poor cumulative survival rate as compared with patients without PD ($\chi^2_{(1)} = 5.05$, $p = 0.025$) (see figure 2B). The 5-year cumulative survival rates of men (78.3%) were closer to that of women (79.3%) in patients with PD.

Discussion. The current study conducted a two-stage community-based screening for PD to estimate prevalence, incidence, and mortality rate of PD among a Taiwanese population. A total of 37 cases of PD were ascertained through this project, which yielded an age-adjusted prevalence rate of 130.1 per 100,000 for all ages and 357.9 per 100,000 for those older than 40 years of age. After the follow-up on 9972 healthy subjects, 15 new cases of PD were identified, yielding the age-adjusted incidence rate of 10.4 per 100,000 for all ages and 28.7 per 100,000 for those older than 40 years of age. The P/I ratio gives 12.5 years for an average duration of survival of PD according to this study. Case fatality rate among 52 patients with PD was estimated at 40.4%. The 5-year cumulative survival rate for PD was 78.9%. PD has a threefold risk for death compared with healthy subjects.

For whites in Europe and America, the age-

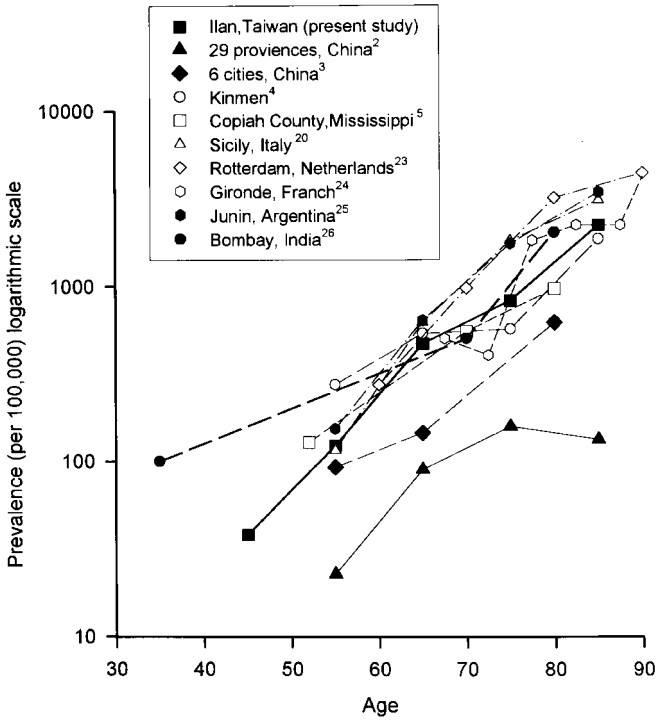

Figure 3. Comparison of age-specific prevalence rates of PD obtained through door-to-door studies. The prevalence rates in Taiwan are much higher than those reported in mainland China but closer to those in Kinmen and Western countries.

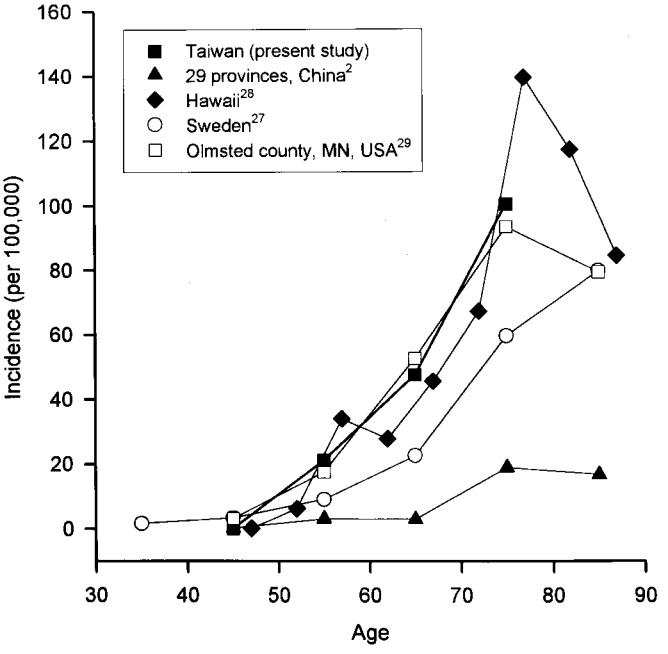

Figure 4. Comparison of age-specific incidence rates of PD reported in China, Sweden, Hawaii, Olmsted County, Minnesota, and Taiwan. The incidence rates in Taiwan are much higher than those reported in mainland China but closer to those in Western countries.

adjusted prevalence rates of PD ranged from 56 to 234 per 100,000 population.[1] East Asian communities in Japan and China had a significantly lower prevalence, ranging from 18 to 73 per 100,000 population.[1] Compared with an overall average, it seems reasonable to hypothesize that Asians are partially protected from PD. One objective of this study was to test this hypothesis. Including this study, there have been four door-to-door surveys of PD prevalence rates among the Chinese population (figure 3). The age-adjusted (to 1970 US census) prevalence rates of PD were 18 per 100,000 in 29 provinces in China[2]; 57 per 100,000 in six cities in China[3];127 per 100,000 in Kinmen[4]; and 130 per 100,000 in Ilan, Taiwan (current study). Our result, which showed approximately seven times the rates of the 29 provinces in China and twice the rates in six cities in China, was closer to those of Kinmen,[4] Copiah County, Mississippi,[5] and other Western countries that obtained prevalence rates of PD through door-to-door studies[20,23-26] (see figure 3).

The age–incidence pattern of PD provides information on PD risk comparative to data from different population groups in other geographic regions. We examined the overall Taiwan date in general broken down by decades of life in accordance with accepted incidence figures from Europe[27] and the United States.[28,29] There were five- to 10-fold higher at each age stratum than age-specific incidence figures from China (figure 4).

Our screening method is a two-stage door-to-door approach identical to those used in mainland China studies, but different from the single-stage method used in Kinmen. The prevalence rates of PD in our study resembled that of the Kinmen study. Accordingly, the difference in the above screening methods may not influence the results. For the sampling method, our study and the Kinmen study were based on two elected cohorts, whereas the two mainland China studies were conducted on the basis of multistage sampling scheme or two-step random sampling method. Regardless of the sampling method, in essence, each study represented one target population in the disease frequency, which indicates the different characteristics, such as environmental factors, in the underlying population. Our diagnostic criteria for PD based on at least two of the four cardinal signs of PD and other causes of parkinsonism must not be apparent, which were exactly the same as those in Kinmen,[4] Sicily,[20] and Rotterdam.[23] In the Chinese studies,[2,3] subjects were diagnosed with PD with at least two of the three PD cardinal signs (resting tremor, bradykinesia, and rigidity). Although methodologic differences might cause variation of prevalence rate of PD, even after adjusting for many of these inconsistencies, geographic prevalence differences persist. After reanalyzing the prevalence surveys with the same diagnostic criteria for PD in the six cities of China,[3] Junín, Argentina,[25] the Parsi community of Bombay, India,[26] Sicily,[20] and Rotterdam,[23] the unusually low prevalence rates of PD in China remained unchallenged.[30] This suggested that substantial differences in prevalence rate among surveys might be caused by reasons quite unrelated

to the diagnostic criteria.[30] These reasons could include genetic differences in susceptibility to disease, differences in exposure to causative factors, and differences in exposure to protective factors.

The reported risk factors for PD among the Chinese varied from region to region.[31-33] In mainland China, patients exposed to industrial chemicals were associated with the development of PD.[31] In Hong Kong, patients engaged in farming and using herbicides or pesticides were found to have a higher risk of PD.[32] In Taiwan, the PD risk was greater among those who previously used herbicides or pesticides and paraquat.[33] Cultivable land is rather limited in Taiwan because of its dense population. To use cultivable land efficiently, herbicides or pesticides and paraquat are extensively used in an agricultural county, such as Ilan. This might account for why Taiwan has a higher prevalence rate of PD than found in the other two Chinese studies. Results from prevalence, incidence, and risk factors of PD in Chinese populations show that living environment, agriculture, and industrial development are more important than ethnic factors in the pathogenesis of PD.

Our study showed that the incidence rates for the above-70 age group were six times higher than the above-60 age group. Increasing age is the only unequivocal risk factor for PD. This is true in all community-based studies, regardless of the absolute prevalence of disease in the population. The possible explanations for the close relationship between increasing age and PD prevalence may be caused by an age-related neuronal vulnerability or a causal mechanism dependent on the passage of time.

After age 65, cumulative survival rates deteriorate logarithmically in patients with PD versus patients without PD. Consistent with previous findings,[7-11] our results showed that PD involves a threefold risk for death as compared with healthy subjects. Specifically, most causes of death in PD are heart disease (33.3%) and lung infection (23.8%). These results were also comparable to earlier studies, which suggested that the real underlying causes for both may be severe extrapyramidal symptoms,[8] a gait disturbance,[11] and infection.[7-10] However, because only few deaths were observed in our studies further investigation into specific causes of death among PD is difficult.

Our results have significant implications for PD. First, simultaneous estimation of prevalence rates and incidence rates not only show the magnitude of disease burden, but also reflect medical demand for patients with PD. For example, the prevalence rate in women is higher than in men, whereas the incidence rate in men is slightly higher than in women. This cannot be fully attributed to a longer life expectancy for women because a higher prevalence remains even after adjustment for age. This may suggest that women are more likely to seek medical attention and thus be expected to survive longer than men after the diagnosis of PD. The almost identical incidence rates between men and women suggest that the cause of PD is the same for both sexes.

Table 4 *Prevalence, incidence, and ratio of PD in community-based studies*

Location	Prevalence per 100,000	Incidence per 100,000	Prevalence/ incidence
Rochester, MN[34]	187.0	20.0	9.4
Carlisle, England[35]	113.0	12.0	9.4
Iceland[36]	162.0	16.0	10.1
Turku, Finland[37]	120.1	15.0	8.0
Yonago, Japan[38]	80.6	10.0	8.6
Sardinia, Italy[39]	65.6	4.9	13.4
Benghazi, Libya[40]	31.4	4.5	7.0
Ferrara, Italy[41]	164.7	10.0	16.5
China[2]	18.0	1.9	9.5
Östergötland, Sweden[27]	115.0	11	10.5
Ilan, Taiwan (current study)	130.1	10.4	12.5

Secondly, the P/I ratio enables one to assess whether the efficacy of treatment for PD is favorable. The larger the ratio is, the better the treatment. The P/I ratio estimate of 12.5 years in our study may suggest a good efficacy of early detection of PD through such community-based screening projects. Table 4 shows that the summary of this ratio includes the current study and other earlier studies that estimate prevalence and incidence rates in the same study. Clearly, our results are comparable to those from Sardinia, Italy[39] but slightly lower than those from Ferrara, Italy.[41] Nonetheless, the average duration of PD in the current study is expected to be longer than the studies before 1980 (Rochester, NY[34]; Carlisle, England[35]; and Iceland[36]). Our results are also more favorable than those from Benghazi, Libya.[40] It should be noted that newly diagnosed PD cases may presumably represent undetected cases without treatment. However, these cases would not have been identified had no community survey of PD been conducted. Therefore, prevalence in our study encompassed routinely clinical detected cases and early-detected cases of PD. This leads to a higher P/I ratio compared with that of estimated from clinical data.

We assume that all people screened negative were healthy in the door-to-door survey and no random sample of screen negative has been conducted. Two reasons account for this. First, it is difficult to make a confirmatory diagnosis for those screened negative in a mass screening. Second, although a random sample from screened negative cases may overcome this drawback, it is still indispensable to invoke enormous negative samples to ascertain sufficient false-negative cases. It seems inefficient because the incidence rate for PD is approximately 10.4 per 100,000. To tackle this problem, an alternative method is to follow up this negative cohort to identify false-negative cases by linking this cohort with nationwide registry-based data, such as National Health Insurance data, with patients diagnosed with

PD. Nevertheless, this method still has an imperfection because cases identified from the National Health Insurance may possibly include new incident cases after its first screening. However, we reckon this possibility may be low because PD is a disease process with a long duration.

Ideally, we should have conducted a second door-to-door survey 5 years after the first to detect the incidence rate of PD. However, doing so may be costly. Instead, we used a medical registry to detect incident cases with onset since the original prevalence date. This approach may underestimate the incidence rate of PD in terms of early detection of PD through a community-based survey, but it may be an unbiased estimate for the incidence rate of PD according to clinically defined PD cases.

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