第三節　　醫師人力推估模式

A.　國際間醫師人力推估模式(投稿 BMJ of public health 審稿中)

Inequities in the Distribution of Physician Workforce around the World

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Background: The size of a country's physician workforce greatly influences the quality of healthcare. The aim of the present study was to create an international physician density (PD) model based on health-related factors.

Methods: Data on PD and 12 variables that could influence PD were extracted from the World Health Organization (WHO), United Nations (UN), Organization for Economic Cooperation (OECD), and World Bank data banks for 195 countries for the years 2004-2006. Multiple stepwise-linear regression was used to derive the model that best predicted PD. A split-sample, cross-validation procedure was performed to evaluate the generalizability of the results. Country-specific PD discrepancies were calculated by subtracting observed PDs from the model-predicted PDs.

Results: Of the 195 countries, 131 had data on PD for the years 2004-2006. Due to multi-collinearity among the variables, only 7 were entered into stepwise regression PD, proportion under age 15 years, proportion over age 60 years, life expectancy, gross domestic product, expenditure on health, and purchasing power parities. The final model was: PD = (5.014 – 0.128×proportion under age 15 years + 0.034×life expectancy)^2. The R^2 of 80.4% from the final 2-variable model was virtually identical to the R^2 of 80.3% from a full model consisting of all 7 variables. The largest PD deficits were in Japan (–15.7 per 10,000), Bosnia/Herzegovina (–15.2), Sri Lanka (–13.8), and Taiwan (–13.7).

Conclusion: There were observed inequities in the distribution of physician workforce around the world, and surprisingly some acute shortages in developed countries.

Country-Specific Predicted and Observed Physician Densities
Rank-Ordered by Discrepancy(上文之附件表格)

Rank	Country	Continent	Analysis Set	Predicted PD	Observed PD	Discrepancy (per 10,000)	Population	Physician Number
1	Japan	AS	Training	36.3	20.6	-15.7	126,804,433	-199,397
2	Bosnia/Herzegovina	EU	Validation	28.8	13.6	-15.2	4,621,598	-7,005
3	Sri Lanka	AS	Training	19.3	5.5	-13.8	21,513,990	-29,629
4	Taiwan	AS		28.7	15.0	-13.7	22,974,347	-31,508
5	Korea	AS	Training	28.6	16.3	-12.3	48,636,068	-59,672
6	Romania	EU	Training	30.8	19.3	-11.5	22,181,287	-25,600
7	Suriname	SA	Training	13.0	1.6	-11.4	486,618	-555
8	Slovenia	EU	Validation	34.3	23.7	-10.7	2,003,136	-2,134
9	Canada	NA	Training	31.1	21.4	-9.7	33,759,742	-32,794
10	Myanmar	AS	Validation	12.9	3.6	-9.3	48,137,741	-44,694
11	Bhutan	AS	Training	9.6	0.5	-9.1	699,847	-635
12	Mauritius	AF	Training	19.3	10.6	-8.7	1,294,104	-1,132
13	Poland	EU	Training	30.5	22.0	-8.5	38,463,689	-32,643
14	Morocco	AF	Training	13.0	5.1	-7.9	31,627,428	-24,973
15	Kiribati	AO	Validation	9.8	2.3	-7.5	115,401	-87
16	Croatia	EU	Training	32.0	24.8	-7.2	4,486,881	-3,237
17	Serbia	EU	Training	27.0	20.0	-7.0	7,344,847	-5,110
18	Montenegro	EU	Validation	26.0	20.0	-6.0	666,730	-399
19	Iran	ME	Training	14.6	8.8	-5.8	67,037,517	-39,190
20	United Kingdom	EU	Training	29.0	23.7	-5.3	61,284,806	-32,431
21	Albania	EU	Validation	16.9	11.8	-5.1	3,659,616	-1,859
22	Tunisia	AF	Validation	18.2	13.4	-4.8	10,589,025	-5,122
23	Seychelles	AF	Training	19.4	15.1	-4.3	88,340	-38
24	Bangladesh	AS	Validation	7.1	2.8	-4.3	158,065,841	-68,214
25	Cyprus	EU	Validation	28.1	24.0	-4.1	1,102,677	-453
26	Vanuatu	AO	Validation	5.5	1.4	-4.1	221,552	-91
27	Luxembourg	EU	Training	29.2	25.3	-3.9	497,538	-193
28	New Zealand	AO	Validation	25.4	22.0	-3.4	4,252,277	-1,436
29	Gabon	AF	Validation	6.2	2.9	-3.3	1,545,255	-509
30	Syria	ME	Training	8.2	5.0	-3.2	22,198,110	-7,090
31	Nepal	AS	Validation	5.1	2.1	-3.0	28,951,852	-8,570
32	Kuwait	ME	Validation	20.9	18.0	-2.9	2,789,132	-822
33	India	AS	Training	8.5	6.0	-2.5	1,180,512,215	-294,800
34	Djibouti	AF	Training	4.1	1.8	-2.3	740,528	-174
35	Ghana	AF	Validation	3.8	1.5	-2.3	24,339,838	-5,699
36	Mauritania	AF	Training	3.4	1.1	-2.3	3,205,060	-743
37	Eritrea	AF	Training	2.6	0.5	-2.1	5,792,984	-1,195
38	Senegal	AF	Training	2.5	0.6	-1.9	14,086,103	-2,691
39	Comoros	AF	Validation	3.4	1.5	-1.9	773,407	-143
40	Togo	AF	Validation	2.0	0.4	-1.6	6,199,841	-977
41	Macedonia	EU	Validation	25.6	24.1	-1.5	2,072,086	-320
42	Finland	EU	Validation	30.5	29.0	-1.5	5,255,068	-796
43	Namibia	AF	Training	4.4	3.0	-1.4	2,128,471	-297
44	Nauru	AO	Validation	9.1	7.7	-1.4	14,264	-2
45	Timor-Leste	AS	Training	2.1	1.0	-1.1	1,131,612	-129
46	Benin	AF	Validation	1.4	0.4	-1.0	9,056,010	-944
47	Sudan	AF	Validation	3.6	2.6	-1.0	41,980,182	-4,240
48	Australia	AO	Training	28.5	27.5	-1.0	21,515,754	-2,165
49	Rwanda	AF	Validation	1.4	0.5	-0.9	11,055,976	-954
50	Germany	EU	Validation	35.0	34.2	-0.8	82,282,988	-6,898

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Rank	Country	Continent	Analysis Set	Predicted PD	Observed PD	Discrepancy (per 10,000)	Population	Physician Number
51	Maldives	AS	Validation	10.0	9.2	-0.8	395,650	-31
52	Côte d'Ivoire	AF	Training	2.0	1.2	-0.8	21,058,798	-1,639
53	Libya	AF	Validation	13.2	12.5	-0.7	6,461,454	-480
54	Cape Verde	AF	Training	5.6	4.9	-0.7	431,822	-31
55	Mozambique	AF	Training	1.0	0.3	-0.7	22,061,451	-1,531
56	Laos	AS	Training	4.2	3.5	-0.7	6,993,767	-477
57	Hungary	EU	Training	31.2	30.5	-0.7	9,880,059	-645
58	Guinea	AF	Validation	1.7	1.1	-0.6	10,324,025	-665
59	Central African Rep.	AF	Training	1.3	0.8	-0.5	4,578,768	-231
60	United States	NA	Training	24.6	24.1	-0.5	310,232,863	-14,835
61	Turkey	ME	Validation	15.0	14.6	-0.5	77,804,122	-3,674
62	Sierra Leone	AF	Training	0.7	0.3	-0.4	5,245,695	-224
63	Burundi	AF	Training	0.7	0.3	-0.4	9,863,117	-406
64	Botswana	AF	Validation	4.4	4.0	-0.4	2,029,307	-74
65	Latvia	EU	Training	31.7	31.3	-0.3	2,217,969	-74
66	Cameroon	AF	Training	2.2	1.9	-0.3	19,294,149	-626
67	Zimbabwe	AF	Validation	1.9	1.6	-0.3	11,651,858	-307
68	Congo (Brazzaville)	AF	Validation	2.2	2.0	-0.2	4,125,916	-71
69	Chad	AF	Training	0.5	0.4	-0.1	10,543,464	-105
70	Malawi	AF	Training	0.3	0.2	-0.1	15,447,500	-150
71	Burkina Faso	AF	Training	0.5	0.5	0.0	16,241,811	-80
72	Ukraine	EU	Training	30.3	30.3	0.0	45,415,596	-47
73	Liberia	AF	Training	0.2	0.3	0.1	3,441,790	30
74	Niger	AF	Validation	0.1	0.2	0.1	15,306,252	170
75	Spain	EU	Validation	35.5	35.9	0.4	40,548,753	1,583
76	Angola	AF	Validation	0.3	0.8	0.5	13,068,161	704
77	Slovakia	EU	Validation	30.1	30.6	0.5	5,470,306	300
78	Mali	AF	Training	0.2	0.8	0.6	13,796,354	844
79	Uganda	AF	Validation	0.2	0.8	0.6	33,398,682	2,044
80	Congo (Kinshasa)	AF	Training	0.3	1.1	0.8	70,916,439	5,561
81	South Africa	AF	Training	6.8	7.7	0.9	49,109,107	4,373
82	Zambia	AF	Validation	0.3	1.2	0.9	12,056,923	1,110
83	Guinea-Bissau	AF	Training	0.2	1.2	1.0	1,565,126	151
84	Andorra	EU	Validation	35.6	36.6	1.0	84,525	8
85	Madagascar	AF	Training	1.8	2.9	1.1	21,281,844	2,270
86	Pakistan	ME	Validation	6.4	7.7	1.3	177,276,594	22,940
87	Sao Tome & Principe	AF	Validation	3.3	4.9	1.6	219,334	36
88	Yemen	ME	Validation	1.7	3.3	1.6	23,495,361	3,871
89	Equatorial Guinea	AF	Training	1.3	3.0	1.7	650,702	108
90	Czech Republic	EU	Training	33.8	35.5	1.7	10,201,707	1,726
91	Afghanistan	ME	Validation	0.2	2.0	1.8	29,121,286	5,274
92	Estonia	EU	Training	30.9	32.8	1.9	1,291,170	249
93	Portugal	EU	Validation	31.6	33.5	1.9	10,735,765	2,081
94	Cook Islands	AO	Training	9.8	11.8	2.0	23,000	5
95	Qatar	ME	Validation	24.2	26.4	2.2	840,926	186
96	Moldova	EU	Validation	23.9	26.5	2.6	4,320,748	1,137
97	Ireland	EU	Validation	25.0	28.2	3.1	4,250,163	1,331
98	Italy	EU	Training	35.7	39.0	3.3	58,090,681	19,097
99	Austria	EU	Validation	32.1	35.5	3.4	8,214,160	2,762
100	Bulgaria	EU	Training	32.3	35.8	3.4	7,148,785	2,436

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Rank	Country	Continent	Analysis Set	Predicted PD	Observed PD	Discrepancy (per 10,000)	Population	Physician Number
101	Denmark	EU	Training	27.4	30.8	3.4	5,515,575	1,897
102	Iraq	ME	Validation	2.9	6.6	3.7	29,671,605	11,054
103	Sweden	EU	Training	31.2	35.0	3.8	9,059,651	3,465
104	Oman	ME	Training	11.0	15.0	4.0	3,525,875	1,398
105	Mexico	NA	Validation	13.7	17.9	4.2	112,468,855	47,141
106	Saudi Arabia	ME	Validation	9.4	13.7	4.3	29,207,277	12,531
107	France	EU	Validation	29.5	33.9	4.4	64,768,389	28,812
108	Malta	EU	Training	30.4	35.6	5.2	406,771	212
109	Switzerland	EU	Validation	32.7	38.0	5.3	7,623,438	4,026
110	Netherlands	EU	Validation	29.3	37.1	7.8	16,783,092	13,090
111	Norway	EU	Training	28.1	36.4	8.3	4,676,305	3,892
112	Lebanon	ME	Training	14.5	23.6	9.1	4,060,766	3,689
113	Bahrain	ME	Training	17.8	27.1	9.3	738,004	686
114	Belgium	EU	Training	30.4	40.1	9.7	10,423,493	10,124
115	Lithuania	EU	Training	29.1	39.6	10.5	3,545,319	3,725
116	Niue	AO	Validation	9.5	20.0	10.5	1,398	1
117	Iceland	EU	Validation	24.5	36.7	12.2	308,910	377
118	Kyrgyzstan	ME	Validation	11.4	24.4	13.0	5,508,626	7,183
119	Armenia	EU	Validation	22.9	36.1	13.3	2,966,802	3,933
120	Russia	EU	Validation	28.5	42.7	14.2	139,390,205	197,550
121	Jordan	ME	Training	7.3	22.0	14.7	6,407,085	9,391
122	Egypt	AF	Training	9.6	24.3	14.7	80,471,869	118,113
123	Tajikistan	ME	Validation	4.8	20.3	15.5	7,487,489	11,635
124	Greece	EU	Validation	35.1	50.8	15.7	10,749,943	16,836
125	Turkmenistan	ME	Training	9.9	25.7	15.8	4,940,916	7,783
126	Uzbekistan	ME	Validation	10.2	26.7	16.5	27,865,738	45,950
127	Belarus	EU	Validation	29.5	46.9	17.4	9,612,632	16,757
128	Georgia	EU	Training	26.5	44.9	18.3	4,600,825	8,442
129	Azerbaijan	EU	Validation	17.2	36.0	18.8	8,303,512	15,637
130	Israel	ME	Validation	17.3	37.4	20.1	7,353,985	14,787
131	Kazakhstan	AS	Validation	16.7	37.3	20.7	15,460,484	31,933

PD = physician density (per 10,000 population)

Discrepancy = Predicted PD minus Observed PD

Physician Number = Discrepancy × Population ÷ 10,000

Continent: AF = Africa, AS = Asia, AO = Australia/Oceania, EU = Europe, ME = Middle East, NA = North America, SA = South America

B. 國際間醫師人力使用模式推估於台灣之應用

常用的醫師計量單位為每萬(或千)人口多少位醫師，但是影響醫師需求量的因素，絕不只是該地區的總人口數[1]。國內關於醫師人力需求之研究，始於 1962 年 Baker[2]等人，研究方法不外從供應面(Supply)、要求面(Demand)及需求面(Need)探討[3]，藍忠孚等[4]則以質性研究的情境分析法，預測未來可能面對的醫師人力問題，並沒有建議合宜人數。「供

應面」的探討是在現今醫師人力數、分佈布、及服務品質恰當的假設下，推測在未來環境中維持此醫療服務水準所需加入的醫師人力，影響供應面的因素為每年醫學院畢業生人數、國考通過率、國外醫學院畢業生回國執業人數、停止執業之醫師人數、工作時數、醫師生產力、醫師年齡性別分佈布、及專科分佈布等，其缺失是沒有對醫師個別服務力差異之考慮，也無法對上述假設做反省;「要求面」模式是基於族群人口對於醫療照護的期待與耗用情況加以考量，這些指標包括醫療執行型態、經濟情況、及族群健康狀況等;「需求面」模式乃依據疾病之盛行率(流行病學）與人口學，估算出維持人民某種程度的健康照護所需的醫師人力，以眼科為例，要了解白內障的盛行率與好發人口年齡分配百分比、佐以需多少眼科專科醫師執行此項手術，據此以推估醫師人力需求，但目前此流行病學與耗用醫師人力數值尚未完整建立，此理想要得到民眾與醫療提供者的認同並不容易。

本研究為了對現今醫療環境下，合宜的醫師人力問題做多方反省，採用「要求面」為主的探討模式，各種影響醫師需求的四大考量面向包括: (1)經濟與教育情況 (2)耗用醫療人力資源的國民健康狀況 (3)國民使用醫療人力資源的行為(醫療業務量) (4)期待達成的醫療品質或國民健康指標。吳肖琪等人在 2003 年[5]發表了此類型之研究，以國外資料建立常模來推估台灣所需要的醫師數。吳教授依據此模式，計算出每萬人口醫師數應該為 28.8 人。但是因為當時國外資料之獲取不易，各國資料乃取自從 1990 至 2000 年之 10 年間範圍，又因至今社會醫療環境變化頗劇，全民健保施行、大型醫院擴建、病人意識抬頭、醫院及教學醫院評鑑實施，有需要收集各國標準化資料重新分析，並加以深入解釋及探討，以提醒可能出現之醫師人力問題，採取及早預防措施。

(1). 研究方法

本研究乃蒐集世界各國之各相關指標及其醫師人數，以逐步迴歸的統計分析(stepwise regression analysis)建立估算醫師人力需求的模式(公式)，然後帶入台灣各項指標資料，以推算台灣醫師人力需求數，最後解釋造成此落差之各方因素並提出解決問題之策略。

自變項與依變項

自變項為影響醫師需求量之各種指標。，作者選取自變項之原則乃一方面考量上述涵蓋要求面(Demand)及需求面(Need)的四大類影響因素，另一方面考量能否完整蒐集到各國之資料，一共選取了與上述面向(經濟與教育情況、耗用醫療人力資源的國民健康狀況、國民使用醫療人力資源的行為、期待達成的醫療品質或國民健康指標)相關的二十三個指標做為自變項。依變項則為世界各國每萬人口醫師數(Physician density, PD)。

資料來源

依變項(醫師人口比)數值取自世界衛生組織[6]資料庫，各國之自變項資料來源包括:世界衛生組織、世界銀行、聯合國之資料庫[7-10]。台灣的資料則取自下列資料庫:內政部統計處、中華民國統計資訊網、行政院衛生署統計處[11-13]。取得各國所有資料後，先決定研究年代，選取原則為每萬人口醫師數資料最完整與最近之年份，然後選取當年各依變項資料完整之國家，以其資料來做統計分析。

統計方法

本研究使用 SPSS15.0 進行逐步迴歸的統計分析(Stepwise regression analysis)，依變項(dependent variables)資料必須符

合常態分佈，且各筆資料相互獨立，自變項(independent variables)資料則須排除高同質性且高度相關之變項，適當選擇之。

本研究以 One-Sample Kolmogorov-Smirnov test 檢定每萬人口醫師數之分佈，確認每萬人口醫師數之分佈為常態；以 Durbin-Watson test 檢定各國每萬人口醫師數分布，確定其各筆資料互為獨立（>2.0 表示互為獨立）[14]；以 Pearson Correlation（two-tailed）檢定所有指標之相關性，將高相關之同類指標（相關係數>0.5 且 p<.01）擇一納入自變項，以排除各變項之間多元共線性的問題。

(2). 結果

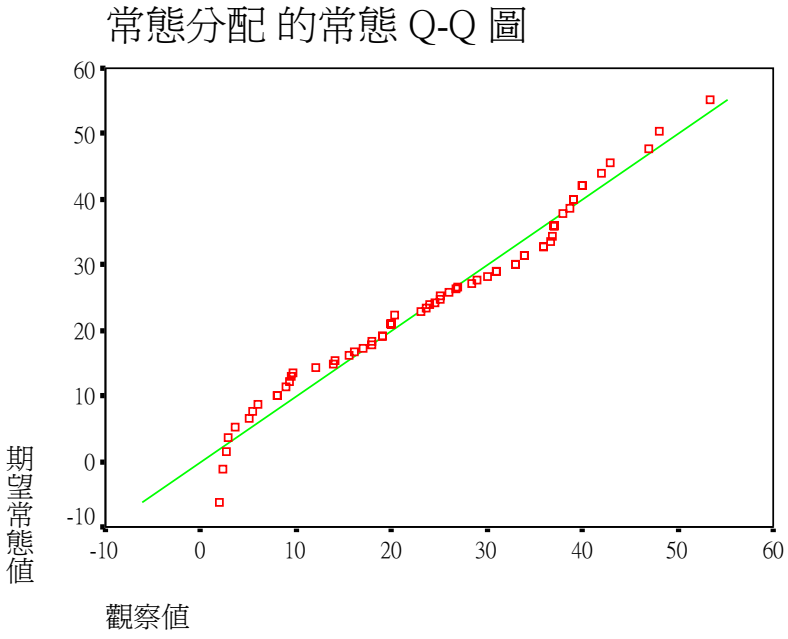
綜覽所取得之各國資料，每萬人口醫師數資料最完整與最近之年份為 2005 至 2006 年，因此選擇 2005 至 2006 年間有完整 23 個自變項資料的各國來做統計分析，當同時有 2005 及 2006 年之資料時，則取 2006 年之資料來分析。在 23 個自變項中，幾個關於識字率的變項僅有 2007 年的資料，且遺漏資料過多(特別是許多先進國家的資料都缺失)，因此去除這四項指標。在這兩年間，具備 19 項完整資料的國家共有六十八個。

分析各自變項資料結果，六十歲以上人口比及十五歲以下人口比兩項人口變項雖然高度相關，卻為負相關，因此選擇六十歲以上人口比做為單一指標；購買力平價指標(PPP)因各國計算方式無明確定義，且極端值過多而不予納入；當指標有不分性別之值及男女分別計算值時，選擇不分性別之值納入其中一個自變項(例如:國人平均餘命、國人平均死亡率、五歲以下國人平均死亡率)。國人平均壽命是很具代表性的國民健康指標，而下列與其高度相關之指標就不予納入，包含：

女性生育率、十五到六十歲死亡率、五歲以下死亡率;代表國民經濟實力的指標包括:平均每人國民所得毛額 (Gross National Income per capita, GNIPC, 以美元計)及國民醫療保健支出占 GDP 比率，在 GDP 及 GNI 兩者高度相關之同類型指標只選取 GDP 納入自變項。綜合以上考量，最後共納入四個自變項：(1)六十歲以上人口比、(2)國人平均壽命、(3) 每萬人口床數、(4)國內每人所得毛額 (Gross National Income Per Capital, GNIPC, 以美元計)。

以 One-Sample Kolmogorov-Smirnov test 檢定每萬人口醫師數之資料分佈，確認其為常態分佈 (p=.58)，請見表 42。以 Durbin-Watson test 檢定各國每萬人口醫師數資料，確定其各值為相互獨立 (Durbin-Watson test =2.336 >2.0) [14]。

表 1　各國每萬人口醫數常態分配趨勢檢定圖



由六十八個國家五個自變項的資料以逐步迴歸(stepwise)方式，推算各自變項與依變項之關係並求得預測醫師人力需求之公式，得到的逐步迴歸公式為：

PD= 3.790 + 0.238 ╳ 每萬人口床數 + 0.758 ╳ 國人 60 歲以上人口比

每萬人口床數及國人 60 歲以上人口比(無標準化)兩項指標之解釋力達 0.636【F(2,65)=56.885, P<0.01】。

上述常模公式之兩項指標數值在台灣 2006 年間為:病床數每萬人口總 57.33 床(去除診所觀察床)，60 歲以上人口比 13.3%，而估算出台灣每萬人口醫師數應為 27.55 位醫師，此預估值的信賴區間範圍為每萬人口 24.72 至 29.87 位醫師。同理類推，台灣在 2007 年病床數每萬人口 58.1 床,60 歲以上人口比 13.6%,則需醫師數每萬人口 27.93 位，此預估值的信賴區間範圍為每萬人口 24.71 至 29.89 位，而 2007 年當年實際醫師人力為 15.60 位，估算數與實際數間的差距為每萬人口 12.33 位醫師，以當年人口數 22958.3(千)人算，共約缺少 28,307 位醫師。 近十年來病床數從每萬人口 51.05 增加到 57.4，60 歲以上人口比從 11.69%增加到 12.39% ，但是實際之醫師密度始終遠低於估算值，每萬人口平均低 12.11 ± 0.24 位醫師(請見圖 11)。

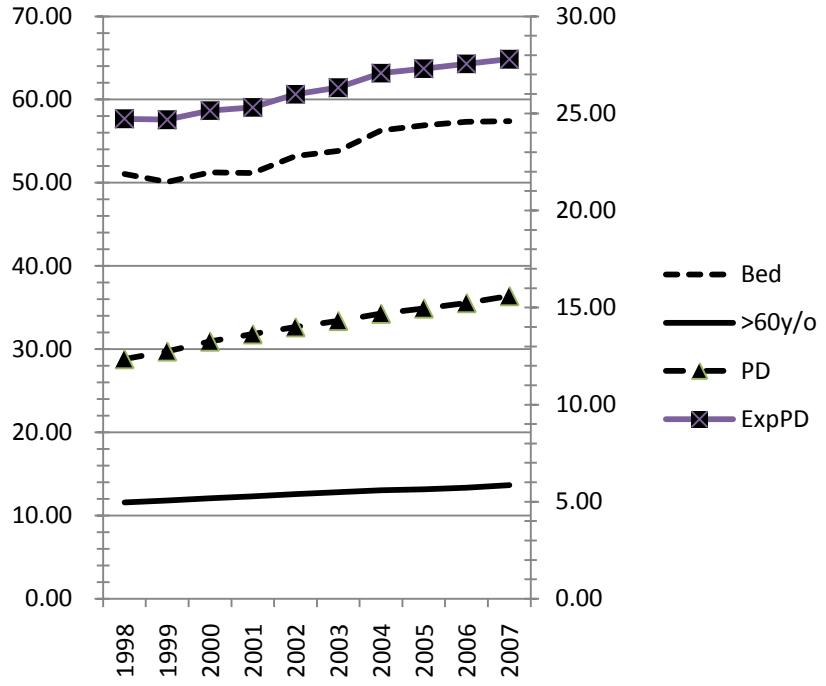


圖 1　1998 至 2007 年間，台灣病床數(bed, 床/萬人)、60 歲以上人口比(>60y/o, %)、實際與估算之醫師人力密度(PD, ExpPD, 位/萬人)之變化。左側座標為病床數與 60 歲以上人口尺標，右側副座標則為醫師人力密度尺標。

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