Socioeconomic Burden of Psoriatic Arthritis in Hong Kong: Direct and Indirect Costs and the Influence of Disease Pattern

TRACY Y. ZHU, LAI-SHAN TAM, YING-YING LEUNG, LAI-WA KWOK, KONG-CHIU WONG, TRACY YU, EMILY W. KUN, and EDMUND K. LI

ABSTRACT. ***Objective.*** To estimate the direct costs and indirect costs of patients with psoriatic arthritis (PsA) in Hong Kong.

Methods. A retrospective cost-of-illness study was performed on 125 patients with PsA. Participants completed questionnaires on demographics, employment status, and out of pocket expenses. Health resources consumption was recorded by chart review and patient self-report questionnaire. Patients were grouped according to disease pattern, i.e., peripheral and axial disease. Multiple regression was used to determine the predictors of the costs.

Results. The average annual direct costs were $4,141 (2006 US dollars) per patient. Costs of inpatient care accounted for 27% of direct costs, followed by costs of visits to healthcare providers (25%). The estimated average indirect costs were $3,127 per patient-year. Forty-eight (42%) patients had no indirect costs. Sixty percent of patients with peripheral disease were still employed, compared to 39% of patients with axial disease. Patients with axial disease had almost twice the indirect costs compared to those with peripheral disease ($p = 0.005$). Increased pain and poor function were independently associated with increased direct costs. Worse physical health status, determined by indirect costs borne by the patient, and poor function and old age predicted high costs.

Conclusion. PsA imposes substantial economic burden. Pain and function are significantly associated with costs. Improvements in treatments to reduce pain and restore function are likely to reduce the costs incurred by these patients. (J Rheumatol First Release April 1 2010; doi:10.3899/jrheum.090988)

Key Indexing Terms:
PSORIASIS ARTHRITIS COSTS DISEASE PATTERN CHINESE

Psoriatic arthritis (PsA) is an inflammatory peripheral and/or axial arthritis associated with psoriasis that affects about 0.2%–1% of the population[1]. PsA has been recognized as a progressive and disabling disease. At the first visit to the clinic, 46% of patients were found to have at least 1 deformed joint and 67% had radiological erosion[2]. In a another cohort of 129 patients, Kane, *et al* found that about half (47%) developed joint erosions in hands or feet at a median interval of 2 years[3]. Studies have indicated that patients with PsA had reduced functional capacity and health-related quality of life (HRQOL) compared to those with psoriasis or healthy subjects[4,5]. The burden of PsA has been reported to be comparable to that of rheumatoid arthritis (RA) or ankylosing spondylitis (AS)[6]. However, compared to RA and AS, there is less information about the economic burden of illness in PsA[7-9]. Cost-of-illness analysis of a disease usually includes the assessment of direct and indirect costs. Direct costs measure the costs of resources used for treating the disease, whereas indirect costs usually measure the productivity loss due to the disease[10]. A US study estimated the direct costs of psoriasis and PsA, by analyses of public or private health databases; but they did not assess the costs of PsA separately or provide the proportion of patients with arthritis[8]. A study in Germany highlighted the direct and indirect costs of illness in several rheumatic diseases, including PsA[7]. However, information about the use of healthcare resources, which might be more useful for comparisons among countries, was limited. Understanding the economic consequences of PsA will help determine the magnitude of this condition and assist policy-

From the Department of Medicine and Therapeutics, Prince of Wales Hospital, The Chinese University of Hong Kong; Department of Medicine and Geriatrics, Tai Po Hospital; and Department of Medicine and Therapeutics, Prince of Wales Hospital, Hong Kong, China.

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T.Y. Zhu, BM; L-S. Tam, MD, Department of Medicine and Therapeutics, Prince of Wales Hospital, The Chinese University of Hong Kong; Y-Y. Leung, FHKAM, Department of Medicine and Geriatrics, Tai Po Hospital; L-W. Kwok, FHKCP; K-C. Wong, FRCP, Department of Medicine and Therapeutics, Prince of Wales Hospital; T. Yu, MPhil, Department of Medicine and Therapeutics, Prince of Wales Hospital, The Chinese University of Hong Kong; E.W. Kun, FRCP, Department of Medicine and Geriatrics, Tai Po Hospital; E.K. Li, MD, Department of Medicine and Therapeutics, Prince of Wales Hospital, The Chinese University of Hong Kong.

Address correspondence to Dr. E.K. Li, Department of Medicine and Therapeutics, The Prince of Wales Hospital, Shatin, N.T., Hong Kong. E-mail: edmundli@cuhk.edu.hk

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makers in allocation of healthcare resources, especially in the current political atmosphere of limited healthcare budgets.

We performed a comprehensive cost-of-illness analysis on patients with PsA in Hong Kong to estimate the direct and indirect costs. We also attempted to identify independent cost predictors for the whole cohort, as well as for patients with peripheral and axial disease, respectively.

MATERIALS AND METHODS

Patients. One hundred twenty-five patients were recruited from the rheumatology clinic of 2 regional hospitals (Prince of Wales Hospital and Alice Ho Miu Ling Nethersole Hospital), which are the only referral centers for a population of almost a million people, out of a total population of around 7 million in Hong Kong. All patients fulfilled the ClASsification criteria for Psoriatic ARthritis (CASPAR)[11] and were followed regularly at the rheumatology clinics of the 2 hospitals. Patients who were not capable of responding to a questionnaire (e.g., for presence of dementia) were excluded. The protocol was approved by the Ethics Committee of the Chinese University of Hong Kong. Written informed consent was obtained from all subjects according to the Declaration of Helsinki for participation in the study.

Data collection and measures. All participants completed a series of questionnaire surveys conducted by trained interviewers. The survey included items pertaining to demographics and socioeconomic characteristics, employment, and healthcare resource use in the preceding 12 months, as well as self-administered questionnaires on disease activity, function, and HRQOL. Participants also underwent clinical reviews by their treating rheumatologist to assess disease activity and severity.

Demographics. Demographic variables included age, sex, marital status (married, single, widow/widower, divorced), and education level (number of years receiving formal education). Participants were queried about their current work situation, which was categorized as employed, unemployed due to PsA, or unemployed not due to PsA. Participants were considered employed if they reported that they had been at work for pay or profit or they had formal job attachment. Participants were also queried for sick leave taken in the preceding 12 months (for those who were employed); whether they were unemployed due to PsA and the duration of unemployment; and the number of days off from household work due to PsA.

Evaluation of disease pattern, disease activity, and severity. Disease pattern was classified clinically according to the attending rheumatologist's perspective. Axial disease was defined as inflammatory arthritis of the back or limitation of motion of cervical/lumbar spine. Patients with predominant axial disease were categorized as in the axial disease group, and those with predominant peripheral arthritis in the peripheral disease group.

Pain, physician's global assessment of disease activity and patient's global assessments on health status were evaluated using a 10-point visual analog scale (VAS), where 0 indicated excellent well-being and 10 indicated feeling extremely unwell. The number of permanently deformed joints was also recorded. Laboratory markers of disease activity included erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) level.

Disease activity was assessed using the Disease Activity Score in 28 joints (DAS28)[12]. The DAS28 was utilized in recent randomized controlled trials[13] and has proven to be one of the most responsive and discriminant instruments[14]. The Psoriasis Area and Severity Index (PASI) was used to assess the extent of skin involvement[15]. Radiographs were reviewed for the presence of erosion. The disability index of Health Assessment Questionnaire (HAQ) was used to measure functional status[16]. HRQOL was assessed with the Chinese version of the Medical Outcomes Study Short-Form 36 (SF-36), which includes a physical component summary (PCS) score and a mental component summary (MCS) score[4].

Cost estimates. Details relating to direct costs of the disease were collected for the preceding 12 months, i.e., use of all types of hospital or clinic services. Results are shown in 2006 US dollars (purchasing power parity, PPP). Hong Kong has a dual healthcare system where public and private sectors coexist. Public hospitals and clinics provide all residents with comprehensive healthcare, including drugs, investigations, ambulatory care, hospitalization, and operations. Access to public healthcare is available to all residents regardless of financial or insurance status. The public is charged nominal fees for healthcare facilities[17]. Private hospitals/clinics are relatively small in number and size, run on a profit basis and utilized mainly by expatriates or wealthier citizens. Fees and charges of private healthcare facilities vary[17]. In Hong Kong, patients with chronic diseases rely mainly on public hospitals; use of private hospital services represents a relatively small percentage[18].

Costs to public and private healthcare. Costs to public/private healthcare included costs of visits to healthcare providers, including general practitioners, specialists, physiotherapists, occupational therapists, psychologists, and others; diagnostic tests (laboratory or imaging tests); medications; emergency room visits; and inpatient care (including rehabilitation hospitalization).

In 1994, the healthcare data clinical management system (CMS) was implemented by the government, providing single log-on access to almost all available clinical information in the public system, from clinic to hospital care[19]. The CMS records all public healthcare resources used, including ambulatory, hospital, and emergency resources; thus all healthcare service data could be easily retrieved. In our study, data on use of public healthcare resources were derived by review of medical records. Average per diem costs (both hospital and ambulatory services) estimated by the government authority was used as a measure of cost to the public healthcare system. The unit costs of some major services have been described elsewhere[20].

We did not have access to private hospital/clinic records, and the costs of private healthcare facilities varied considerably. Therefore, utilization of private healthcare resources was reported by patients, and average per diem costs estimated by the government authority were used as a measure of costs.

Patients' out of pocket expenses. Patients' out of pocket expenses in the preceding year were reported by the patients, including costs of health products; nonconventional therapies (e.g., hydrotherapy, acupuncture, massage); aid devices; and direct non-healthcare resources, including transportation expenses, private household helpers, and adaptations to houses. These expenses are not covered by the government system.

Indirect costs (productivity loss). Indirect costs were determined only for participants of traditional working age (≥ 18 to ≤ 65 yrs at the time of the study). The human capital approach (HCA) was used to calculate indirect costs[21]; the HCA measures lost production, in terms of lost earnings, of a patient or caregiver, using wages as a proxy measure of the output of work time. It often includes the value of household work, usually valued as the opportunity cost of hiring a replacement from the labor market[22]. In our study, indirect costs included loss of productivity due to sick leave (only for those who were still employed); unemployment due to PsA (only for those who were PsA-related unemployed); and days off from household work due to PsA. Wages were derived from Wage and Payroll Statistics, the Census and Statistics Department of Hong Kong.

Statistical analyses. Statistical analyses were performed using Statistics Package for Social Sciences (SPSS for Windows, version 13.0, 2006; SPSS Inc., Chicago, IL, USA). Results are expressed as mean ± SD for normally distributed data. For non-normally distributed data, median and interquartile range are given. Chi-square test and Student t test were used to compare categorical and normally distributed continuous variables, respectively. For non-normally distributed continuous data, Mann-Whitney U test was used.

Multiple linear regression was used to determine predictors of increased direct costs. Because 42% of patients had no indirect costs, the combination of logistic regression and a linear model was preferable to determine predictors of increased indirect costs. This approach to analyzing

data with clumping at zero has been demonstrated by Chang, *et al*[23]. Briefly, a logistic regression was used to model probability of zero indirect costs, and stepwise multiple linear regression was used to model the non-zero continuous indirect costs. Due to skewness of the costs data, the results were log-transformed (base 10) for the linear regression model. Covariates in the regression model included age, sex, years of education, disease duration, PASI score, physician's global assessment, pain score, patient's global assessment, damaged joints and DAS28 score, CRP level, HAQ score, and PCS and MCS scores. The p value for a variable to remain in the model was < 0.05. Selection of final model was based on the R^2 and an evaluation of the residual plots. A sensitivity analysis was performed to determine whether the test was sensitive to outliers (a case was an outlier if it was 3 SD from the mean.

RESULTS

Clinical features of PsA patients. The demographic and clinical characteristics of the 125 patients in this study are summarized in Table 1, cross-classified by peripheral and axial disease. Thirteen (10.4%) patients had distal joint disease; 48 (38.4%) had oligoarthritis involving ≤ 4 joints; 40 (32%) had polyarthritis involving ≥ 5 joints; and 24 (19.2%) had axial involvement. The diagnosis of axial involvement was based on clinical findings, and only 50% of patients had features of radiological sacroiliitis. Five patients had axial disease without peripheral joint involvement. Fifty-two percent of patients had erosions on radiographs. One hundred five (84%) patients had psoriasis at the time of assessment.

Healthcare resource use and direct costs. Data for healthcare resource use in the preceding 12 months are shown in Table 2. One hundred three (82%) patients had seen a rheumatologist; 74 (59%) had visited a dermatologist; only 14% required visits to allied health professionals. A majority of patients required blood tests (108/125, 86%) or urine tests (6/125, 6%). Fifty-eight (46%) patients required imaging tests, most of which were conventional radiographic examinations. Only 12 (10%) patients required more expensive examinations, such as ultrasound imaging, computed tomography scan, and magnetic resonance imaging. Thirty-three (26%) patients made 68 visits to the emergency department over 1 year. Twenty patients (16%) had 32 hospital stays in the preceding year, of which only 2 had been hospitalized more than twice (one admitted 3 times and one 6 times, respectively). None of the patients required rehabilitation hospitalization. No operations or day-case surgeries were reported.

A majority of patients (123/125, 98%) were taking medications. No patient had ever used biologic therapies. The most commonly used medications, in order of frequency of use, were skin preparations (including topical corticosteroids; 86%), nonsteroidal antiinflammatory drugs and analgesics (78%), anti-ulcer drugs (62%), and immunosuppressants (56%). Methotrexate was the most commonly used immunosuppressant (34%), followed by sulfasalazine (22%).

Only 28 patients used private hospital facilities, most of which were visits to private general practitioners.

Table 1. Demographic and clinical characteristics of PsA patients with peripheral and axial disease. Values are mean ± SD or median (interquartile range) unless otherwise indicated. There was no significant difference in demographic and clinical characteristics between patients with peripheral and axial disease, except in mental component summary score of the SF-36.

Characteristic	Whole Group, n = 125	Peripheral Disease, n = 101	Axial Disease, n = 24
Age, yrs	47 ± 12	48 ± 13	46 ± 10
Male, no. (%)	65 (52)	51 (51)	14 (58)
Married, no. (%)	84 (67)	68 (67)	16 (67)
Education, yrs	9 ± 4	8.8 ± 4.0	9.1 ± 3.0
Age at PsA diagnosis, yrs	40 ± 12	41 ± 12	36 ± 12
Age at psoriasis diagnosis, yrs	36 ± 14	30 ± 14	34 ± 13
PsA disease duration, yrs	6.9 (2.0–12.4)	6.4 (2.1–11.5)	10 (2.0–17.3)
PASI score	2.1 (0.9–7.4)	2.5 (0.9–7.3)	1.8 (0.9–10.3)
Physician global (VAS 0–10)	2.0 (0–3.0)	2.0 (0–3.0)	2.0 (1.0–4.0)
Pain (VAS 0–10)	4.8 ± 2.6	4.7 ± 2.5	5.0 ± 2.9
Patient global (VAS 0–10)	4.6 ± 2.3	4.4 ± 2.3	5.2 ± 2.2
ESR, mm/h	30.2 ± 26.0	38.0 ± 35.6	31.7 ± 28.1
CRP, mg/l	10.7 ± 15.2	14.1 ± 19.3	11.4 ± 16.0
No. of damaged joints	1 (0–4)	1 (0–4)	2 (0–5)
DAS28	3.8 ± 1.5	3.8 ± 1.5	3.8 ± 1.6
HAQ (0–3)	0.5 (0.1–1.0)	0.4 (0–0.9)	1.0 (0.1–1.3)
PCS	40 ± 9	41 ± 9	37 ± 10
MCS	43 ± 11	44 ± 12	38 ± 10[†]

[†] p < 0.01, comparison between patients with peripheral and axial disease. PASI: Psoriasis Area and Severity Index; VAS: visual analog scale; ESR: erythrocyte sedimentation rate; CRP: C-reactive protein; DAS28: Disease Activity Score in 28 joints; HAQ: Health Assessment Questionnaire; PCS: physical component summary score of the Short-Form 36; MCS: mental component summary score of the Short-Form 36.

Table 2. Utilization of public healthcare resources among PsA patients with peripheral and axial disease. Results are mean ± SD and median (interquartile range).

Healthcare Use	Whole Group, n = 125		Peripheral Disease, n = 101		Axial Disease, n = 24	
No. of visits to healthcare provider	9.8 ± 11.1	6 (4–12)	8.9 ± 10.0	6 (4–9)	13.6 ± 14.3	10 (5–19)
Rheumatologist	2.6 ± 2.3	2 (1–4)	2.7 ± 2.4	3 (2–4)	2.3 ± 1.8	3 (1–3)
Dermatologist	2.0 ± 3.0	2 (0–3)	2.0 ± 3.1	2 (0–3)	2.0 ± 2.2	2 (0–3)
Orthopedist	0.9 ± 1.5	0 (0–2)	0.9 ± 1.6	0 (0–2)	0.9 ± 1.4	0 (0–2)
Allied health provider	1.3 ± 4.6	0 (0–0)	1.1 ± 4.1	0 (0–0)	2.1 ± 6.3	0 (0–0.8)
General medicine	0.7 ± 1.6	0 (0–0)	0.4 ± 1.2	0 (0–0)	1.7 ± 2.6†	0 (0–4)
Others	2.3 ± 6.8	0 (0–2)	1.8 ± 6.0	0 (0-1)	4.6 ± 9.4	0 (0–4)
No. of diagnostic tests	12.9 ± 11.8	11 (4–18)	12.5 ± 12.1	11 (4–17)	14.0 ± 10.4	14 (5–21)
Chemical pathology test††	11.4 ± 10.6	10 (3–17)	11.2 ± 11.0	9 (3–17)	12.3 ± 8.6	13 (4–18)
Imaging test	1.5 ± 2.4	0 (0–2)	1.4 ± 2.2	0 (0–2)	2.0 ± 2.8	0 (0–5)
No. of emergency department visits (among the whole group)	0.5 ± 1.3	0 (0–1)	0.6 ± 1.4	0 (0–1)	0.4 ± 0.8	0 (0–0.8)
No. of emergency department visits (among users)	2.1 ± 1.9	1 (1–2)	2.1 ± 2.0	1 (1–2)	1.7 ± 0.8	1.5 (1–2.3)
Duration of inpatient care, days (among the whole group)	1.7 ± 7.5	0 (0–0)	1.1 ± 4.9	0 (0–0)	4.0 ± 13.9	0 (0–0.8)
Duration of inpatient care, days (among users)	3.5 ± 8.3	0 (0–3)	3.8 ± 8.9	0 (0–4)	2.2 ± 4.8	0 (0–3.8)

† p = 0.004, Mann-Whitney U test, between patients with peripheral and axial disease. †† Including blood and urine tests.

Thirty-four percent of patients used self-purchased health products and 16% used nontraditional therapies. Expenses for transportation to healthcare providers were recorded for 99 patients (79%). Aids and private household helpers were used by a relatively small number of patients (14 and 1 patients, respectively).

Components of direct costs are shown in Table 3. The estimated average annual direct costs were $4,141 per patient. Costs of inpatient care accounted for the largest component of direct costs (27%), followed by costs of visits to healthcare providers (25%). Twenty-three percent of direct costs were patients' out of pocket expenses, 82% of which were costs of health products and nontraditional therapies. Costs of diagnostic tests and medications each accounted for roughly 10% of direct costs respectively. The costs of emergency room visits were small.

Indirect costs. Indirect costs were calculated only for patients of traditional working age (n = 115), 63 (54.8%) of whom were still employed at the time of the assessment. For those who were still employed, 37 (58.7%) of 63 required taking sick leave during the preceding year, for a median 6 days (range 2–120 days). Among those who were unemployed, 27 (51.9%) of 52 attributed the unemployment to PsA, with a median unemployment of 6.6 months (range 0.1–12 mo). The estimated average indirect costs were $3,127 per patient-year (Table 4). Forty-eight (42%) patients had no indirect costs; only 5 of them had axial disease. For those who had indirect costs, the average costs were $5,321 (SD $7,615) per patient-year (median $1,357).

Influence of disease pattern on direct and indirect costs. One hundred and one patients were defined as having peripheral disease, whereas 24 had axial disease. No differ-

Table 3. Annual direct costs of patients with peripheral and axial PsA. Results are mean ± SD and median (interquartile range). 2006 USD, 1 USD = 5.527 HKD; Purchasing Power Parities. No significant difference between patients with peripheral and axial disease.

Expense Category	Whole Group, n = 125		Peripheral Disease, n = 101		Axial Disease, n = 24	
Visits to healthcare providers	1,045 ± 1,029	760 (507–1,144)	979 ± 959	760 (507–1,079)	1,323 ± 1,268	1,080 (526–1,758)
Diagnostic tests	429 ± 521	257 (87–563)	378 ± 408	257 (69–530)	643 ± 825	385 (132–678)
Medications	471 ± 811	247 (72–557)	481 ± 879	241 (72–532)	428 ± 428	356 (52–677)
Emergency room visits	80 ± 201	0 (0–103)	82 ± 208	0 (0–103)	71 ± 173	0 (0–77)
Inpatient care	1,102 ± 4,692	0 (0–0)	785 ± 3,241	0 (0–0)	2,439 ± 8,408	0 (0–448)
Private hospital resources	54 ± 136	0 (0–0)	46 ± 117	0 (0–0)	91 ± 196	0 (0–68)
Patients' out of pocket expenses	960 ± 1,937	221 (26–1,086)	780 ± 1,159	244 (29–1,086)	1,716 ± 3,694	185 (22–1981)
Health products	574 ± 1,492	0 (0–434)	440 ± 937	0 (0–434)	1,140 ± 2,788	0 (0–543)
Nontraditional therapy	210 ± 717	0 (0–0)	166 ± 598	0 (0–0)	394 ± 1,084	0 (0–0)
Aid devices	2 ± 20	0 (0–0)	3 ± 22	0 (0–0)	0	0
Non-healthcare resources	174 ± 359	43 (20–163)	171 ± 377	43 (15–119)	183 ± 274	52 (22–250)
Direct costs	4,141 ± 5,661	2,446 (1,398–4,970)	3,530 ± 4,369	2,446 (1,309–4,075)	6,711 ± 9,014	3,524 (1,509–8,817)

Table 4. Annual direct costs (per patient) of patients with peripheral and axial PsA. Results are mean ± SD and median (interquartile range).

Costs	Whole Group		Peripheral Disease		Axial Disease	
No. of days off from household work, days*	8.2 ± 42.5	0 (0–0)	7.7 ± 43.9	0 (0–0)	10.4 ± 37.7	0 (0–0)
Duration of annual sick leave, days**	11.8 ± 23.8	3.0 (0–7.5)	10.2 ± 23.2	3 (0–6.5)	16.1 ± 29.3	7 (0–19.0)
Duration of unemployment, months***	7.1 ± 4.4	6.6 (2.8–12.0)	6.9 ± 4.9	6.6 (2.0 ± 12.0)	7.3 ± 3.8	7.3 (4.2–11.3)
Indirect costs (productivity loss), 2006 USD†	3,127 ± 6,386	309 (0–2,827)	2,604 ± 6,042	90 (0–1,206)	5,199 ± 7,386††	1,357 (181–7,446)
Due to limitation of household work*, 2006 USD	323 ± 1,662	0 (0–0)	300 ± 1,712	0 (0–0)	410 ± 1,485	0 (0–0)
Due to sick leave**, 2006 USD	1,039 ± 2,833	166 (0–577)	1,109 ± 3,042	136 (0–543)	626 ± 898	317 (0–1,040)
Due to PsA-related unemployment***, 2006 USD	10,664 ± 8,859	7,811 (3,364–16,284)	10,816 ± 9,375	10,495 (3,037–16,284)	10,452 ± 8,574	7,811 (4,864–16,284)

* Based on 115 patients of working age, 92 with peripheral disease and 23 axial disease. ** Based on 63 patients of working age and employed, 54 with peripheral disease and 9 axial disease. *** Based on 27 patients who were PsA-related unemployed, 16 with peripheral disease and 11 axial disease. † Indirect costs included lost of productivity due to sick leave, unemployment due to PsA, and days off from household work due to PsA. Calculations based on 115 patients of working age, 92 with peripheral disease and 23 axial disease. 2006 USD, 1 USD = 5.527 HKD, Purchasing Power Parities. †† $p < 0.005$, Mann-Whitney U test, comparison between patients with peripheral and axial disease.

ences in demographics and clinical characteristics were found between the 2 groups, but patients with axial disease had significantly lower scores in the MCS (Table 1). Patients with axial disease paid more visits to a general practitioner ($p = 0.004$; Table 2). Use of emergency room was similar between the 2 groups (27% and 25% for patients with peripheral and axial disease, respectively). A higher proportion of patients with axial disease was hospitalized during the preceding year, compared to those with peripheral disease (25% vs 14%, respectively), although this was not statistically significant ($p = 0.181$). There were no significant differences in annual direct costs and costs of each component between the 2 groups (Table 3).

For the 115 patients of working age, 92 had peripheral disease and 23 axial disease. The employment rate was higher in patients with peripheral disease (59% vs 39%, respectively; $p = 0.092$). Although the length of sick leave and PsA-related unemployment were longer in patients with axial disease, the differences did not reach statistical significance. Patients with axial disease had almost twice the indirect costs compared to those with peripheral disease ($p < 0.005$).

Multivariate analysis. The results of stepwise multivariate regression analysis for annual direct and indirect costs are shown in Table 5. The table shows independent variables in the final model, along with adjusted coefficients, p values, and R^2 for a linear regression model, as well as odds ratios and p values for a logistic regression model. Increased pain and poor function measured by HAQ were independently associated with increased direct costs. Worse physical health status, as expressed by lower score on the PCS, determined whether the patient had indirect costs. Poor function and old age independently predicted high indirect costs. The tests were not sensitive to outliers.

Table 5. Independent predictors of direct and indirect costs. Only variables with statistical significance in the final regression models are shown. Due to skewness of direct and indirect cost data, a logarithmic transformation (base 10) was performed prior to the regression analysis.

Patient Group	Direct Costs, All Participants			Productivity Loss, Participants Age ≤ 65 years				
				Logistic Regression		Linear Regression of Log_{10} (productivity loss)		
	Adjusted Coefficient (95% CI)	p	R^2	OR (95% CI)	p	Adjusted Coefficient (95% CI)	p	R^2
Whole group (n = 125)			0.092					0.255
Pain (VAS, 0–10)	0.049 (0.087, 0.011)	0.013						
HAQ (0–3)	0.277 (0.111, 0.444)	0.001				0.502 (0.225, 0.779)	0.001	
PCS				0.948 (0.907, 0.991)	0.019			
Age						0.021 (0.002, 0.039)	0.030	
With peripheral disease (n = 101)			0.142					0.213
Patient global (VAS, 0–10)	0.044 (0.011, 0.077)	0.010						
CRP, mg/l	0.005 (0.001, 0.010)	0.049						
HAQ (0–3)				2.503 (1.052, 5.953)	0.038	0.564 (0.227, 0.901)	0.002	
With axial disease (n = 24)			0.577					0.287
Pain (VAS, 0–10)	0.225 (0.321, 0.130)	< 0.0001						
Physician global (VAS, 0–10)	0.130 (0.001, 0.258)	0.048						
HAQ (0–3)	0.449 (0.041, 0.857)	0.033						
Education, yrs						–0.132 (–0.252, –0.013)	0.032	

VAS: visual analog scale; HAQ: Health Assessment Questionnaire; PCS: physical component summary score of the Short-Form 36; CRP: C-reactive protein.

Subgroup analysis was performed to determine the independent predictors of direct costs and indirect costs in patients with peripheral and axial disease (Table 5). For patients with peripheral disease, worse patient global assessment and high level of CRP predicted high direct costs. Whether the patient had indirect costs and the amount of indirect costs were both predicted by poor function. For patients with axial disease, increased pain and poor function and worse physician global assessment were independent predictors of high direct costs. For those who had indirect costs, patients with lower education levels generated high indirect costs. These tests were not sensitive to outliers.

DISCUSSION

This is one of the first studies analyzing the overall economic burden of PsA in Hong Kong. We found that costs of PsA are comparable to those of other rheumatic diseases, such as AS. We previously reported the costs of AS using similar methodologies[20]. Compared to AS in Hong Kong, the direct costs of PsA were 23% higher ($4,275 vs $3,487, respectively; 2006 US dollars). Comparisons of results from different studies are challenging due to differences in methodologies and healthcare systems. A recent study in Hungary determined the average direct and indirect costs of PsA (not on biologic therapy) as €1,681 and €2,600 (2007 Euros), respectively[24]. The rate of patients taking early retirement (24.6%) was similar to that in our study (24.8%). High costs of nonmedical services (49% of direct costs) such as transportation, informal care, and home remodeling were reported. The costs of PsA in Italy were also reported as substantial[9]. The average direct costs were €943 per 6 months, with about 67% attributable to the cost of drugs. However, the data were derived from patients who failed or were intolerant of conventional therapies[9]. It was possible that these patients might use more healthcare resources because of higher disease activity or disability. A study in Germany determined the average annual direct and indirect costs of PsA as €3,156 and €7,919 (using the human capital approach) per patient-year (2002 Euros), respectively, both higher than those estimated by our group[7]. The difference in direct costs is largely because of the significantly lower costs of medications in our study. But we may have underestimated the costs of medication since the unit price issued by the government may not reflect the true costs or market prices of the drugs[25]. The employment rate was higher among patients of working age in Germany (63% vs 51%), and the proportion of patients taking early retirement was lower (19% vs 25%) than in our study. The higher indirect costs in Germany were probably due to the higher average gross daily incomes (€95 in Germany vs €62 in Hong Kong; 1 Euro = 9.76 Hong Kong dollars).

Our study also determined cost predictors. In the study in Germany, disease activity measured by 0–10 scale and function measured by the Hannover Functional Status Questionnaire (FFbH; similar to the HAQ and transformable into HAQ values) were major predictors of direct costs, while function, disease duration, and age at disease onset were predictors of indirect costs[7]. In the study from Hungary, apart from function, severity of psoriasis (by PASI) was also a predictor of total costs[24]. In our study, severity of psoriasis did not influence costs, probably due to the large proportion of patients with mild skin lesions (PASI < 10: 82%). The major predictors of direct costs were function and pain. Thus treatments that improve function or reduce pain will be cost-effective in view of the high costs associated with function and pain.

Currently, the tumor necrosis factor-α (TNF-α)-blocking agents have opened new horizons for the treatment of PsA, showing particular effectiveness in patients with serious disease. They have also been considered cost-effective[9]. However, no patient in our cohort was using anti-TNF-α agents. The use of these expensive medications is limited in Hong Kong[26], because they are not within the government's reimbursement system and patients have to pay for them themselves. Our study addresses the wide socioeconomic influence of PsA as a chronic disease. Our results can provide a baseline to evaluate the cost-effectiveness of these more expensive treatments and help policy-makers allocate healthcare and research funds in the future.

We attempted to determine the differences in costs between patients with peripheral and those with axial disease. The percentage of patients with axial disease was similar to that reported by others[27,28]. The results showed that patients with axial disease had lower employment rates and generated higher indirect costs. This is consistent with findings from Zink, *et al*, where patients with axial involvement had higher rates of early retirement and sick leave during the previous 12 months compared with those with peripheral disease[6]. There was no difference in peripheral joint involvement between the 2 groups. The higher indirect costs in patients with axial disease are probably due to the burden incurred by axial involvement, which may further impair patients' capability of being employed. But the relatively small number of patients with axial disease makes the comparison inconclusive.

The relatively small sample size in our study is its main limitation. In particular, the number of patients with axial disease available for the calculation of each category of indirect costs was small. Robust estimates of direct and indirect costs and reliable comparisons between patients with peripheral and axial disease cannot be calculated. We observed higher costs of most of the healthcare resources in patients with axial disease. However, these differences did not reach statistical significance, which indicates a larger sample size is needed. The multivariate analysis is also compromised by the small sample size and the high percentage of patients without indirect costs, which limits the interpretation of data on the predictors of costs. Another major lim-

itation is the methodology of statistical analysis. Although we used an approach to deal with a clump of zero costs, concerns should be addressed about the skewness of the data that remain in the patients with positive costs. It is more desirable to analyze untransformed costs so that the models predict actual costs in dollars. For example, nonparametric bootstrap methods or multilevel/hierarchical models are developed to analyze such skewed data. Because of the structure of the Hong Kong healthcare system, we combined use of both public and private healthcare in our analysis, which decreases the generalizability of our results to other populations under different healthcare systems. Other limitations include its retrospective design and recall bias, especially the relatively long recall period (12 months). However, the use of public healthcare resources, which is the largest part of direct costs, was derived from patients' charts, which should be accurate.

We found that PsA imposes substantial economic burdens, not only because of the healthcare resources consumed in the management of this condition, but also because of the productivity loss due to work disability. Pain and function are significantly associated with costs. Improvements in treatments to reduce pain and restore function are likely to reduce the costs incurred by these patients. Our results may provide information for policy-makers allocating healthcare or research expenditures.

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