

Work, Unemployment and Life Satisfaction among Patients with Diisocyanate Induced Asthma—A Prospective Study

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Abstract: Work, Unemployment and Life Satisfaction among Patients with Diisocyanate Induced Asthma—A Prospective Study: Päivi L PIIRILÄ, et al. Department of Occupational Medicine of the Finnish Institute of Occupational Health, Finland—Occupational asthma has been found to be associated with lowered socio-economic outcomes, an increased unemployment rate and a decreased quality of life. The compensation of occupational diseases is comparatively favourable in Finland. Our aim was to follow-up the working status and life satisfaction of patients with diisocyanate-induced asthma in 245 cases diagnosed during 1976–1992. A questionnaire was sent out on average 10 (3–19) yr after the diagnosis to the surviving 235 patients. The questionnaire was validated by re-examining 91 of them clinically, and with spirometry, histamine challenge test and peak flow surveillance. Of the 213 responding patients, 14% were unemployed, and for 50% of them unemployment was caused by asthma. Unemployment was associated with nocturnal asthma symptoms (OR 10.93; CI 2.69–44.452), increased PEF variability (OR 8.46; CI 1.52–46.97) and with the use of short-acting β -sympathomimetic medication ($p=0.045$). Satisfaction with life was associated with present working (OR 3.50; CI 1.73–7.06) and with good condition of asthma as assessed by the use of asthma medication (OR 0.49; CI 0.27–0.89) and objective measurements of the asthma condition, e.g. PEF variability (OR 0.21; CI 0.08–0.59). As a conclusion, unemployment was remarkably low as compared with earlier reports and related to the period of simultaneous economic recession. Unemployment, as well as dissatisfaction with life were associated with poor conditions of asthma. Unemployment was associated with improper

asthma care favouring the use of short-acting β -sympathomimetic medication. Proper follow-up of asthma is essential for minimizing the social complaints of occupational asthma, as well as for enhancing life satisfaction.

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Diisocyanates, TDI (toluene diisocyanate), MDI (diphenylmethane diisocyanate) and HDI (hexamethylene diisocyanate) are the most common low-molecular-weight chemicals to cause asthma. The respiratory symptoms tend to persist for years, even after termination of diisocyanate exposure^{1–5}. In addition, professional downgrading, reduction of work-derived income^{9, 12, 13} and rather high unemployment figures of 25–39% in patients with diisocyanate-induced asthma have been reported^{6, 8–10}. In a study concerning asthma caused by western red cedar, the corresponding unemployment figure was 41%¹¹. The quality of life, as measured by total counts of quality of life, asthma symptoms, limitation of activities, emotional dysfunction and exposure to environmental stimuli, has been found to be significantly worse in patients with occupational than with non-occupational asthma¹⁴.

In several countries insufficient compensation praxis^{8–10} causes economic problems for patients with occupational asthma. By comparison, in Finland compensation of occupational diseases is rather favourable. Every case of occupational asthma is carefully examined, and cases accepted as occupational asthma will be compensated for asthma medication by the insurance companies. When a case of occupational asthma has been verified, avoidance of further exposure is recommended.

During 1976–1992, 245 cases of diisocyanate-induced asthma, caused by MDI, HDI or TDI were diagnosed at

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Table 1. The original occupations of the patients with diisocyanate-induced asthma

Car painters and car repairers	68 (28)
Workers producing or handling polyurethanes	55 (22)
Foremen, supervisors, engineers	20 (8)
Painters and pigment handlers, gluers etc.	30 (12)
Electricity, machine assemblers	17 (7)
Office workers	10 (4)
Carpenters	9 (4)
Welders and metal sheet workers	8 (3)
Cleaners	6 (2)
Textile, leather or shoe workers	15 (6)
Offset workers	3 (1)
Isolators	3 (1)
Electronic workers	2 (<1)
All	246 * (115)

* Some of the 213 responding patients have given 2 professions.

the Finnish Institute of Occupational Health. Our aim was to conduct a follow-up study of working status and life satisfaction of patients with diisocyanate-induced asthma. Since the clinical outcome of this material was published earlier¹⁵⁾, some repetition of the earlier published data, and the extension of some additional clinical points were unavoidable.

Patients and Methods

Patients and study design

All consecutive patients with diisocyanate-induced asthma diagnosed at FIOH in 1976–1992 were studied (245 patients; 192 men and 53 women) in 1995¹⁵⁾. Their mean age was 50.5 yr (SD 11.4 yr), and the mean duration of the follow-up was 10.4 yr (SD 4.41 yr); 60.5% were smokers, and 36% non-smokers; 114 (54%) were employed, and 32 (15%) had diisocyanate exposure in their present work.

The patients' original occupations are presented in Table 1. The greatest number belonged to the car painter and car repair occupations, 28%. Polyurethane producing work is included in several occupations, e.g. plastic workers, foundry workers, coating makers and element makers'. After being diagnosed with diisocyanate-induced asthma, the patients were advised to avoid further isocyanate exposure. 13 of the patients tried to continue working using respiratory protection¹⁵⁾. After diagnosis the following actions were taken: in 72 cases (30%) work in the original work place was continued without diisocyanate exposure (this may have presupposed change of work tasks), in 109 (44%) re-education, in 39 (16%) occupational pension, in 14 (6%) change of workplace, in 2 (1%) assessment of work capacity. The clinical status of the patients was followed up at FIOH at 12 months, after which the clinical surveillance was transferred elsewhere.

Questionnaire study

A questionnaire was sent to 235 patients with previously diagnosed diisocyanate-induced asthma, i.e. all those alive. The previously described questionnaire¹⁵⁾ queried the subject's present employment status, diisocyanate exposure, smoking habits, symptoms of asthma, use of asthma medication and satisfaction with life.

Clinical follow-up examinations

Two hundred and thirteen (91%) patients responded to the questionnaire and 167 patients (78%) answered as being ready for the control studies, if needed¹⁵⁾. One hundred and twenty-one patients were called for control examinations. All IgE-positive patients were called. IgE-negative patients with a positive bronchial provocation test were selected randomly. As a result, 52 patients with an immediate reaction and 62 with a late reaction in the specific inhalation challenge tests were selected. In addition, 7 IgE-positive patients were included whose diagnosis was based on peak expiratory flow variation. From all these 121 patients 91 responded¹⁵⁾. The clinical examinations comprised lung function studies including spirometry, bronchodilation test, histamine challenge, and diffusing capacity tests.

Lung function methods

The lung function methods, including spirometry and histamine challenge test¹⁶⁾, at the control visit were previously reported in detail earlier¹⁵⁾. Diurnal peak flow level was monitored every morning and afternoon during the two-week period.

Statistical methods

The association of the work situation, diisocyanate exposure, etc., with self reported symptoms and use of medication as well as lung function results were analyzed

Table 2. Employment status by age group according to the questionnaire in 1995 (N=213, those responding to the questionnaire)

Age (years)	Same employer	New employer	Re-educated	Changed occupation	Unemployed	Retired	Occupational pension [#]
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
< 30	1 (1)	4 (2)	3 (1)	3 (1)	1 (1)	0 (0)	0 (0)
31–50	17 (8)	72 (34)	57 (27)	77 (36)	17 (8)	18 (8)	9 (4)
> 51	10 (4)	24 (11)	18 (8)	27 (13)	14 (7)	69 (32)	28 (13)
All	28 (13)	100 (47)	73 (34)	107 (50)	29 (14)	87 (41)	37 (17) *

*To make figures comparable, percentages have been calculated from the total number of answers (213), although all questions were not completely answered, and there may be several answers by one patient. [#]Pension based on the disability caused by diisocyanates induced asthma.

Table 3. New occupations of 90 workers after the diagnosis of occupational asthma

Occupations	No. of patients with a new occupation	Re-educated (no.)	No. of unemployed of those re-educated (N=73)
Technician, mechanic, etc.	18	20	6
Real-estate personnel	12	7	1
Packing etc.	7		
Metal work, including welding	7	3	
Small-sized-industry	7	2	
Office worker	7	8	2
Builder	4		
Car or bus transport professions	4	7	2
Nursing or other social professions	5	6	1
Trade and sales	5	8	
Masseur	3	3	
Farmer	2		
Supervisor, education	4	4	1
Cook, baker etc.	2	1	1
Electronic worker	1		
Garden, animal care	1	11	
Designer	1	2	
All	90	73 (81%)	14 (19)

using logistic regression models. Odds ratios (OR) and their 95% confidence intervals (95% CI) were calculated. Dependent variables were working, re-education and employment parameters, and satisfaction with life. Independent variables were the self-reported clinical variables, as well as functional outcome parameters (spirometry finding, bronchial hyperreactivity and PEF variation). These analyses were adjusted for age in 1995, smoking as pack years, gender and atopy found in prick testing.

Results

Patients

The questionnaire was answered by 213 patients (91%). The follow-up time from the baseline studies to the

questionnaire ranged from 3.0 to 19.0 yr (mean 10.4 ± 4.4)¹⁵. The number of deceased patients prior to the questionnaire study was ten; one more died during the questionnaire phase. According to the Finnish cause of death register (Statistics Finland), the cause of death was asthma in one case, heart disease in 3, pneumonia in 4, lung aspergillosis in one and cancer in 2 cases. In three patients, cancer had been diagnosed, one in the kidney, one lingual cancer and one case with acute myeloplasic leukaemia.

Patients' working status

The patients' working status are presented in Table 2. At the time of the study, 93 (44%) were employed. The reason for being unemployed or retired, as reported by

Table 4. Self-reported clinical data and findings in the clinical control examination related to working conditions and satisfaction with life

Parameter	Working in the previous job after diagnosis (Yes, N=36; no N=94)	Unemployed (Yes=24, no, N=93)	Changed occupation (Yes, N=108; no, N=81)	Re-educated (Yes, N=73 no, N=118)	Satisfied with life (Yes, N=141, no, N=72)
Use of asthma medication for the past 12 months (Yes, N=134; no, N=69)	1.07; 0.37–3.09	5.52 1.63–18.65	0.88; 0.41–1.87	1.56; 0.77–3.18	0.45 0.23–0.89
Occurrence of asthma symptoms (Yes, N=166; no, N=33)	0.64 0.17–2.45	3.82 0.80–18.23	0.87 0.33–2.30	2.43 0.94–6.30	0.31 0.11–0.84
Occurrence of asthma symptoms during night (Yes, N=94; no, N=74)*	4.41 1.49–13.36	10.93 2.69–44.45	0.85 0.50–1.81	0.60 0.29–1.22	0.30 0.15–0.61
Spirometry finding abnormal (Yes, N= 43; no, N=42)*	2.71 0.38–19.28	4.36 0.93–20.54	0.73 0.24–2.20	0.64 0.24–1.72	1.13 0.42–3.06
Bronchial hyperreactivity present (Yes, N= 54; no, N=33)*	0.56 0.09–3.58	2.83 0.57–14.08	1.03 0.33–3.18	0.73 0.27–1.97	1.15 0.42–3.14
PEF variation increased (Yes, N=36; no, N=51)*	0.29 0.52–16.62	8.46 1.52–46.97	1.52 0.50–4.57	1.47 0.56–3.91	0.211 0.08–0.59
Asthma medication used at control visit (Yes, N=62; no N=25) *	2.01 0.19–21.23	6.54 0.75–57.20	2.30 0.72–7.32	1.16 0.39–3.44	0.69 0.24–2.03
Inhaled steroid used at control visit (Yes, N= 52; no N=34)*	6.56 0.64–67.39	3.68 0.67–20.29	1.54 0.52–4.63	1.00 0.37–2.69	0.48 0.17–1.35

The OR values have been corrected for age, smoking, sex and atopy. * information is based on the results in the control examinations (N=91), those without asterix are based on the questionnaire (N=213, but the total number varies, because not all answers were completed).

the patients, was related to their diisocyanate asthma in 92 cases (80%).

Thirty-six patients (28%) had continued in their original job for an average of 31 ± 34 months (range 2–108 months). At the control examinations (N=91), 30 (33%) reported isocyanate exposure after the diagnosis of occupational asthma, and only 6 patients (6.5%) remained at their original work place¹⁵⁾. Out of 213 patients, 107 (50%) had changed profession (Tables 2 and 3). A total of 73 had been re-educated (Table 3), which was paid for by insurance companies in 67 (93%) cases. Three (4%) patients had paid for the re-education themselves, and in 3 cases (4%) the payment was received from social insurance.

Those still working had fewer asthma symptoms, used less asthma medication and had less PEF variability than those unemployed (Table 4). Those who had continued in their original exposed work, had more nocturnal asthma symptoms than those who had changed job (OR 4.41; 1.49–13.36).

According to responses to the questionnaire, 24 (11%) of the subjects were unemployed and 5 (2%) were on an unemployment pension at the time of the query. Twelve

(50%) of the unemployed workers replied that asthma was the cause of unemployment. Of those unemployed, 16 had changed profession and 14 had been re-educated (Table 3). Unemployment associated significantly with the use of asthma medication and occurrence of nocturnal asthma symptoms (Table 4). Unemployed patients had increased PEF variability, and a tendency towards impairment of spirometry finding, and bronchial hyperreactivity (Table 4). In general, those unemployed used more asthma medication, especially short-acting β -sympathomimetic medication in the control examinations than those employed ($p=0.045$ in two-tailed Fisher's exact test). Unemployment was not associated with the duration of exposure to diisocyanates, age, atopy, the type of isocyanate, isocyanate-specific IgE production or reaction type in the specific challenge test in the year of diagnosis.

Medical follow-up

According to patient records, the recommendation for medical follow-up after confirmation of the occupational asthma diagnosis was the work place health service in 105 cases (43%), private care in 8 cases (3%), municipal health care centres in 30 cases (12%), hospital outpatient

Table 5. Nonspecific factors causing worsening of asthma in patients with diisocyanate-induced asthma. The response rate varied from 76 to 166 per question

Smoke	139 (84%)
Exhausts	138 (83%)
Odors	119 (75%)
Cold weather	117 (72%)
Exercise	118 (72%)
Dusts	103 (70%)
Tobacco smoke	108 (68%)
Stuffy nose	103 (67%)
Pollen	69 (47%)
Cleaning substances	69 (47%)
Dry weather	78 (54%)
Mental stress	61 (45%)
Animal dander	43 (33%)
Changes in temperature	40 (31%)
Wind or draft	38 (29%)
Warm weather	26 (21%)
Foods	20 (16%)
Alcohol	15 (12%)

clinics in 41 (17%), and was not mentioned in patient records in 60 cases (24%). In 1995, we found that these recommendations had not been fully realized. Forty-six (19%) patients had regular medical control of their asthma, and occasional controls had been carried out by an additional 108 (44%) patients. Medical surveillance was carried out by the work place health services in 30 cases (12%), private health care in 32 cases (13%), municipal health care centres in 78 cases (32%), and by hospital outpatient clinics in 14 cases (6%).

The occurrence of asthma symptoms and use of asthma medication according to the questionnaire were reported previously¹⁵⁾. In that report, it was revealed that 82% still suffered from asthma symptoms, and 66% were using asthma medication; 34% reported having discontinued asthma medication after the diagnosis of occupational asthma.

When the 91 patients came to the control examinations, short-acting β -sympathomimetic medication was used by 40 (44%), inhaled steroids by 27 (30%), long-acting β -sympathomimetics by 10 (11%), and theophyllamines by 8 (9%) patients. Based on the control examinations, the actual need for asthma medication was found to be distinctly greater: short-acting β -sympathomimetic medication was started in 56 cases (62%), inhaled steroids in 54 cases (60%), long-acting acting β -sympathomimetics in 24 cases (27%) and theophyllamines in 3 cases (3%).

Sixty-nine percent of patients suffered respiratory symptoms from pollen and 43% from animal dander (Table 5), although most symptoms were caused by non-specific stimuli.

Satisfaction with life situation

A majority of the patients, 141 (66%), were satisfied with their present life situation whereas 72 (34%) were unsatisfied (Table 4). The reason for not being satisfied was related to asthma or respiratory symptoms (41; 57%), unemployment (18; 25%), poor economic situation (9; 12.5%), low compensation (6; 8%), musculoskeletal problems (5; 7%), their new job (2; 3%), personal social problems (2; 3%), and other reasons (11; 15.2%). Some patients reported several reasons for dissatisfaction.

Satisfaction with one's life situation was strongly associated with present employment (OR 3.50; CI 1.73–7.06), but there was no association with change of profession or re-education. Satisfaction with life situation was associated with clinical parameters, i.e. those who were satisfied with life did not have asthma symptoms, did not use asthma medication, and had less PEF variation than those not satisfied with life (Table 4).

Discussion

The present material is comparatively large and reports a long follow-up of patients with diisocyanate-induced asthma. In the studies on socio-economic outcome, including analysis on working status, the follow-up periods have usually varied from 6–12 months^{8–10)} up to 4 yr^{5, 6)}, except in the work of Yassi⁷⁾ with a follow-up of about 10 yr, or in red cedar asthma with 7 yr of follow-up¹¹⁾. Ross and McDonald reported on 84 patients, otherwise the numbers of studies on the social aspects in diisocyanate-induced asthma have varied between 9–40 cases^{5, 7, 8–10, 17)}.

The percentage of those unemployed in this study was 14%, which is significantly lower than that which has been reported from other countries with unemployed figures varying from 25% to 41%^{8–11)}. The unemployment figure of 14% should be weighed against the high overall unemployment in Finland of 15.4% in 1995 (Finnish Labour Force Survey). In our study, the rate of unemployment in working-aged (<65 yr old) patients was 18.9%, which was somewhat higher than in the whole population in that year. Nevertheless, this is a surprisingly low percentage, because in the early 1990s Finland suffered from a severe economic recession.

The fairly low unemployment rate compared to other studies, is possibly related to the change of occupation and re-education, owing to the favourable compensation praxis and vocational rehabilitation of occupational diseases in Finland. The compensation system resembles that in Quebec¹⁸⁾. The most important forms of compensation include re-education with full salary, unemployment compensation for a reasonable time, pension, as well as compensation for disablement, which works as an incentive for coming forward with complaints. There is also a lower threshold to start re-education and to leave one's previous job, in contrast to the situation in other countries, where in part the compensation system

results in patients staying in their original work places¹²⁾.

A high number of patients (N=73) had been re-educated. The re-education is planned individually, based on the subject's talents, original level of education, age and possibilities for employment in his or her domicile. For the most part, re-education has been successful, considering the employment status, as well as the presence of asthma symptoms and use of medication, although, re-education of technicians or mechanics might be questionable. Six of those who were unemployed had been re-educated in these occupations. The work of technicians may be distributed widely within a plant, and exposure to some airway-irritating or sensitizing agents may be possible.

The present study indicated that most patients felt respiratory symptoms were caused by non-specific stimuli. Less than half of the patients felt symptoms resulted from pollen or animal dander, and according to skin prick testing, atopy was 29%¹⁵⁾. The results indicate possible negative effect of irritative factors in the working or home environment on patients' asthma, which should be taken into account in rehabilitation and re-education projects.

Stability of asthma seems to be important for employment status. There was a significant association between unemployment and the use of asthma medication, especially short-acting β -sympathomimetics, and the occurrence of nocturnal asthma symptoms, as well as the objective measurements of functional impairment of asthma. According to our clinical and functional studies in the present material¹⁵⁾, the use of inhaled short-acting β -sympathomimetics reflected irregular or old-fashioned treatment of asthma, rather than mild asthma. In addition, half of the patients felt that asthma was the cause of their unemployment. This indicates that a less stable asthma may have contributed to the unemployment status. The finding is in accordance to Gassert *et al.*¹⁹⁾ who found a high employment risk in severe asthma.

Our clinical and functional studies¹⁵⁾ showed clear deficiencies in the long-term medical surveillance of the patients. At control examinations, the need for anti-inflammatory treatment was registered in 60% of cases whereas only 30% had received such treatment. The undertreatment was not likely to have depended on economic reasons, as the costs of medication for occupational diseases is covered by insurance. The undertreatment may depend on cessation of regular control by the work place health service because of cessation of work or change of employer. The finding emphasizes the importance of regular control and adequate treatment as an essential part of rehabilitation.

Only a small number of patients, altogether 13%, were working for the same employer as before their occupational asthma diagnosis. This is less than in the study of Ross and McDonald⁶⁾, where about half in the two younger age groups, and 35% in the oldest age group

had continued working for the same employer as before the diagnosis. In that study, 40% had left their jobs after the diagnosis, and almost all had been unemployed for varying periods of time. Those who continued working in their previous jobs, involving continued diisocyanate exposure, had a poorer clinical outcome⁶⁾. In our study, those who had continued in the exposed work for some time (a not exactly defined period) after the occupational asthma diagnosis differed from the others in having significantly more nocturnal asthma symptoms.

The proportion of re-educated workers was large in our survey. The rehabilitation seems to have succeeded in the respect that only 6 (6.5%) reported having diisocyanate exposure in the present work. Their asthma condition was fairly good, though the exposure levels are not known. Although, this number of patients is too small for thorough analysis, surprisingly, the present diisocyanate exposure at the work place did not influence the self-reported or clinical parameters. This finding may reflect improved work hygiene and awareness of risks involved with the use of isocyanates at work places nowadays. A probable reflection of this has been the steep decline in new diisocyanate induced asthma cases in the last decade, with less than 5 new cases diagnosed yearly according to the Finnish Register of Occupational Diseases in 2000–2003, a phenomenon also reported in some other countries²⁰⁾.

In the planning of the study, the main focus was on clinical issues, as reported previously¹⁵⁾. To ensure maximum compliance, the questions on life quality were reduced to the essentials. The strongest reason for satisfaction with one's life situation was present employment. We did not find any earlier studies on the association of quality of life and employment in the literature. The next most important reason for satisfaction was the clinical condition of asthma. Our patients using asthma medication, and those whose asthma was unstable as verified in the function tests were less content than those with stable asthma. The latter result is in accordance with the study of Malo *et al.*¹⁴⁾, where those who were using inhaled anti-inflammatory agents had a significantly less satisfactory quality of life as compared with those receiving bronchodilators only or no medication.

In conclusion, the present study showed a rather low unemployment rate in patients with diisocyanate-induced asthma in our country compared to earlier publications. In a majority of cases the continuance in working life was possible. The most likely explanation for this is possibly the comprehensive Finnish statutory schemes of compensation, as well as the vocational rehabilitation of the occupational asthma cases diagnosed based on strict clinical and functional criteria. Both the continuance in working life as well as satisfaction with the general life situation was strongly dependent on the stability of asthma.

Nevertheless, there is still need for improvements, e.g.

unemployment was slightly higher than the mean unemployment level of the country, and there was unemployment even among those who had been re-educated. In addition, patients with respiratory symptoms associated with occupation, but without functional findings leading to an asthma diagnosis may in our country remain in continuing exposure as well as being denied compensation and medical follow-up. Compensation for an occupational disease also has problems, and comprehensive compensation is always an expensive decision. Reported experiences and comparisons with other countries may possibly help to develop more effective compensation systems to ensure medical treatment and to prevent social problems associated with occupational diseases. In working life, the clinical stability of asthma, as well as asthma medication are essential. It is also important to ensure regular medical surveillance of the asthma condition. This responsibility should not be left to the patient's initiative, and compensation for occupational diseases should cover arrangements for asthma follow-up.

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