A Prospective Study of Work Perceptions and Psychosocial Factors Affecting the Report of Back Injury

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A longitudinal, prospective study was conducted on 3,020 aircraft employees to identify risk factors for reporting acute back pain at work. The premorbid data included individual physical, psychosocial, and workplace factors. During slightly more than 4 years of follow-up, 279 subjects reported back problems. Other than a history of current or recent back problems, the factors found to be most predictive of subsequent reports in a multivariate model were work perceptions and certain psychosocial responses identified on the Minnesota Multiphasic Personality Inventory (MMPI). Subjects who stated that they "hardly ever" enjoyed their job tasks were 2.5 times more likely to report a back injury ($P = 0.0001$) than subjects who "almost always" enjoyed their job tasks. The quintile of subjects scoring highest on Scale-3 (Hy) of the MMPI were 2.0 times more likely to report a back injury ($P = 0.0001$) than subjects with the lowest scores. The multivariate model, including job task enjoyment, MMPI Scale-3, and history of back treatment, revealed that subjects in the highest risk group had 3.3 times the number of reports in the lowest risk group. These findings emphasize the importance of adopting a broader approach to the multifaceted problem of back complaints in industry and help explain why past prevention efforts focusing on purely physical factors have been unsuccessful. [Key words: back injuries, industrial injuries, workplace injuries, psychosocial factors]

BACK DISORDERS, commonly described as back injuries, are one of the most expensive health care problems for the industrialized nations of the world and are by far the single most expensive musculoskeletal malady.[19,26,29,41] An injury model alone does not explain the commonly used term "industrial back problem." The majority of those who file back-injury claims are unable clearly to describe an associated incident or injury,[45] and it seems that only a small percentage of those who report back problems when surveyed actually file back-injury claims.[28,37–39,46] Nearly 85% of individuals recall back symptoms by the time they are 50 years of age.[2,3,24,40,44] Because back problems most commonly occur during the most productive years of life, great attention has been given to the prevention and treatment of back injury among industrial workers.[1,33]

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Our earlier retrospective evaluation of the injury reports of 31,200 Boeing Company blue-collar employees during a 15-month period suggested the importance of nonphysical factors in industrial back-injury claims.[11] We have published data from our subsequent prospective study examining the relationship between physical factors, such as isometric lifting strength, flexibility, and cardiovascular fitness, and the report of acute back problems among industrial workers.[4–6]

This article discusses the factors found by our data analysis to have the strongest relationship to incidence of back-injury claims: work perceptions and certain psychological measures from the Minnesota Multiphasic Personality Inventory (MMPI). The purpose of this article is neither to propose pre-employment screening tools for the report of back-injury claims nor to describe specific back disorders in relation to the potential risk factors studied. Rather, it is prospectively to evaluate factors associated with work-related back-injury complaints.

METHODS

In a Boeing Company factory in western Washington, 3,020 hourly employees volunteered to participate in a longitudinal, prospective study of risk factors for back problems. Participation was open to all employees receiving hourly wages. Approximately 75% of those solicited volunteered. The subjects were 21–67 years of age, and 78% were men. Part of the volunteer agreement between the research team, labor, and management, was that those solicited would not be singled out if they did not volunteer. This provision limited our ability to track employees who did not volunteer.

We investigated the relationship between back problems reported among workers in this industrial setting and physical, psychosocial, and workplace factors. After volunteering for the study, each subject completed a cardiovascular-risk questionnaire, which was followed by an examination to assess physical attributes, such as lifting strength, flexibility, aerobic capacity, spinal canal size according to B-scan ultrasonography, and anthropometric measures, such as height and weight.

At the time of the physical examination, each subject was asked to complete demographic and psychosocial questionnaires. To ensure subject safety during physical testing, screening was performed for current health problems. Subjects were excluded from strength testing if current back symptoms were present at the time of testing or had caused them to miss work in the previous 6 months. Subjects were questioned, either at the time of their physical examination or on a take-home questionnaire, about their medical history: previous back discomfort or problems, type of treatment (ie, operative versus nonoperative), and previous back-injury claims in the prior 10 years. Subjects were observed, while working at the Boeing Company, for an average of approximately 3 years from the time of examination at entry into the study. Back problems were identified through three separate and parallel tracking systems. Notification occurred through a variety of mechanisms: reporting to the company medical department or filing an incident report or industrial insurance claim, including those initiated through an employee's visit to his or her personal physician. This study

did not investigate the actual presence of back symptoms or specific back disorders.

Fifty-four percent of all study volunteers returned completed take-home questionnaires. The MMPI was used to assess traits that have been associated clinically with back disability and chronic pain. The questionnaire consisted of 566 true–false questions; the results were divided into 10 clinical scales, several validity scales, and one scale for low-back pain.[15,22] MMPI responses were collated into scale scores. Each scale was originally intended to represent a "personality trait," greater scale elevations ordinarily implying more of some characteristic and lower scores implying less (Table 1).

A measure of the family support system was obtained by the use of the family APGAR, a brief, six-item family function questionnaire.[21,36] A modified work APGAR, which evolved from the family APGAR through the efforts of Smilkstein[21] and Margaretta Nordin (Personal communication, Hospital for Joint Diseases, Orthopaedic Institute, New York, New York, 1988), was used to examine the perceptions of support at the workplace. The original work APGAR was based on the hypothesis that the components of interpersonal relationships at the workplace are similar to those of the family (Figure 1).[18] The work APGAR was modified based on findings from the retrospective analysis of the Boeing company work force.[11]

The health locus of control (HLOC) also was evaluated as a possible predictor of back-pain reports.[47] It purports to measure a person's expectations regarding the locus of control of physical health and well-being.[47] In addition, demographic information, such as education, marital status, and work history was collected. Most of the demographic and psychosocial information was obtained from the take-home questionnaires. Fifty-four percent (1,569/3,020) of all volunteers completed their questionnaires.

Analyses involving the work APGAR and MMPI are based on data from these employees. Back injuries were reported by 136 (8.7%) of the 1,569 who completed packets. Of the 1,451 who did not complete their modified work APGAR and MMPI packet, 143 (9.9%) reported back injuries. The difference in the injury rates (9.9% versus 8.7%) between the two groups was not statistically significant ($P = 0.05$).

To assess the effect of the physical aspects of the workplace, all job types that employed more than 19 workers were analyzed for heavy and tiring tasks in terms of maximal loads on the spine based on a biomechanic mathematic model.[35] Perceived physical exertion as a possible risk factor for back pain complaints among industrial workers was also studied.[12,13]

During the more than 4-year follow-up period, which began at the time of premorbid data collection, 279 of the subjects reported having back problems. The average follow-up period per subject was approximately 3 years because of the 15-month period during which volunteers entered into the study and occurrences such as transfers and job terminations. The potential follow-up period ranged from 1 day to a maximum of 4¼ years.

Table 1. Minnesota Multiphasic Personality Inventory (MMPI): Overview of Clinical Scales

1. HS (Hypochondriasis): concern about health and somatic functioning
2. D (Depression): morale, moodiness and feelings of hopelessness and sorrow
3. Hy (Hysteria): tendencies toward somatic complaints or denial of emotional distress
4. Pd (Anti-social): reflects impulsivity, low frustration tolerance, poor social adjustment, and anger
5. Mf (maculinity-femininity): identification with the stereotyped masculine or feminine role
6. Pa (Paranoia): elevation suggests paranoid characteristics; the absence of elevation does not preclude the presence of these characteristics
7. Pt (Psychasthenia): anxiety, low self-confidence, low self-esteem, excessive sensitivity, and moodiness
8. Sc (Schizophrenia): disorganized thinking, feeling of alienation, isolation or social withdrawal, and general anxiety
9. Ma (Hypomania): reflects expansiveness, energy level, and activity level
10. Si (Social introversion): discomfort in interpersonal relations
11. LBP (Low back pain): restlessness and denial of anger

Source: Fordyce (1979), Graham (1987), Lachar (1974).

	Almost always	Some of the time	Hardly ever
1) I am satisfied that I can turn to a fellow worker for help when something is troubling me.			
2) I am satisfied with the way my fellow workers talk things over with me and share problems with me.			
3) I am satisfied that my fellow workers accept and support my new ideas or thoughts.			
4) I am satisfied with the way my fellow workers respond to my emotions, such as anger, sorrow, or laughter.			
5) I am satisfied with the way my fellow workers and I share time together.			
* 6) I enjoy the tasks involved in my job.			
* 7) Please check the column that indicates how well you get along with your closest or immediate supervisor			

Fig 1. Modified Work APGAR. The Work APGAR was modified for use in this study with the addition of items 6 and 7.

Data Analysis. The reports of an acute back injury occurred at different times from the participants' enrollment in the study. Thus, the methods of the time to failure analysis (sometimes called survival analysis) were used.[25] The methods include the product limit, or Kaplan–Meier curves, and the Cox proportional hazards regression model. The product limit curves show the percentage of subjects who have not experienced the event in question during the follow-up period. The Cox proportional hazards regression model is a statistical model that expresses the risk of having an event in terms of a number of predictor variables. The Cox proportional hazard model also supplies an instantaneous relative risk associated with each variable in the model. The relative risk is the ratio of the estimated predictability of an event over a short time interval for those subjects with the variable of interest. The relative risk is adjusted for other variables in the model. (Models using more than one variable are called multivariate models; those with one variable are univariate models.) A subject was at risk of reporting an acute industrial back injury only during the time the subject was working. Thus, the exposure time for the subjects did not include time during layoffs, or time from termination of employment.

The potential predictor variables were first evaluated univariately. Discrete variables were evaluated by the use of the product limit curves; continuous variables were evaluated by the use of the Cox proportional hazards model.

Because more than one factor influenced the occurrence of a report of an acute back injury, it was desirable to construct simple, or parsimonious, models with as few variables as possible that explain the proportional hazards regression model. The step-up, stepwise proportional hazards regression was used. At the first step, the regression model selects the variable with the most predictive power (ie, the smallest P value). For the remaining variables, the P value for the ability to give additional predictive information beyond that supplied by the first variable selected is computed for each variable. Then the variable with the smallest of these P values is added to the model. Variables continue to be added until all the variables out of the model have a P value of 0.05 or greater; that is, the variables not in the model do not add statistically significant predictive power to the variables already in the model.

The predictive power of the Cox models was assessed by product limit plots as follows. The model predicts survival as a function of a linear combination of the predictor variables. The subjects who reported an acute back injury were divided into 5 groups of equal numbers of subjects going from lowest risk to highest risk. The divisions for these quintiles of risk were used to define five subgroups of all the subjects. Product limit plots of these quintiles of subjects allow visual assessment of the predictive power of the model.

This prospective study evaluated 37 possible variables to assess the predictive power of work perceptions and psychosocial factors. The question regarding the history of back injury raised the total potential predictive variables to 38. When many variables are simultaneously examined, the nominal P values for each variable can be misleading because there are so many opportunities to err. This is called the multiple comparison problem. We used a conservative approach, the Bonferroni inequality,[31] and declared variables univariately statistically significant only if $P < 0.05/38 = 0.00132$. Because there are numerous intercorrelations between variables, including MMPI scales, the chances of errors of inference are not as severe as the Bonferroni inequality would imply. Thus, variables for which $P < 0.05 > 0.00132$ will be considered of borderline statistical significance. Moreover, the results discussed here will focus on those variables contributing to the multivariate model.

RESULTS

In univariate analysis, those reporting back problems tended to be younger than those not reporting problems. Age did not enter into the multivariate model. Thirty-nine percent had a history of prior back treatment (46 subjects had previous back surgery). No differences were found between those reporting and not reporting acute back injury according to gender, work conditions, and other demographic variables. Current back symptoms at the time of premorbid testing, or those causing work loss in the prior 6 months, had the strongest relationship to the report of future acute back problem complaints (univariate $P < 0.0001$) (Table 2).

Other than current back problems at the time of testing, several of the variables were clearly related to the report of back problems after multiple comparisons were taken into account (ie, $P < 0.00132$) (Table 3). The questions ranked in importance by their P value were modified work APGAR "enjoy job tasks" and "can communicate with peers;" MMPI Scale 4, modified work APGAR "response of peers to emotion;" and history of previous back treatment. Variables of borderline statistical significance ($P < 0.005$) included MMPI Scale 3, modified work APGAR "time shared with peers" and MMPI Scale 8. Multivariate analysis of only the MMPI scales found Scale 3 to have the strongest relationship to the report of acute back problems.

Among subjects with a history of prior back treatment, 28.2% had reported an acute industrial back problem during the following 36 months of exposure as compared with only 15.4% of those without a previous history of back treatment (Figure 2). The relationships of back-injury reports to Scale 3 of the MMPI and the modified work APGAR are graphically displayed in Figures 3 and 4. These factors were chosen based on the results of the multivariate analysis of modified work APGAR and MMPI scales and history of previous back treatment (Table 4). Quintiles were determined by multivariate Cox regression modeling, and the combined effects of back pain history, MMPI scale 3 (Hysteria) score, and job task enjoyment for the modified work APGAR were taken into account.

Table 2. General Description of Subjects With Complete Psychosocial and Workplace Perception Data

Variable	Number of Subjects	Percentage of Subjects
Gender		
Female	416	26
Male	1197	74
Marital status		
Single, never married	127	8
Married, live together	1071	68
Married, live apart	47	3
Divorced, live alone	125	8
Widowed, live alone	22	1
Single, widow, and live with another individual	193	12
Prior history of treated Back Injury		
Yes	613	39
No	968	61
Highest level of education		
Grade school	35	2
High school or GED	761	47
Business or trade school	190	12
Community college or university	612	38
Graduate or professional school	15	1

Table 3. Univariate Analysis of Workplace Perception and Psychosocial Factors

Variable	P Value
MMPI scales	
MMPI (L-Validity scale)	0.2728+
MMPI (F-Validity scale)	0.0060+
MMPI (K-Validity scale)	0.3803+
MMPI (Hs) Scale 1	0.0139+
MMPI (D) Scale 2	0.2018+
MMPI (Hy) Scale 3	0.0014+
MMPI (PD) Scale 4	0.0008+
MMPI (mf) Scale 5	0.9275+
MMPI (Ps) Scale 6	0.0973+
MMPI (Pa) Scale 7	0.0178+
MMPI (Sc) Scale 8	0.0045+
MMPI (Ma) Scale 9	0.0868+
MMPI (Si) Scale 10	0.2882−
MMPI (low back scale)	0.0118+
Modified work APGAR	
Can turn to fellow workers	0.0012−
Can communicate with peer	0.0001−
By support/acceptance by peers	0.0118−
By response of peers to emotions	0.0010−
By way shares time with peers	0.0035−
Enjoy job tasks	0.0001−
Get along with supervisor	0.0336−
Family APGAR	
Can turn to family for help	0.5733+
With family communication	0.3891−
With family acceptance and support	0.8356−
With expression and response of emotions	0.3247−
With family time shared	0.6910−
Health locus of control	0.2583−

The +(−) sign following P value denotes the direction of the response.

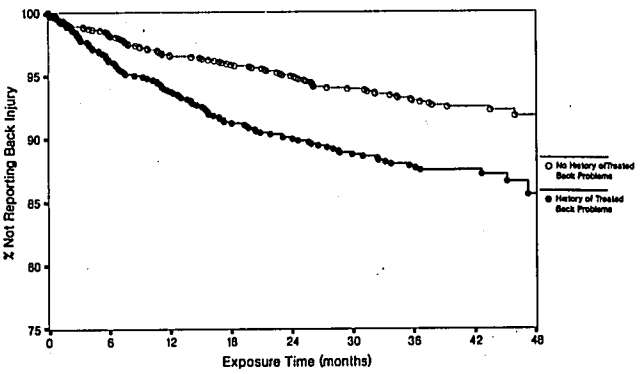

Fig 2. History of treated back problems versus subsequent back injury reports. This graph compares the percentage of subjects reporting subsequent back problems in those with and without a history of previously treated back problems. A steeper slope represents higher back injury reporting.

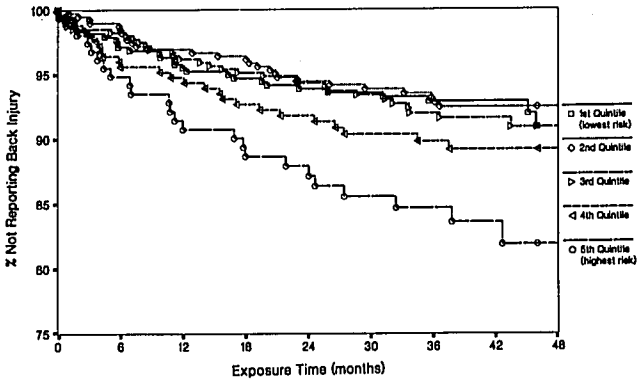

Fig 3. MMPI Scale 3 versus subsequent back injury reports. This graph displays the percentage of subjects reporting back problems over the follow-up period within each quintile of MMPI Scale 3 (Hysteria) scores. MMPI Scale 3 quintiles were established such that approximately the same number of injury reports are in each quintile. The highest Scale 3 score represented the highest risk.

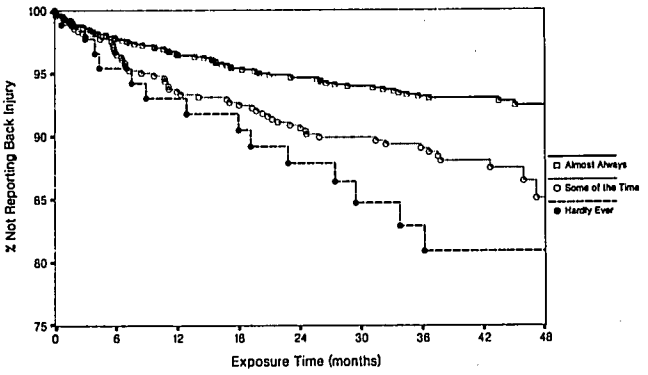

Fig 4. Work APGAR (enjoy job) versus subsequent back injury reports. This graph compares the percentage of subjects reporting subsequent back problems depending upon their response to the Modified Work APGAR statement, "I enjoy the tasks involved in my job." A steeper slope represents higher back injury reporting. Subjects who "hardly ever" enjoyed their job tasks were at highest risk.

All risk quintiles had a substantial percentage of subjects reporting an acute back problem during the follow-up period according to the multivariate Cox regression modeling. There was, however, a step gradient with quintiles 1 and 2, comprising 63.6% of the subjects (Figure 5). These quintiles had a combined 5.5% probability of reporting an acute back problem within 3 years compared to the higher 18.6% risk in the top two quintiles, which comprised only 9.1% of the employees.

DISCUSSION

Three previous prospective studies described risk factors specific for the report of back problems. Cady et al[16,17] followed approximately 1,600 fire fighters in southern California for 3 years. Biering-Sorensøn conducted a 1-year study of back trouble in approximately 900 people near Copenhagen, Denmark.[8,9] In another study, Troup et al[42] observed 2,891 British workers for 1 year. In all three studies, the subjects were evaluated primarily for physical factors and observed for a period of time for report of back pain. In a later study, Troup et al[42] found that a history of previous back problems was the strongest risk factor, enhancing the predictive ability of other variables. That study found

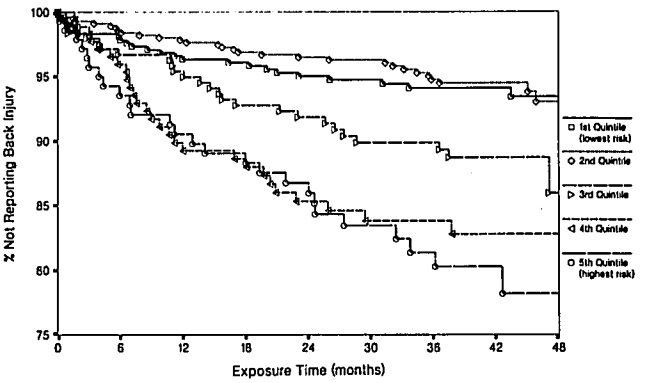

Fig 5. History of treated back problems, MMPI Scale 3, and Work APGAR (enjoy job) versus subsequent back injury reports. The quintiles in this graph were determined by multivariate Cox regression modeling and take into account the combined effects of back pain history, MMPI Scale 3 (Hysteria) score, and response to the job task enjoyment question on the Work APGAR (modified). Subjects in the highest risk quintiles were more likely to have had a history of back problems, scored high on MMPI Scale 3, and responded negatively regarding job task enjoyment.

Table 4. Predicting Acute Back Injury Reports* (P Value Entries)

Variable	*Univariate Analysis*	*Multivariate Analysis (in final model)*	*Relative Risk*	*(95% Confidence Interval)*
Entire population (n = 1326, Inj = 117)†				
Enjoy job (Modified Work APGAR)‡	0.0001	0.0001	1.70	(1.31, 2.21)
Scale 3 (MMPI)§	0.0003	0.0032	1.37	(1.11, 1.68)
Prior back pain‡	0.0010	0.0050	1.70	(1.17, 2.46)
Those with a history of prior back injury (n = 518, Inj = 63)				
Enjoy job (Modified Work APGAR)‡	0.0003	0.0006	1.85	(1.30, 2.62)
Scale 3 (MMPI)§	0.0195	0.0286	1.34	(1.17, 1.54)
Those without a history of prior back injury (n = 808, Inj = 54)				
Enjoy job (Modified Work APGAR)‡	0.0220	0.0353	1.53	(1.09, 2.29)
Scale 3 (MMPI)§	0.0334	0.0475	1.41	(1.19, 1.68)

*Using the Cox Proportional Hazards Regression Model.
†Only subjects with complete information on the Modified Work APGAR, MMPI, and history of back problems were included in these analyses. Inj = the number of subjects reporting back injuries.
‡For an increase of 1 unit.
§For an increase of 10 units.

perceived physical capacities more important than directly measured capacities in predicting back problems among industrial workers.

Our findings also indicate that previous history of back problems strongly affects the report of subsequent back pain. The recurrence of symptoms is a common aspect of the natural history of back problems,[7,9,10,32,42,43,45] and the term *re-injury* is probably a misnomer.

Other than current back problems at testing, the modified work APGAR score and the individual items measured (eg, hardly ever enjoy job tasks) had the strongest influence of all the physical and nonphysical variables analyzed on the report of acute back injury. This predictive power held true even when controlling for sex and previous history of back problems.

The MMPI was second to the modified work APGAR in predicting the report of back injury in our working subjects. The health locus of control and family APGAR did not significantly predict the report of back pain.

This study is the first to evaluate the MMPI premorbidly as a predictor of acute back pain. The MMPI has been used extensively in relation to clinical pain.[14,20,30,34] It is considered a potentially useful index for selective aspects of behavior (eg, readiness to report or deny emotional distress, body complaints, energy/lethargy, and balance of order/confusion). Most experts consider the labels for the scales such as Hypochondriasis, Depression, Hysteria, etc., to be antiquated and not dependable as a diagnostic or clinical label.[14,15,22,23,27]

Overall, the MMPI scale score elevations found in this study are less than those found in patients with chronic pain.[14,30] As expected, our working population yielded mean MMPI scale elevations close to those of general populations. However, univariate analysis showed significant predictive power for Scale 3 (HY), Scale 4 (PD), Scale 8 (SC), and the LBP Scale (low-back pain) between those who ultimately reported acute industrial back problems and those who did not (Table 3).

Individually, both the modified work APGAR and the MMPI showed strong predictive strength, especially in subjects with a previous history of back treatment. It is important to note that the 89 subjects who reported not enjoying their job on the modified work APGAR, or the 157 making up the highest quintile Scale 3 of the MMPI, had work tasks and conditions comparable to the remainder of the 1,569 volunteers. This finding suggests that failing to enjoy one's job, and whatever personal and social unhappiness go into an elevated Scale 3 on the MMPI, are not simply a function of the type of job a person holds.

This study was done in a diverse, highly sophisticated manufacturing industry where job tasks do not tend to be extremely stressful for the back. Yet the back-injury claim rate seemed to be similar to that of other American industries where back stresses are considered to be higher.[10,11]

Individuals with very serious back limitations, or those with minor limitations in extremely physically demanding jobs, might be expected to report back pain at work. These data suggest, however, that in jobs of less extreme physical demands, such as was frequently the case in our study group, nonphysical factors may well affect the report of less serious episodes of back pain discomfort. The expected episode of back pain, admitted to by 50% of people in the working age group, may be the crucial added burden that results in the reporting of back injury in those who already perceive themselves as distressed (elevated MMPI scores). A job that is perceived to be a burden, unenjoyable, unfulfilling, and providing few assets may strongly influence the readiness to report a back problem. Possibly, persons who enjoy their jobs or are in less emotional distress underreport back injury, or persons who enjoy their jobs less or are in greater emotional distress overreport. In either case, however, the central finding remains: report of back injury is an event that may be influenced by a complex set of factors that cannot be understood solely in terms of biomechanic or ergonomic considerations. Perhaps normally expected back pain is the final straw that breaks the already burdened camel's back.

The results of this study may not apply as strongly to cases of severe symptoms, or in work situations involving heavy job requirements, but they at least indicate that other factors can influence the readiness to file a back-injury claim when symptoms or job demands are less extreme. Such claims filing would appear to involve factors other than simply the presence of back symptoms because nearly 50% of individuals in the general population cite such problems each year, whereas only 2–5% file claims.[9,37,38,42,46] It must be remembered that only 9.4% of the employees studied reported hardly ever enjoying their job on the work APGAR or a significantly elevated (ie, T-score of 70 or more) Scale 3 on the MMPI. Of those who did, most did not have a back-injury claim. Thus, although these measures show a statistically reliable relationship to the criterion of back-injury claim, the effect is not sufficiently powerful to permit the use of these measures for pre-employment screening. The results reported here also show that reporting a back-injury is not a simple event: It is subject to the influence of a number of factors.

We conclude that the statistically significant, though clinically modest, predictive power of work perceptions and psychosocial factors for reports of acute back pain among industrial workers argues against the exclusive use of an injury model to explain such problems. That such a psychometrically simple-minded device as the modified work APGAR could yield such significant predictive validity suggests that the parameters it addresses are probably of great importance. It is reasonable to expect that future studies using more sophisticated measures of "job satisfaction," and related parameters, may yield yet greater predictive power.

Study of the relative contributions of many physical and nonphysical variables show that evaluations of back problems in industry that exclude these highly significant work perception and psychosocial variables are of limited value. Simple, unidimensional approaches that ignore the effect of work perceptions and psychological factors on back-injury reporting oversimplify a multifaceted problem.

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