REVIEW ARTICLE

BACKS TOOL: A STUDY IN IDENTIFYING ASSOCIATED FACTORS OF OCCUPATIONAL CHRONIC LOW BACK PAIN IN A DEVELOPING COUNTRY

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ABSTRACT

In the absence of objective definition of work- relatedness; decision- making processes, assessments, investigations, treatment and rehabilitation on chronic back pain due to work had been challenging. BACKS questionnaire was designed to assist physicians in determining occupational low back pain among employees from the aspect of reliability and validity. Each identified employee with history of chronic back pain was given chronic back pain was given the BACKS Tool prototype to be filled in. Data was analyzed via stepwise linear regression to develop a temporary model for the BACKS Tool questionnaire. A total 220 respondents were included in the study. Among the associated factors of chronic occupational back pain were physical demand, psychological demand, colleagues who complain of similar back pain, job task involved in twisting for more than 20°, age of the employees and Pain Score that was reported by the respective employees. The regression reported sensitivity of 90.9% and specificity of 95.5%. In search of determining work-relatedness among employees with occupational back pain versus those due to aging, a screening tool had to be developed to assist in providing scientific assessments that would improve employee satisfaction during educational promotion and counseling.

KEYWORDS: *Chronic, back pain, occupational, work- related, regression*

INTRODUCTION

Occupational musculoskeletal pain has been mind boggling for many physicians. The diagnosis **of** musculoskeletal diseases alone is relatively much simpler based on history, physical examination and investigative tools such as radiographs which could be done intra- operatively via ultrasound, computerized tomographic (CT) scan and the magnetic resonance imaging (IMR). Suffice to say, there is actually limited orthopaedic anomalies that is unknown. Now, the challenge is on the period proximity of achieving the diagnosis, the skills of the surgeon and the rehabilitation period to achieve optimal recovery.

These periods and rehabilitation outcomes could be measured in terms of sickness absence from work, lost working days, medicals cost as well as benefits awarded during the recovery process. For example, the United States spent USD 509.30 million in 2006 to USD 516.50 million in 2007 on employees with low back pain.[1] The Social Security Organization of Malaysia on the other hand is heavily concentrated on safety issues at work including commuting accidents. Nevertheless, low back pain is the **second most common benefit being awarded among** health illnesses due to work.[2]

From the occupational **physician's** point of view, the question is of whether an employee with chronic back pain is due to work (occupational) or not. Occupational back pain confirmation had been challenging as one (60%- 80% of individuals) would have experience at least one episode of back pain at some stages of their lives.[3,4,5,6] To date, there has yet to be an agreed consensus or criteria to define work- relatedness.[6,7] These guidelines or criteria are important to assist in work-relatedness determinants.

In the absence of objective definitions, the dilemma had significant impact on our decision-making process, assessment, investigations, treatment and rehabilitation on disabling chronic back pain.[4,7,8,9,10] Such challenges co- existed even among developed countries.[2,11] During this past decade, a guideline in the form of work-relatedness criteria was developed in Netherlands[12] which was also validated qualitatively among experts[13]from the respective country. Therefore, a similar quantitative assessment is needed in a developing country such as Malaysia.

The best approach in determining work-relatedness would still be according to the standards issued by the National Institute of Occupational Safety and Health/ American College

of Occupational and Environmental Medicine.[14] With regards to low back pain that has multi-factorial variables (occupational and non-occupational factors) that influences the evaluation and conclusion of work- relatedness. With so much confounding factors, it would be best if these factors served as apportionments to establish an objective work- relatedness conclusion.[15,16]

On the matter at hand, a Back Apparatus: a Collaborative effort between the Malaysian National University Medical Centre (UKMMC) and Social Security Organization (SOCSO) (BACKS) Tool was designed to assist physicians in determining occupational low back pain among employees in a developing country such as Malaysia. Therefore, the study not only aims to strengthen the factors but to develop a reliable and valid screening tool in determining occupational back pain. Variables such as ergonomic- related factors, work organization factors, employee's psychosocial factors at work, individual characteristics, and health lifestyles will be determined whether they are associated with occupational disabling low back pain.

MATERIAL AND METHODS

This cross- sectional study was carried out from January to June 2012. The respondents were claimants **who** had submitted their application to Social Security Organization (SOCSO) for episodes of low back pain. All respondents that fulfilled the study criteria based on the 2011 SOCSO back injuries registry were identified. Each identified employee with history of chronic back pain was given the BACKS Tool prototype to be filled by the identified workers.

The Medical Board decisions were used to stratify the respondents into occupational and non-occupational groups. The registry of the spinal related injuries or claims were identified, accessed and patients medical records such as working or houses addresses as well as contact numbers were recorded. Cases were traced via the Appellate Medical Board Team, Medical and Rehabilitation Unit of the SOCSO Headquarters. The interview and assessments were conducted after the Medical Boards were conducted in the various government hospitals around the country.

Study Criteria

Based on factor analysis as recommended by van De Vijver,[17] a total 210 respondents have to be identified to fulfil the 41 questions designed on the BACKS Tool prototype based on the possible factors that would suggest chronic occupational back pain among the identified employees. Besides the decisions made by the Medical Board or with a minimum of Temporary Disablement as defined under the Malaysian Employees' Social Security Act 1969 (Act 4) Revised 2009[18]and the SOCSO guidelines,[19] the outcome of work- relatedness in the Kuiper questionnaire[9]was also recorded. The BACKS prototype has 2 sections; work- relatedness and the adapted Oswestry Disability Questionnaire (ODQ). The questions on the first section consisted of responds in the form of Likert scores.

Workers that were aged between 20- 60 years old with history of chronic or recurrent low back pain and submitted medical benefits and compensation from SOCSO in 2011 without major changes of their environment and psychological exposure at work for the past year were included in this study. Any changes in the working environment, job task, new diagnosis, claims for more than 3 years[19] or new SOCSO registration numbers were considered as separate claims or respondents. Specifically, workers who experienced sharp back pain prior to a fall at workplace were included into the study. A significant chronic back pain is defined as chronic history of low back pain >12 weeks in the past year, Pains Scale above 0.20 unit **and Oswestry Disability Questionnaire (ODQ) to be above 20.0%.**

Pregnant workers, workers with pyogenic back conditions, back pain related to cancer on current treatment or back injuries due to acute accidents or commuting injuries at work were excluded from this study. For example, back pain due to a fall from height such as from a vehicle, stairway or fall on flat surface of the rest room was excluded from the study. The data analysis with linear regression and multivariate analysis were performed via Statistical Package for Social Science (SPSS) Version 18.0. Once the data was collected, **various analyses** were used to develop a temporary model for the BACKS Tool questionnaire. From there, a predictive model **via regression analysis** of work- relatedness of chronic back pain was developed as stated below (example);

$$Y= \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \ldots\ldots + \beta_n x_n$$

Whereby Y= predictive outcome
x= variables
n= number of variables
β= constant
β_0= outcome intercept

For the regression to be accepted, the following assumptions have to be fulfilled;

a) Absence of outliers
b) Satisfactory level of independence
c) Residuals were normally distributed
d) Variance constance
e) Acceptable or similar levels of linear **collinearity**

Summarized from Chan.[20]

RESULTS

A total 1132 cases with back- related injuries and infirmities were reported to SOCSO in 2011. 350(30.90%) respondents fulfilled the study criteria outlined. 110 (31.43%) respondents declined from participating the study while 20 (5.71%) respondents did not complete the given BACKS questionnaire. Table 1 described the socio-demographic among the 220 (62.86%) respondents that participated in the study. The majority of the respondents were males (79.09%), Malays (57.73%), married individuals (89.55%) with secondary level of education (62.30%) who worked as factory operators (23.65%) and diagnosed with prolapsed intervertebral disc (43.65%). Table 2 showed that the Likert scores of various anthrometry& assesement scores, socio- demographic, health behaviours and workplace factors were associated with occupational chronic disabling back pain via univariate analysis. Table 3 showed multivariate analysis using stepwise linear regression analysis that demonstrated associations between occupational back pain with high physical demands, among colleagues with similar pain, twisting activities at >20°, high Visual Analog Scale, low psychological demands and among young employees. A statistical relationship was established using stepwise regressiona analysis as below;

$Y= \beta_0 + \beta_1x_1 + \beta_2x_2 + \beta_3x_3 + \beta_4x_4 + \beta_5x_5 + ... + \beta_nx_n$

Whereby Y= predictive outcome
x= variables
n= number of variables
β= constant
β_0= outcome intercept

Work- relatedness ($x \geq 0.57$)

= **-0.19 + 0.74(Physical demand) + 0.54(Colleague pain) + 0.52 (Twisting >20°) + 0.35 (Pain score) – 0.63(Psychological demand)– 0.01Age**

The relationship above explained the adjusted R square was 67.4%. The linear regression reported absence of outliers with standardised residual $\pm$ 0.99. The data points of the regression was independant with Dubin- Watson value of 2.18. Figure 1 showed that the normality assumption of the residual was satisfied. Figure 2 showed that the scatter plot of the constant variance were not problematic versions. All the parameters above illustrated that the regression above achieved multicollinearity. Figure 3 showed the discriminatory analysis of the equation above. The sensitivity was noted as 90.9% and specificity was 95.5%. The Area Under the ROC curve was 97.4%.

DISCUSSION

In the process of developing a new questionnaire, the designed tool has to be subjected to various reliability and validity testing. Among the reliability types include repeated measurements, internal consistency and interjudge reliability in the form of level of agreement between experts.[21] In terms of validity, there were content, construct, face and criterion validity that need to be tested. Content and face validity of the BACKS prototype had been conducted using qualitative research in a previous study. This current study managed to identify factors of chronic disabling back pain related to work. Similar to many studies that had used univariate analysis, the Likert scores of the socio- demographic factors (age and body mass index), health behaviours (history of back injury, history of medical illness, fitness level, exercise type, smoking workers and passive coping) and workplace factors (job demands, colleagues who smoke, colleagues with similar back pain, manual handling, twisting activities at work, handling vibrating tools or vehicles, absence of weight training and activities that involved pushing or pulling at work) were noted to be related to work.

Table 1: Distribution of Respondents

1(A)	Socio- demography and medical history	No.	(%)
	a) Gender	220	100.00
	Male	174	79.09
	Female	46	20.91
	b) Race	220	100.00
	Malay	127	57.73
	Chinese	40	18.18
	Indian	48	21.82
	Others	5	2.27
	c) Marital Status	220	100.00
	Married	197	89.55
	Single	23	10.45
	d) Education	220	100.00
	Primary	30	13.64
	Secondary	137	62.27
	Tertiary	53	24.09
	e) Presenting Diagnosis	220	100.00
	Prolapse Intervertebral Disc	96	43.65
	Back strain	86	39.09
	Lumbar spondylosis	14	6.36
	Back pain with motor vehicle accident history	13	5.91
	Back pain with fall history	4	1.82
	Degenerative Spinal Disease	4	1.82
	Failed Back Syndrome	1	0.45
	Generalised pain	1	0.45
	Spondylolisthesis	1	0.45
	f) Occupation	220	100.00
	Operator	52	23.65
	Technician	47	21.36
	Professional	25	11.36
	Office Worker	23	10.45
	Unemployed	21	9.54
	General Worker	19	8.64
	Labourer	12	5.45
	Driver	10	4.55
	Agriculture Worker	7	3.18
	Others	4	1.82
1(B)	**Socio- demography**	Mean	SD
	a) Age (years old)	38.94	10.10
	b) Working period (years)	14.26	8.93
1(C)	**Anthropometry & Assessment Scores**		
	a) Body mass index (kgm^{-2})	26.85	5.08
	b) Pain Score	0.60	0.16
	c) ODQ Score	0.43	0.17

SD: Standard Deviation

Table 2: Bivariate Analysis on Factors Related to Work

No.	Variable	Mean (SD)		t value	*p* value
		WR	NWR		
1.	Age (years)	34.28 (7.76)	43.61 (10.05)	-7.71**	< 0.01
2.	BMI (kgm^{-2})	25.43 (4.55)	28.15 (4.89)	-4.27**	< 0.01
3.	History of back pathology	0.849 (0.29)	0.46 (0.34)	9.22**	< 0.01
4.	History of medical illness	0.87 (0.26)	0.56 (0.35)	7.34**	< 0.01
5.	Structured exercise	0.57 (0.23)	0.46 (0.20)	3.78**	< 0.01
6.	Exercise for 30 to 45 minutes	0.50 (0.20)	0.44 (0.19)	2.53*	0.01
7.	Minimum exercise ≥ 3 days	0.48 (0.17)	0.43 (0.18)	2.16*	0.03
8.	Light exercise	0.70 (0.21)	0.51 (0.25)	6.04**	< 0.01
9.	Moderate exercise	0.59 (0.24)	0.42 (0.19)	5.74**	< 0.01
10.	Smoking worker	0.58 (0.22)	0.52 (0.22)	2.13*	0.03
11.	Smoking colleague	0.64 (0.19)	0.52 (0.20)	4.43**	< 0.01
12.	Passive coping	0.76 (0.13)	0.67 (0.17)	4.16**	< 0.01
13.	Physical demand	0.88 (0.13)	0.53 (0.19)	16.13**	< 0.01
14.	Psychological demand	0.75 (0.12)	0.57 (0.17)	9.25**	< 0.01
15.	10- 25kg weight/ hr	0.86 (0.18)	0.48 (0.20)	14.56**	< 0.01
16.	10- 25kg weight/ day	0.87 (0.17)	0.56 (0.24)	10.93**	< 0.01
17.	> 25kg weight/ hr	0.85 (0.20)	0.47 (0.19)	14.40**	< 0.01
18.	> 25kg weight/ day	0.83 (0.22)	0.50 (0.21)	11.57**	< 0.01
19.	Lorry or vibrating machinery for > 2 hrs	0.81 (0.24)	0.43 (0.18)	13.59**	< 0.01
20.	Twisting >40º	0.90 (0.13)	0.56 (0.24)	13.38**	< 0.01
21.	Twisting >20º	0.88 (0.15)	0.51 (0.20)	15.35**	< 0.01
22.	Bending 30º- 90º	0.89 (0.13)	0.57 (0.23)	12.60**	< 0.01
23.	Bending >90º	0.89 (0.17)	0.52 (0.21)	14.22**	< 0.01
24.	Object pushing/ pulling	0.79 (0.07)	0.57 (0.22)	9.85**	< 0.01
25.	Pain among Colleague	0.78 (0.18)	0.36 (0.20)	16.53**	< 0.01
26.	Weight training	0.39 (0.15)	0.27 (0.12)	6.37**	< 0.01
27.	Pain Score	0.67 (0.12)	0.53 (0.16)	7.46**	< 0.01
28.	Oswestry Disability Questionnaire	0.51 (0.15)	0.36 (0.17)	6.54**	< 0.01

***level of significance, p<0.01, *level of significance, p<0.05, SD: Standard Deviation, WR: Work- related, NWR: Non work- related*

Table 3: Multivariate analysis using linear regression

No.	Variable	OR_{adj}	Beta	t value	*p* value	Collinearity Statistics	
						Tolerance	VIF
1.	Colleague pain	1.35	0.30	4.54**	< 0.01	0.34	2.93
2.	Twisting > 20º	1.31	0.27	4.17**	< 0.01	0.36	2.75
3.	Physical demand	1.43	0.35	4.23**	< 0.01	0.21	4.69
4.	Age	0.86	-0.15	-3.51**	< 0.01	0.78	1.28
5.	Psychological demand	0.81	-0.21	-3.35**	< 0.01	0.36	2.76
6.	Pain score	1.11	0.11	2.39*	0.02	0.73	1.38

***level of significance, p<0.01, *level of significance, p<0.05, OR_{adj}: Adjusted Odd Ratio*

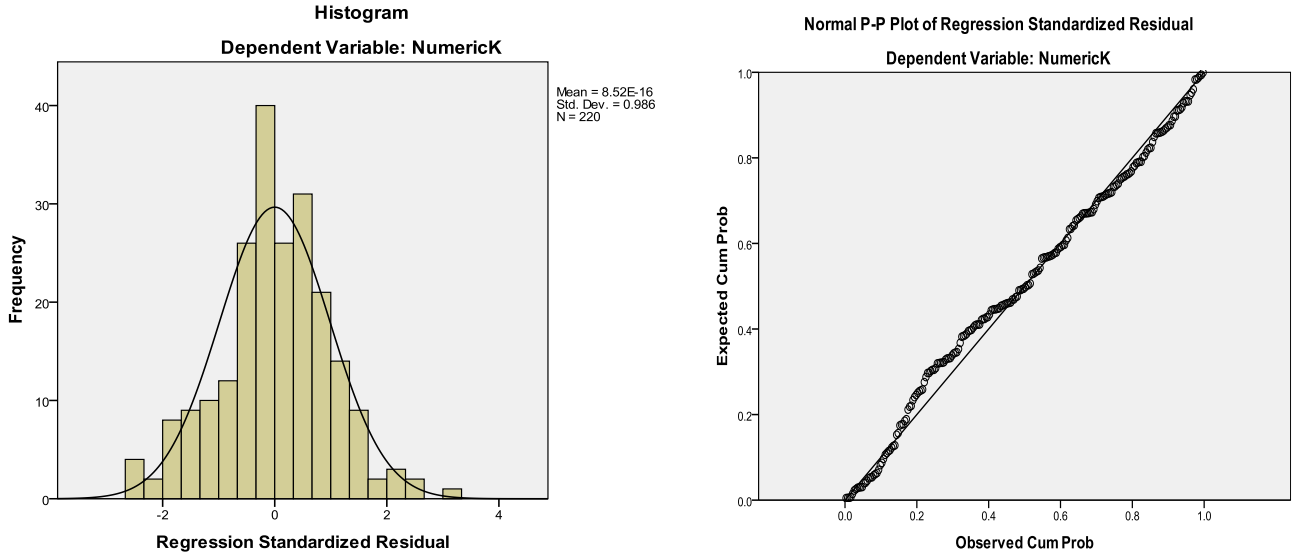

Figure 1: Normality Assumptions of the Residuals

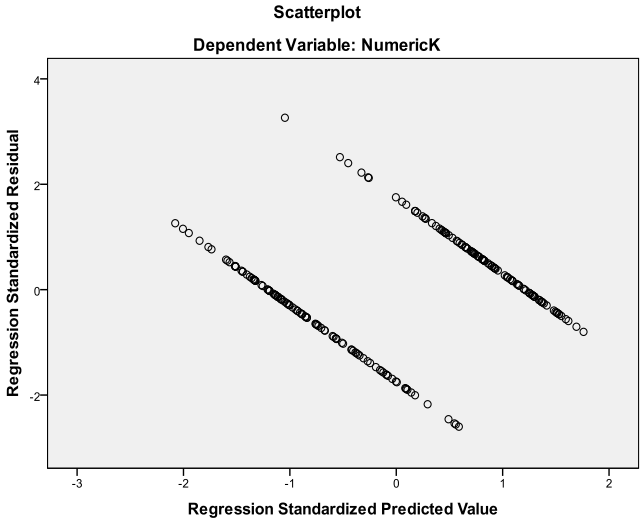

Figure 2: Constant Variance

Age and body mass index (BMI) evidence of occupational associations had been conflicting among previous papers.[6,22,23] However, with increased of age the probability of the back pain due to work had been shown to be reduced in our research as previously mentioned by Kim et al.[1]even via multivariate analysis. Consistent with the healthy worker effect, an episode of chronic back pain among the younger populations would suggest a higher apportionment towards work-relatedness. The mean of our population of chronic back pain workers due to work had been 38.94 ± 10.10 years old. This finding illustrated the difference between back pain due to aging or degenerative factors with occupational related as reported by older literatures. BMI was not significant in the multivariate analysis; consistent with Robinson et al.[24] and Kaaria et al.[25]

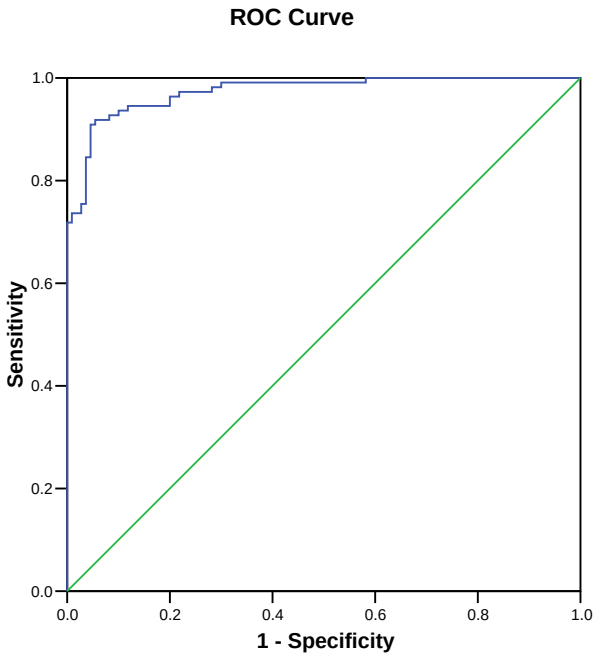

Figure 3: ROC Curve of the BACKS Tool Equation

History of back injuries or surgeries, medical illness, physical exercise, physical fitness, smoking and passive coping Likert scores were significantly associated with chronic occupational back pain as mentioned by clinical experts and previous researches.[24,26,27,28]However, these medical behaviour scores were not significant via regression analysis. Perhaps, a better variable or case definiton had to be designed to achieve stronger statistical associations.

Among the various workplace factors, the Likert scores of twisting more than 20^{o}, job demands and presence of colleagues with similar back problems at work showed statistical significance as compared to other factors such as manual handling, bending, pushing or pulling jobs, passive smoking at work or weight training via regression analysis. The relationship which suggest having more than one colleague with similar back pain to be related to work was supported by clinical experts and affected workers themselves. Unlike the former, twisting effects and high job demand had been previously reported **significantly related to chronic occupational back pain (especially workers aged above 40 years old).**[23,25,29]The non-significance via multivariate analysis involving excessive manual handling and bending has thus far been conflicting.[6,23,24,27,30,31,32] Finally, the Pain Score in a scale of 10 being the worst pain experienced was also noted to have an influence in determining occupational chronic back pain. A regression relationship obtained could be used to develop predictive values, a form of criterion validity.[21]

The fact thatthe study was of cross- sectional design limited the strength of the evidences that were proposed. Despite a stringent exclusion criteria, the selection bias appeared with a large number of respondents **who** declined from the study. It was difficult to contact some respondents especially from parts of North Borneo, Malaysia compared to respondents of West Coast of Malaysia. Recall bias was present but limited to experiences and hazard exposure of duration for the past one year alone in 2011. The information obtained from respondents after the sessions of

the SOCSO Medical Board were conducted on similar practising standards among clinicians. The questions posed to the respondents were adapted from existing standards, literatures and experienced experts to improve the quality of information that was retrived.

Inter- observer bias was reduced as limited individuals were trained as research assistant among the SOCSO officers that served in different parts of Malaysia. **This research primarily focussed on efforts to develop a statistical agorithm to relate a chronic back pain to work in a form of probability. With regards to single blinding, the outcome of work- relatedness had been decided a year earlier by the Medical Board since 2011. The Medical Board's decisions in no way influence by the methodology of our study that was conducted in the late 2012. The study also acknowledged that the BACKS prototype would require concurrent validation or comparison by using other similar standards or questionnaire for comparisons in another seperate study.**

There were numerous questionnaires that had been developed with their respective objectives. There were a few popular questionnaires which include the Nordic Musculoskeletal Questionnaires (NMQ), Roland- Morris Disability Questionnaire (RMDQ), and Oswestry Low Back Pain Questionnaire (OLBPQ) that assess the symptoms of low back pain or the severity of the back disabilities.

On the other hand, there were some questionnaires that are designed in determining work- relatedness such as the non- specific low back pain (WNBP)[33] and the Back pain Risk score for Office Workers (BROW) questionnaire from Thailand.[34]The literature search noted that the WNBP had numerous gaps and would require a lot of further research to reach the BACKS objectives and standards. BROW on the hand only focused narrowly at addressing office workers.

Finally, WHO too had taken the effort to develop criteria which included both physical and psychosocial assessments to diagnose low back pain. According to WHO,[35] the criteria involved;

- **a) History and physical examinations including the assessment of spinal motility (modified Shober's test);**
- **b) Pain measurement via Visual Analog Scale (VAS),**
- **c) Oswestry disability,**
- **d) modified Zung, and**
- **e) modified somatic perception questionnaires.**

Over the years, many questionnaires had been developed with regards to assessing low back pain. The subsequent work would focus to validate and compare the BACKS equation with WNBP and BROW, statistically. These tools ranged from work-relatedness, diagnosis of low back pain, low back pain with disability, recovery from disability, prognosis after treatment of back illness and identifying predictive values for the types of employees who could return to work.

CONCLUSION

In search of determining work- relatedness among employees with occupational back pain versus those due to aging, a screening tool had to be developed to assist in providing scientific assessments that would improve employee satisfaction during educational promotion and counseling. Despite reporting of high sensitivity (90.9%) and specificity (95.5%), the regression equation obtained must be tested further with a separate study to strengthen the criterion validity of the BACKS Tool. It is recommended that the subsequent study should compare the concurrent validity of the BACKS Tool with other existing questionnaires in determining chronic occupational back pain based on current medical standards in a developing heterogenous country such as Malaysia.

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