

# The Discriminant Ability of Physical and Psychological Factors in Stratification of Patients with Low Back Pain Based on Start Back Screening Tool

**Nava Yadollahpour\*, Shahla Zahednejad, Mohammad Jafar Shaterzadeh Yazdi, Fateme Esfandiarpour**

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## Abstract

STarT back Screening Tool (SBT) is a multidimensional screening questionnaire developed for Low Back Pain (LBP) stratification based on some physical and psychological predictors of chronic LBP. The role of physical impairments in the patients' stratification based on SBT remained unclear. In this study we used Discriminant Function Analysis (DFA) to investigate the discriminant ability of the physical factors in comparison to psychological and clinical factors in the categorization of patients with chronic LBP based on SBT in Physical Therapy (PT) settings. Patients with chronic LBP (n = 157) referred for PT treatment, complete a series of questionnaires including SBT and several uni-dimensional psychological and clinical questionnaires. Physical Impairment Index (PII) was used for objective evaluation of physical impairments. DFA revealed that physical, psychological and clinical variables contributed to SBT categorization, however the psychological variables were stronger predictors of SBT categorization than physical variables. Higher correlation between uni-dimensional psychological measurement tools and SBT and relatively lower correlation between objective physical factors and SBT confirmed SBT as a psychological screening questionnaire for patients with chronic LBP.

**Keywords:** Physical, psychological, STarT Back Screening Tool, Low Back Pain, Discriminant Function Analysis

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## Nava Yadollahpour\*

PhD Candidate, Musculoskeletal Rehabilitation Research Center, School of Rehabilitation Sciences, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.

## Shahla Zahednejad, Fateme Esfandiarpour

PhD, Musculoskeletal Rehabilitation Research Center, School of Rehabilitation Sciences, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran.

## Mohammad Jafar Shaterzadeh Yazdi

PhD, Musculoskeletal Rehabilitation Research Center, School of Rehabilitation Sciences, Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran

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**E-mail:** nava.pt84@yahoo.com

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## Introduction

Low back pain (LBP) is the most prevalent musculoskeletal disorder and almost 80% of the people experience LBP once during their life (Abedi et al., 2015, Mehrdad et al., 2016, Meucci et al., 2015). LBP is associated with several physical and psychological impairments which adversely affects personal, social, and economical parts of the life (Foster and Delitto, 2011, Hill and Fritz, 2011, Main and George, 2011b, Main and George, 2011a). Against the general increase in low back pain researches, available treatments produced insufficient outcomes. A compelling argument for achieving better treatment results is to match groups of patients with the most appropriate treatment for their profile, referred to as stratification (Foster et al., 2011, Foster et al., 2013). Many physical and psychological factors considered to be effective in treatment outcomes and consequently the patient's stratification (Janowski et al., 2010, Marshall et al., 2017, Nicholas et al., 2011).. STarT back Screening Tool (SBT) is a multidimensional screening questionnaire developed for LBP stratification based on some physical and psychological predictors of chronic LBP (Hill et al., 2008). Based on SBT's overall and psychological subscale scores, patients are categorized at low, medium or high risk of developing chronic LBP and are stratified to matched treatments (Hill et al., 2008).

Psychometric characteristics of SBT including validity, reliability and responsiveness were evaluated and confirmed previously (Hill et al., 2008, Hill et al., 2010a, Hill et al., 2010b, Hill et al., 2011, Khan, 2017, Pilz et al., 2017, Robinson and George, 2012, Bier et al., 2017, Wideman et al., 2012). Different studies compared SBT to uni-dimensional psychological and clinical questionnaires (Beneciuk et al., 2013, Beneciuk et al., 2014, Beneciuk and George, 2015, Beneciuk et al., 2016, Beneciuk et al., 2015, Khan, 2017, Pilz et al., 2017, Robinson and George, 2012). The results of these literatures indicated positive correlation between SBT and pain intensity, disability, and different psychological measures (Beneciuk et al., 2013, Beneciuk et al., 2014, Beneciuk and George, 2015, Beneciuk et al., 2016, Beneciuk et al., 2015). These correlations revealed that SBT can substitute several uni-dimensional psychological and clinical assessment questionnaires and it considered as an advantage for SBT (Beneciuk et al., 2015). But it should be considered that SBT provides an overall information about the patient's profile and high risk subgroup may require more detailed evaluation (Beneciuk et al., 2015, Traeger and McAuley, 2013).

As mentioned above, SBT consisted of some physical factors in addition to psychological factors. Physical impairments (i.e. range of motion limitation and muscle weakness) play an important role in the treatment outcomes and their assessment described as a prominent part of the evaluation process in patients with LBP (Delitto et al., 2012, Waddell et al., 1992). However, the role of physical impairments in the patients' stratification based on SBT remained unclear. In this study we used Discriminant Function Analysis (DFA) to investigate the discriminant ability of the physical factors in comparison to psychological and clinical factors in categorization of patients with chronic LBP based on SBT in Physical Therapy (PT) settings. The results of this study can provide an insight into the discriminant ability of the physical, psychological and clinical factors, as independent variables, in the patients' stratification based on SBT.

## Materials and Method

This was an analytic cross sectional study; data were collected between November 2016 and January 2018 from 4 private and 3 educational outpatient physical therapy clinics at Jundishapour University of Medical Sciences, Ahwaz.

### *Participants*

Patients with chronic LBP, having symptom from 12<sup>th</sup> thoracic vertebrae or lower, including radiating pain to buttocks or lower limbs for more than 3 months, referred by a specialized physicians to PT were participated in the study (Abedi et al., 2015). Inclusion criteria were age between 18 and 65 y/o, and the ability to read and write Persian language (Abedi et al., 2015, Beneciuk et al., 2015). People were excluded from the study if they have any history of systemic disorders, malignancy, spinal fractures, recent surgery, or pregnancy (Abedi et al., 2015, Beneciuk et al., 2015, Robinson and Dagfinrud, 2017). After evaluation of the inclusion and exclusion criteria by a physical therapist, the research process was explained for the participants and informed consent was delivered. The method of this study was approved by ethical committee of Ahwaz Jondishapour University of Medical Sciences.

### *Data collection*

Demographic and historical variables: participant's age, gender, height, weight, level of education, and career were recorded. LBP history including previous surgery, symptoms duration and onset, and previous treatments were obtained.

Various questionnaires were completed by participants at the researcher attendance. The physical impairments were evaluated by the researcher based on physical impairment index (PII) (Waddell et al., 1992). To eliminate the confounding effects of fatigue, the questionnaires order and physical evaluation was assigned randomly. Based on the subjects demand, 1 to 3 minutes of rest was given to

them between the evaluation and various questionnaires completion. The evaluation was done at one session prior to physical therapy initiation, and take 45 minutes to 1 hour time. The details of utilized assessment tools in this study are summarized here.

#### *STarT back Screening Tool (SBT)*

SBT is a 9 item multi-dimensional screening questionnaire, used to stratify LBP patients based on modifiable prognostic factors. This questionnaire includes both physical and psychological factors which determined as strong independent predictors of chronic LBP. Four question are related to physical factors (disability, pain in other areas, and referred leg pain) and 5 question are related to psychological factors (fear, catastrophizing, depression, anxiety, and bothersomeness). Based on overall score and psychological subscale score, people are dividing into 3 subgroups, low (LR), medium (MR) or high risk (HR) to become chronic. LR subgroup determined based on overall score, but MR and HR subgroups are differentiated based on psychological sub score. Validity and reliability of Persian version of this questionnaire had been revealed in previous study (Abedi et al., 2015).

#### *Psychological questionnaire*

The uni-dimensional psychological questionnaires used in this study were selected based on psychological construct evaluated by SBT and availability of a valid Persian versions.

#### *Tampa scale of kinesiophobia (TSK)*

This questionnaire was used to evaluate the fear of movement and injury or re-injury (Lundberg et al., 2009, Roelofs et al., 2004, Woby et al., 2005). The Persian version of this questionnaire has high validity and reliability and its prognostic and concurrent validity are revealed (Jafari et al., 2010).

#### *Beck depression inventory (BDI)*

BDI was used for depression evaluation. The Persian version of BDI has validity and reliability properties (Ghassemzadeh et al., 2005).

#### *Pain catastrophizing scale (PCS)*

This questionnaire was utilized for pain related catastrophic thoughts assessment. Psychometric properties of Persian version of this questionnaire are investigated and confirmed in previous studies (Raeissadat SA et al., 2013).

#### *Fear Avoidance Beliefs Questionnaire (FABQ)*

Fear Avoidance Beliefs Questionnaire-Physical Activity subscale (FABQ-PA) and Fear Avoidance Beliefs Questionnaire-Work subscale (FABQ-W) were used to evaluate the patients' beliefs and attitudes about how physical and work activities affect their LBP (Askary-Ashtiani et al., 2014, George et al., 2010). The validity and reliability of Persian version of this questionnaire were previously reported (Askary-Ashtiani et al., 2014).

#### *Clinical measures:*

Numerical pain rating scale was used to evaluate pain severity. This scale range is from 0 (no pain) to 10 (maximal intolerable pain). The subject's present, minimal and maximal pain severity during last 24 hours was recorded and the mean of these three scores was considered as the pain severity (Beneciuk et al., 2015).

#### *Ostwestry disability index (ODI)*

ODI was used for disability evaluation. The Persian version of this questionnaire has acceptable validity and reliability (Mousavi et al., 2006).

#### *Physical Impairment Index (PII)*

PII was used for objective evaluation of LBP related physical impairments. This index was developed by Waddell et al (1992) and includes 7 tests, which were selected through 27 movement impairment assessment tests (posture, pain, range of motion, movement strength) (Waddell et al., 1992, George et al., 2010). The combination of these 7 tests gives the researcher an index with the maximal ability to differentiate between LBP and healthy people. PII is used to evaluate the lumbar range of motion in different directions, the abdominal muscle strength and endurance, and the lumbar vertebral pain on palpation. Its score range is between 0 to 7 and higher scores show severe physical impairments (Waddell et al., 1992, Fritz and Piva, 2003).

#### *Data analysis*

All data analyses were performed using SPSS (version 16). Intake descriptive statistics were calculated for demographic, clinical, and psychological measures and also for PII. Differences of these variables across SBT subgroups were evaluated using analysis of variances (ANOVA). Then DFA was performed to determine which variables are better predictors of SBT categorization using uni-dimensional psychological measures (TSK, BDI, FABQ-PA, FABQ-W, and PCS), NPRS, ODI, and PII as the independent variables (Şener Büyüköztürk and Çokluk-Bökeoğlu, 2002).

## Results

During the data collection, 369 patients with LBP were referred to the examiner. Sixty-eight were excluded due to acute symptoms and 144 were excluded mostly due of the age above 65 (n=54) and inability to read and write (n=43). Finally 157 patients were participated in the study. Obtained data from this population and differences between SBT-based subgroups are summarized in table1.

Box's Test of Equality of Covariance Matrices revealed that within-group variance-covariance matrices were equal across groups ( $p = 0.09$ ), therefore the assumption of homogeneity of covariance matrices between groups for DFA was satisfied.

DFA run with enter independents together method with 8 independent variables (NPRS: Wilk's  $\lambda = 0.78$ ,  $p < 0.001$ ; TSK: Wilk's  $\lambda = 0.54$ ,  $p < 0.001$ ; BDI: Wilk's  $\lambda = 0.61$ ,  $p < 0.001$ ; FABQ-PA:  $\lambda = 0.74$ ,  $p < 0.001$ ; FABQ-W  $\lambda = 0.92$ ,  $p < 0.001$ ; PCS: Wilk's  $\lambda = 0.54$ ,  $p < 0.001$ ; ODI: Wilk's  $\lambda = 0.77$ ,  $p < 0.001$ ; PII: Wilk's  $\lambda = 0.83$ ,  $p < 0.001$ ) suggested that each predictor contributed uniquely to SBT categorization and resulted in 2 discriminant functions for the 3 SBT subgroups.

The overall test of the 2 functions was significant (chi-squares = 130.60, Wilk's  $\lambda = 0.42$ ,  $p < 0.001$ ) indicating that predictor scores were able to discriminate among the 3 SBT subgroups.

The test for function 2 alone was also significant (chi-squares = 15.09, Wilk's  $\lambda = 0.9$ ,  $p = 0.03$ ) indicating that even after removing function 1, there remained significant discrimination. 91.6% (eigenvalue = 1.15, canonical R = 0.73) and 8.4% (eigenvalue = 0.1, canonical R = 0.3) of the SBT subgroups variance was explained through function 1 and 2, respectively. The pooled within-groups correlation between discriminating variables and standardized canonical discriminant functions, as well as the standardized canonical discriminant functions coefficients (analogous to multiple regression beta weights) are provided in table 2.

The first function was considered as the most important (Şener Büyüköztürk and Çokluk-Bökeoğlu, 2002) and based on the standardized coefficients for the first discriminant function (table3), TSK and PCS demonstrated the strongest relationship with the discriminant function and FABQ-W and PII demonstrate the weakest relationship. Overall, 69% of cross-validated grouped cases were correctly classified (85.7% for low-risk, 64.6% for medium-risk, and 87.2% for high-risk categories).

## Discussion

The overall intent of the study was to evaluate the discriminant ability of the physical factors in LBP stratification based on SBT.

Distribution of patients through SBT subgroups (8.9% LR, 61.1% MR, and 29.9% HR) was in consistent with previous studies run in PT settings in such a way that most of the patients were categorized as MR subgroup (Beneciuk et al., 2015, Fritz et al., 2011, Robinson and Dagfinrud, 2017), while in primary care setting most of the patients were in LR subgroup (Bier et al., 2017, Hill et al., 2008). However, in our sample HR subgroup percentage was higher than LR subgroup percentage. This inconsistency may be related to cultural and socioeconomic differences and suggest that in our sample patients with higher risk of developing chronic disability were referred to PT. In consistent with previous research the patient's age, gender, height, weight, level of education, symptom duration and symptom onset had no effect on the SBT categorization (Beneciuk et al., 2012, Beneciuk et al., 2015, Hill et al., 2008, Hill et al., 2010a). Risk-dependent relationship (LR<MR<HR) was seen for all uni-dimensional psychological measures (TSK, BDI, FABQ-PA, FABQ-W, and PCS), clinical measures (NPRS and ODI), and also for PII. These were in consistent with previous studies and may confirm that clinicians in busy clinics can use SBT as first line screening questionnaire, instead of using multiple full length uni-dimensional questionnaires (Beneciuk et al., 2015). This risk-dependent relationship seen for PII as an objective assessment tool revealed that SBT can also replace physical evaluation of patients with LBP by physical therapists, with the caution that SBT gives overall information about the physical and psychological profile of the patient and patients which categorized as HR may need more detailed evaluation.

DFA revealed that all investigated uni-dimensional psychological factors, self-reported disability and physical impairments contributed to SBT categorization, but psychological factors are better predictors than disability and physical impairments. Kinesiophobia and catastrophizing have the strongest influence on risk categorization by SBT. Fear about how work activity influence LBP and physical impairments were the weakest predictors of risk categorization by SBT. Against to the results of Beneciuk et al. in our study depression was a weaker predictor than catastrophic thoughts and kinesiophobia (Beneciuk et al., 2015). Self-reported disability was a weaker predictor of SBT categorization. Overall, in our study, higher correlation between psychological factors than physical factors and SBT categorization confirmed SBT specifically as a psychological screening questionnaire.

Classification based on resulted functions from DFA showed that the model work excel at identifying patients at LR and HR subgroups, but almost 36% of the patients at MR subgroup were categorized incorrectly. These suggest that it may be required to include more predictors for categorization of patients at MR subgroups (Şener Büyüköztürk and Çokluk-Bökeoğlu, 2002).

Some limitations of our study should be considered. The first limitation was the cross-sectional design of the study. In addition to be an assessment questionnaire, SBT is also a treatment monitoring tool and for better comparison the physical, clinical, and psychological factors should be evaluated through longitudinal studies (Fritz et al., 2011, Main et al., 2012, Wideman et al., 2012). The other limitation that should be considered was due to the used methodology. In the analysis each uni-dimensional psychological questionnaire, self-reported disability questionnaire, and also the PII were considered as one score, although each of them consist several items. Given that previous research revealed that considering each item of the questionnaires as a single item in the analysis resulted in finer detailed findings and more distinguishing characteristics (Nielsen et al., 2016), it proposed that this approach (single-item strategy) used in future researches and the results compared to one score analysis. (Larsson et al., 2017).

## Conclusion

Our results add to the existed evidence which supports SBT as a concise and clinical assessment tool in PT settings. High correlation between uni-dimensional psychological measurement tools and SBT and relatively lower correlation between objective physical factors and SBT confirmed SBT as a psychological screening questionnaire for patients with LBP.

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Table 1. Patient's demographic, clinical, psychological measures and PII mean (SD)

Variable	Total sample (n = 157)	SBT low risk (n=14, 8.9%)	SBT medium risk (n=96, 61.1%)	SBT high risk (n=47, 29.9%)	P Value
Demographic					
Age (y)	41.25 (10.56)	39.64 (11.64)	41.01 (10.48)	42.21 (10.55)	0.68
Gender, n female	104 (66.2%)	10	60	34	0.49
Height (M)	1.62 (0.09)	1.63 (0.11)	1.63 (0.09)	1.59 (0.09)	0.10
Weight (kg)	72.02 (9.41)	72.21 (9.38)	72.83 (9.95)	70.31 (8.16)	0.32
Level of education					
Diploma or below	81 (51.6%)	8	53	20	0.64
BSc	60 (38.2%)	5	33	22	
Above BMS	16 (10.2%)	1	10	5	
Symptom Duration (m)	10.57 (6.29)	9.71 (5.82)	10.9 (6.34)	10.14 (6.42)	0.69
Symptom Onset					
Suddenly	55	5	33	17	0.97
Gradually	102	9	63	30	
SBT measures					
Overall score (0-9)	5.87 (1.60)	2.79 (0.42)	5.53 (1.01)	7.49 (0.88)	*<0.01
Psychological score (0-5)	2.73 (1.31)	0.43 (0.51)	2.31 (0.75)	4.26 (0.48)	*<0.01
Psychological measures					
PCS (0-52)	25.76 (11.57)	11.79 (5.40)	22.66 (8.78)	36.28 (7.87)	*<0.01
BDI (0-63)	36.54 (12.72)	21.21 (11.7)	34.95 (10.96)	44.34 (11.09)	*<0.01
TSK (17-68)	37.46 (11.52)	26.50 (7.25)	33.44 (8.91)	48.96 (8.14)	*<0.01
FABQ-PA (0-24)	11.94 (3.67)	8.64 (2.70)	11.15 (3.40)	14.53 (2.88)	*<0.01
FABQ-W (0-42)	9.42 (4.60)	8.29 (2.36)	8.70 (4.22)	11.23 (5.35)	*<0.01
Clinical measures					
NPRS (0-10)	5.76 (1.465)	4.43 (1.50)	5.49 (1.37)	6.70 (1.06)	*<0.01
ODI (0-50)	27.73 (9.21)	17.43 (9.63)	26.56 (7.89)	33.19 (9.21)	*<0.01
PII (0-7)	4 (1.656)	2.36 (1.33)	3.83 (1.49)	4.83 (1.61)	*<0.01

SD, Standard Deviation; BSc, Bachelor of Science; SBT, STaRT Back Screening Tool; NPRS, Numerical Pain Rating Scale; RMDQ, ODI, Oswestry Disability Index; TSK, Tampa Scale of Kinesiophobia; BDI, Beck Depression Inventory; PCS, Pain Catastrophizing Scale; FABQ-PA, Fear Avoidance Beliefs Questionnaire-Physical Activity subscale; FABQ-W, Fear Avoidance Beliefs Questionnaire-Work subscale; PII, Physical Impairment Index.

Table 2. Pooled within-groups correlation

predictors	Discriminant functions			
	1		2	
	Standardized coefficients <sup>1</sup>	Correlation coefficients <sup>#</sup>	Standardized coefficients <sup>1</sup>	Correlation coefficients <sup>#</sup>
NPRS	0.178	.494*	0.101	0.045
TSK	.306	0.840*	-1.202	-.469
BDI	.254	0.734*	.612	.301
FABQ-PA	0.112	0.538*	0.320	-.052
FABQ-W	-0.014	0.254	-0.280	-.287*
PCS	.374	.852*	.176	-.011
ODI	.158	.495*	.303	.333
PII	.037	.410*	.265	.318

NPRS, Numerical Pain Rating Scale; ODI, Oswestry Disability Index; TSK, Tampa Scale of Kinesiophobia; BDI, Beck Depression Inventory; PCS, Pain Catastrophizing Scale; FABQ-PA, Fear Avoidance Beliefs Questionnaire-Physical Activity subscale; FABQ-W, Fear Avoidance Beliefs Questionnaire-Work subscale; PII, Physical Impairment Index

Indicate Standardized Canonical Discriminant Function Coefficients

<sup>#</sup>Indicate Pooled within-groups correlations between discriminating variables and standardized canonical discriminant functions

\*Largest absolute correlation between each variable and any discriminant function