

## RESEARCH ARTICLE

# Effect of Patient Resilience and the Single Assessment Numeric Evaluation (SANE) Score on Return to Sport Following Anterior Cruciate Ligament Reconstruction Surgery

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## Abstract

**Background:** This study aims to determine the effect of resilience, as measured by the Brief Resilience Scale (BRS), and perceived self-efficacy of knee function, as measured by the Single Assessment Numeric Evaluation (SANE) score on return to sport outcomes following ACL Reconstruction (ACLR) surgery.

**Methods:** Seventy-one patients undergoing ACLR surgery were followed up for a minimum of one year. At six-months post-op, ACLR patients completed the BRS and the SANE score. Patients were stratified into low, normal, and high resilience groups, and outcome scores were calculated.

**Results:** The median return to sports participation, in months post-operatively, for the low, normal, and high resiliency groups were 7.1, 7.3, and 7.2 months, respectively ( $P=0.78$ ). A multiple logistic regression analysis revealed that the SANE score was a significant predictor of return to sport at nine months when adjusted for age, sex, and BRS score ( $P=0.01$ ). Patients that returned to sport by nine months demonstrated a mean SANE score of 92.7, compared to a mean of 85.7 ( $P=0.08$ ). In patients who had returned to sport, neither the BRS resilience group nor the SANE score were significant predictors of the returned level of competition status ( $P=0.06$ ;  $P=0.18$ ).

**Conclusion:** The SANE score may serve as a significant predictor of return to sport when adjusted for age, sex, and BRS score. Resilience, as measured by the BRS, was not significantly associated with return to sport, but may have utility in specific patient populations.

**Level of evidence:** IV

**Keywords:** ACL, ACLR, BRS, Resilience, SANE

## Introduction

Sports-related injury in athletes not only causes significant healthcare expense but can also result in long-term physical and psychosocial problems (1). Anterior cruciate ligament (ACL) injuries have been implicated in long-term dysfunction, and 98% of orthopedic surgeons recommend surgery if the patient intends to return to sport (1, 2). Despite improvements in surgical techniques, perioperative care, and rehabilitation, a large percentage of athletes still fail to return to sport (3-5).

The identification of robust prognostic variables is

necessary to more optimally treat patients following ACLR (3, 6). Recently, there has been increased awareness regarding the psychological factors associated with recovery from surgery (7-9). Studies have demonstrated the utility of psychometric surveys, such as the Brief Resilience Scale (BRS) and the Single Assessment Numeric Evaluation (SANE) score, in the setting of cancer prognosis, trauma, and recovery following total shoulder arthroplasty [Figure 1] (8, 10-12). However, there is scarcity in the literature regarding predictive psychological factors in the ACLR population

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(2). To our knowledge, no study has related the BRS or the SANE score in ACLR patients or in return to sport outcomes in any population (8, 9). With prior evidence demonstrating the impact of psychologic distress on postoperative outcomes, understanding these variables may help orthopedic surgeons optimize treatment. If low resilience patients or those scoring low on the SANE are associated with decreased return to sport rates, efforts can be taken post-operatively to target at-risk populations. Thus, in the present study, we aim to assess the effect of resilience, as measured by the BRS, and perceived self-efficacy of knee function, as measured by the SANE score, on return to sport outcomes in ACLR patients.

## Materials and Methods

### Participant Identification and Enrollment

Prior to initiation of this prospective cohort, ethical approval was obtained from the Institutional Review Board of a large tertiary care Midwestern academic hospital. Inclusion criteria were English proficiency, age 14 years or older, participation in a recreational or competitive sport, and ACL rupture with or without meniscal injury, with subsequent surgical reconstruction. Participants were identified at the standardized follow-up appointment six months post-surgery and informed consent/assent was obtained. Given that our study was a preliminary analysis on a novel topic, a formal a priori power analysis was not performed. Results from this pilot analysis will be used to guide future directions.

### Surgical Details

All ACLR procedures were performed by two fellowship trained orthopedic sports medicine physicians at a large tertiary-care academic hospital. Surgical technique was left to surgeon preference and included bone-tendon-bone, hamstring, and quadriceps tendon autografts. All

reconstructions done were single incision arthroscopic with medial portal ACL drilling technique. All patients were managed with the same post-operative physical therapy protocol.

### Outcome Scores and Follow-up

The primary outcomes in this study were return to sport status at nine months and time until return to sport. Return to sport was defined as return to any sport at any level (i.e. recreational, high school/collegiate, professional). Demographic information, sport played, competition level, the BRS, and SANE scores were recorded at the six-month post-surgery appointment. Regarding the BRS, patients were instructed to indicate the degree to which they agreed with each statement by selecting one box per line. Responses ranged from strongly disagree to strongly agree [Figure 1]. All six responses were totaled, yielding a minimum score of six and maximum of 30 with higher scores signifying increased resilience. Regarding the SANE, patients were asked how they would rate their knee as a percentage of normal on a scale of 0-100, with 100 being normal. Following the six-month visit, patients were cleared to return to sport if they had no swelling, no pain, symmetric quadriceps girth and if they passed functional testing in physical therapy which typically involved achieving 90% of the non-operative leg in strength and other functional tests. At nine months post-operation, participants were contacted by phone and asked, "have you returned to sport?" Return to sport was defined as a return to practice or competition at any level. Return to a sport different than that at the time of injury was considered acceptable. If returned, further information, including the type of sport, date of return, and level of competition (compared to pre-injury) was recorded. If they had not returned by nine months, patients were contacted again 12 months post-operatively and on an as needed basis thereafter.

### Brief Resilience Scale (BRS)

Please respond to each item by marking <b>one box per row</b>		Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
BRS 1	I tend to bounce back quickly after hard times.	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
BRS 2	I have a hard time making it through stressful events.	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
BRS 3	It does not take me long to recover from a stressful event.	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
BRS 4	It is hard for me to snap back when something bad happens.	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1
BRS 5	I usually come through difficult times with little trouble.	<input type="checkbox"/> 1	<input type="checkbox"/> 2	<input type="checkbox"/> 3	<input type="checkbox"/> 4	<input type="checkbox"/> 5
BRS 6	I tend to take a long time to get over set-backs in my life.	<input type="checkbox"/> 5	<input type="checkbox"/> 4	<input type="checkbox"/> 3	<input type="checkbox"/> 2	<input type="checkbox"/> 1

Figure 1. The Brief Resilience Scale questionnaire with 6 items and Likert score options.

### Statistical Analysis

Statistical analysis was performed using SPSS software and R Studio by an investigator with PhD statistical training. Based on the BRS, patients were stratified into low, normal, and high resilience groups, defined as less than one standard deviation (SD), within one SD, or above one SD from the mean BRS. Baseline demographics were compared using the respective parametric test, including analysis of variance and chi-square tests. BRS group and SANE score were compared to return to sport outcomes, as a continuous and categorical variable, and the corresponding analyses, including Kruskal-Wallis tests, Fisher's Exact tests, Spearman's correlation, and Wilcoxon Rank Sum tests, were performed. A multiple logistic regression including age, sex, BRS score, and SANE score, was performed, with return to sport at nine-months as the outcome. A Shapiro-Wilk's test was used to assess normality. A  $P$ -value < 0.05 was considered significant.

### Results

#### Patient Overview

A total of 71 patients were enrolled in the study and underwent baseline data collection. Twelve patients were lost to follow-up, and three patients were found to have incomplete data – these 15 patients were therefore removed upon final data analysis [Figure 2]. This left a total of 56 patients, 30 males and 26 females, with a mean age of 19 and range of 14 – 43 years. Three types of autografts were utilized, 44 bone-tendon-bone patellar tendon, seven quadriceps tendon, and five hamstrings [Table 1]. Patients were followed for a minimum of nine months from the date of surgery (Mean 13 months, Standard Deviation [SD] 5.6). Median time from date of surgery to return to sport was 7.2 months (range 3.2-

15.4). Seventy-one percent of patients reported return to some level of sport by nine months, with 64% returned to their prior level of play nine months post-surgery. Ten patients returned to a different sport from that at the time of injury. The mean BRS was  $23.5 \pm 4.2$ ; thus, the low resilience group was defined as a BRS of 18 or below; normal resilience, 19 to 27; and high resilience, 28 to 30. Nine patients were low resilience (mean 16.8, range 16-18), 35 were normal resilience (mean 23.4, range 19-27), and 12 were high resilience (mean 29.1, range 28-30). There were no statistically significant differences regarding age, sex, and graft type among the three stratified BRS cohorts ( $P > 0.5$ ) [Table 1].

#### Return to Sport Outcomes

The median return to sports participation, in months post-operatively, for the low, normal, and high resiliency groups were 7.1 (range 7-9), 7.3 (range 3-15), and 7.2 (range 3-10) months, respectively ( $H = 0.5$ ,  $P = 0.78$ , Kruskal-Wallis Test) [Figure 3a]. There was no significance difference when comparing BRS resilience group to return to sport at the nine-month mark ( $P = 0.84$ , Fisher's Exact Test). Bivariate correlation analysis of BRS and number of months until return to sport revealed a correlation coefficient of  $-0.14$  ( $P = 0.34$ , Spearman's Correlation). Patients that returned to sport by nine

	Low Resilience	Normal Resilience	High Resilience
	n=9	n=35	n=12
<b>Gender</b>			
Male	7	16	7
Female	2	19	5
<b>Mean Age at Surgery</b>	18.8	18.9	18.5
<b>(%) Graft Type</b>			
Patellar (BTB <sup>a</sup> )	8	26	10
Hamstring	0	4	1
Quadricep	1	5	1
<b>Mean BRS<sup>b</sup></b>	16.8	23.4	29.1
<b>Mean SANE<sup>b</sup></b>	92.8	89.2	94.2
<b>Return to Sport</b>			
months 9	7/9	25/35	8/12
months 12	7/9	27/35	9/12

a, bone-tendon-bone; b, six months post-surgery

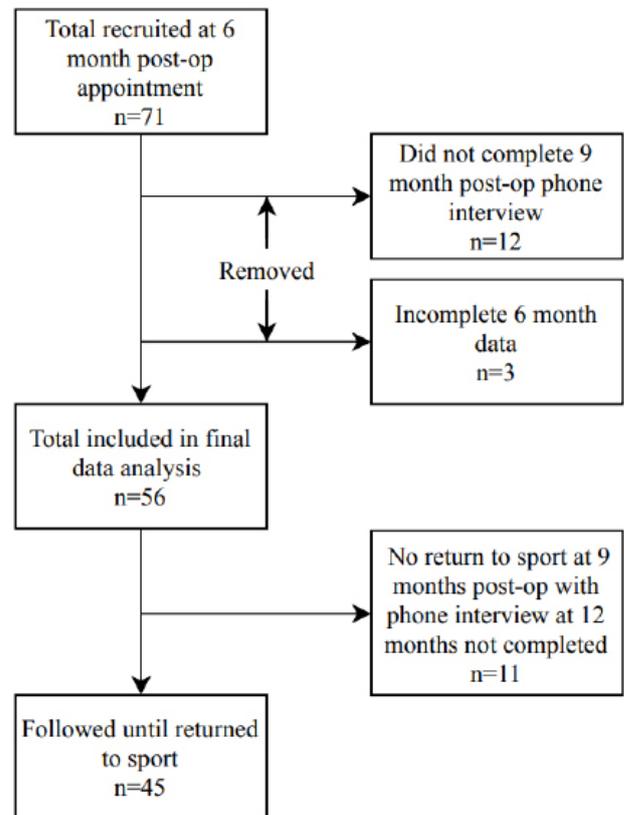
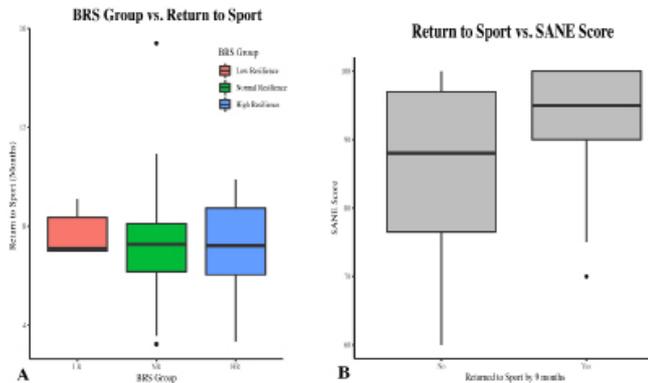


Figure 2. Study Flowchart.



**Figure 3. a) BRS resilience group was not significantly associated with time until return to sport ( $P=0.78$ ); b) SANE score was not significantly different between patients who had returned to sport at nine months and those who had not ( $P=0.08$ ).**

months demonstrated a mean SANE of 92.7, compared to a mean of 85.7 in those that did not return by nine months ( $P=0.08$ , Wilcoxon Rank Sum Test) [Figure 3b]. Bivariate correlation analysis of SANE score and number of months until return to sport revealed a correlation coefficient of  $-0.21$  ( $P=0.17$ , Spearman's Correlation). A multiple logistic regression analysis revealed that SANE score was a significant predictor of return to sport at nine months when adjusted for age, sex, and BRS score ( $P=0.01$ , odds ratio = 1.1, 95% CI = 1.03-1.2).

The BRS was not significantly correlated with SANE scores ( $r=0.01$ ,  $P>0.5$ ). There was no significant difference when comparing the BRS resilience groups or SANE score to the level of competition status in patients who had returned to sport by nine months ( $P=0.06$ , Fisher's Exact Test;  $H=3.4$ ,  $P=0.18$ , Kruskal-Wallis Test) [Table 2, Figure 4].

#### Dropout Patients

Eleven patients reported that they had not returned to sport at nine months with subsequent attempts to contact them at 12 months or later unsuccessful. The mean BRS and SANE score of this group was 23.5 and 85, respectively, not significantly different from the experimental cohort ( $P=0.668$ , Kruskal-Wallis Test;  $P=0.06$ , Wilcoxon Rank Sum Test).

#### Discussion

Despite advances in surgical techniques and rehabilitation protocols, the likelihood of return to sport following ACLR remains suboptimal (4, 5). For the first time, we identify the SANE score as a predictor of return to sport nine months following ACLR. Furthermore, we find no significant differences in return to sport based on patient resilience.

Resilience has been defined by many as a person's ability to bounce back or recover from stress (12). Based on this definition, Smith and colleagues created a targeted measure for resilience called the Brief Resilience Scale (BRS), which has shown to be a valid measurement of resilience in both medical and non-medical settings [Figure 1] (12). The Single Assessment Numeric Evaluation (SANE) score asks patients to rate their knee function on a scale of 0 to 100 and has also been shown to be a reliable reflection of knee symptoms after ACL reconstruction (13). The BRS has been gaining traction as an important psychologic trait predictive of outcome, and multiple studies have advocated its role in providing individualized treatment (14-16). Previous studies have correlated the BRS and the SANE score to other functional outcomes—such as the PROMIS-43—in the postoperative setting (17). However, to our knowledge, none have assessed their effect on return to sport rates in the ACLR population (3, 8, 18, 19). Our study explored whether the BRS or the SANE score contribute to the phenomenon of strikingly low rates of return to sport following ACLR surgery.

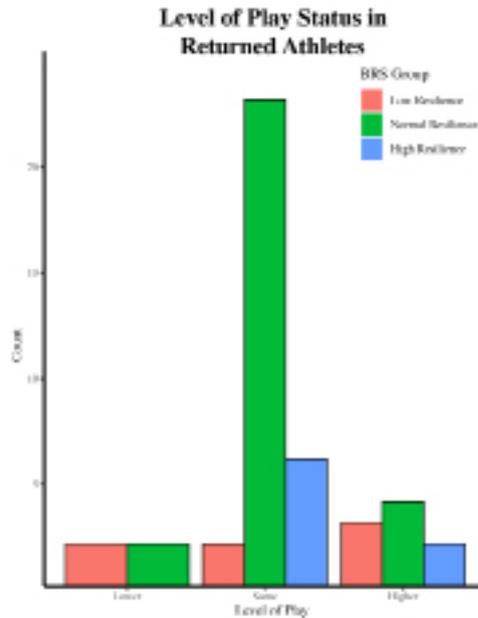
#### The Brief Resilience Scale

Similar to previously reported data, our cohort revealed that 71% of patients returned to sport by nine months, with 64% returned to their preinjury level or higher (5, 20). However, contrary to our hypothesis, the BRS was not significantly associated with return to sport. We propose a few etiologies for these findings.

Returning to sport is a complex phenomenon that is impacted by myriad variables, many of which are unrelated to physical or mental status. For example, on phone interview, many patients did not return to sport due to extraneous reasons (i.e., athlete burnout) even though they possessed high resilience and were able to return to sport. Thus in these patients, returning to sport may be irrespective of resilience, and more so related to a decline in "athletic identity", as described by Brewer et al. (21). In addition, return to sport analysis was confounded by variation in post-operative

**Table 2. Level of play status upon post-operative return to sport by nine-months**

	BRS Group		
	Low Resilience	Normal Resilience	High Resilience
<b>Total patients returned to sport</b>	78% (7/9)	83% (29/35)	75% (9/12)
Lower level	22% (2/9)	6% (2/35)	0% (0/12)
Same level	22% (2/9)	66% (23/35)	58% (7/12)
Higher level	33% (3/9)	11% (4/35)	17% (2/12)
Did not return	22% (2/9)	17% (6/35)	25% (3/12)



**Figure 4.** In the cohort of patients who had returned to sport by nine months, the level of competition relative to their pre-injury status was assessed. BRS resilience group was not a significant predictor of the level of play status in returned athletes ( $P=0.06$ ).

therapy, especially because we were unable to reliably track participation in and adherence to prescribed rehabilitation. Patient differences in socioeconomic status, for example, was an uncontrolled variable that may have contributed to the variability in the quality and length of rehab.

On the other hand, our outcome measures may have been too aggressive. A nine-month return to sport timeframe in our cohort, which was primarily composed of high-risk, high-impact sports (e.g. soccer, American football), may be premature. A recent study by Besicher et al. reported that young athletes who return to sport before nine months after ACLR surgery are seven times more likely to reinjury compared to those that delay return (22). Clinicians may need to reexamine the ideal return to sport date in this patient population.

In addition, resilience is inherently different from other variables shown to be associated with return to sport, such as the knee self-efficacy scale (K-SES), or the International Knee Documentation Committee (IKDC) functional assessment (23). Unlike these functional assessments, resilience is an enduring characteristic of one's personality that has shown to remain relatively stable from baseline to 12 months post-operation (18). In addition, the BRS does not specifically mention sport, knee function, or ACL injury. Although resilience has been shown to correlate with other functional assessments, it may be insufficient in predicting a strict, binary outcome such as return to sport. In a recent study, Chavez and colleagues experienced similar results when assessing the effect of resilience on outcomes following a nonopioid pain regimen after knee arthroscopy (24).

Resilience scores alone, as measured by the BRS, may simply be inadequate to predict return to sport (24).

Interestingly, however, the BRS demonstrated potential utility in returned level of competition analyses. In our cohort, higher resilience BRS groups showed a trend towards higher level return-to-play statuses ( $P=0.06$ ) [Figure 4]. In addition, multiple studies demonstrating the utility of the BRS are in older adult populations compared to the teenage population seen in our cohort (11, 14, 17, 18). These findings, in context with other studies, suggest that the utility of the BRS may depend on the demographic in question and the outcome being studied (24, 25). Future studies targeting specific patient demographics may be useful in elucidating the predictive value of the BRS (24, 26).

#### **The Single Assessment Numeric Evaluation**

The SANE score appeared to have a stronger effect than the BRS on return to sport in the nine-month time frame. Our results showed that patients with higher SANE scores trended towards higher rates of return to sport at nine months ( $P=0.08$ ). Previous studies have shown that female patients with ACLR are less likely to return to sport than males (24, 27). In a study by Edwards et al., younger age was also associated with improved return to sport (28). Based on these previous findings, and our hypothesis that the BRS and SANE score are associated with return to sport, a multiple logistic regression was performed, and select predictor variables, namely age, sex, BRS score, and SANE score, were chosen. In our cohort, the SANE score was a significant predictor for return to sport (odds ratio = 1.1,  $P=0.01$ ) when adjusted for age, sex, and BRS score. These results corroborate previous studies that demonstrate that knee function metrics, such as the K-SES, serve as preoperative predictors of functional knee outcomes one year after ACLR (8). These findings further the idea that self-perceived functional assessments may be more sensitive at predicting return to sport than an enduring metric like resilience.

When comparing the BRS with the SANE score, patients in the low, normal, and high resilience BRS groups demonstrated no significant differences in the SANE scores when queried six months post-surgery. These findings contrast with the relationship described between the BRS and SANE scores in post-operative total shoulder arthroplasty patients (11). The reason for this is unclear but may potentially be explained by differences between the two studies with respect to patient factors such as age, operation, and joint involved (24).

#### **Limitations and Future Directions**

A significant limitation of the study was a limited sample size. Approximately 17% of enrolled patients (12/71) were unable to be contacted to assess return to play status. Although this is considered an acceptable percentage and baseline data does not suggest significant differences among those lost to follow-up, it did reduce the study's power (29). In addition, there were 11 patients that did not respond to the 12-month phone interview after they reported no return to sport at

nine months, making attrition bias a concern; however, the fact that there was no significant difference in mean BRS or SANE score between the two groups makes it less likely that their lack of follow-up affected our findings. Heterogenous types of grafts was another limitation in our study. An increase in sample size would homogenize graft subtypes, increase study power, widen trends in BRS analyses, and/or potentiate the predictive value of the SANE score.

Assessment of outcome measurements can also be optimized. As mentioned above, follow up at nine-months may be premature, as a more longitudinal protocol may unmask potential findings. In addition, the use of additional validated functional questionnaires such as the IKDC and K-SES is essential to not only compare with the BRS but also further identify prognostic factors in this patient population (17).

Moving forward, we plan to address the limitations to our study by including a larger number of patients, administering additional validated questionnaires, and expanding follow-up over a longer time period in order to investigate the possibility of any longer-term relationships not identified by this study.

Our study is the first prospective observational cohort study to investigate the role of resilience and perceived self-efficacy of knee function on return to sport following ACLR. Our results suggest that resilience, as measured by the BRS, is inadequate to predict return to

sport outcomes, but may have utility in specific patient demographics and level of play analyses. Self-perceived functional assessments, such as the SANE score, however, show promise in predicting return to sport outcomes.

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**Patient Consent:** Informed consent was obtained from study participants

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