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# Falls and fear of falling: an underestimated sequelae in Behçet's disease

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## Abstract

**Background** Behçet's disease (BD) is an inflammatory autoimmune disorder. Balance is a multifactorial process that is ultimately affected in BD leading to frequent falls. Fear of falling (FOF) is a significant risk factor for falls. The study aimed to evaluate the risk of falls and FOF in BD and their relations to disease activity and damage.

**Results** In BD patients, the history of falls and FOF was 65.6% and 48.4%, respectively. The Berg Balance Scale was low in BD patients ( $P=0.003$ ). Falls and fear of falling showed significant relations with the disease activity and disease damage ( $P<0.001$ ). There were significant relations between fallers with arthritis ( $P=0.003$ ) and active neurological affection ( $P=0.004$ ) than non-fallers. A higher balance scale significantly independently decreases the risk of falls ( $AOR=0.79$ ,  $P=0.005$ ) and FOF ( $AOR=0.904$ ,  $P=0.039$ ); however, high BD damage and disease duration increase the risk with  $AOR=2.364$ ,  $P=0.009$  and  $AOR=0.769$ ,  $P=0.088$ , respectively.

**Conclusion** Arthritis and active neurological affection are significantly related to falls and FOF; also, FOF is significantly related to active uveitis. Impaired balance, long disease duration, and high disease damage score are significant risk factors for falls and FOF in BD.

**Keywords** Behçet's disease, Falls, Fear of falls, Balance

## Background

Behçet's disease (BD) is an inflammatory autoimmune disorder presented by variable clinical manifestations with waxing and waning disease activity and severity. The main pathologic mechanism is vasculitis affecting all types of blood vessels of different sizes from large to small blood vessels. Therefore, BD affects almost all systems of the body with manifestations varying from oro-genital ulcerations, cutaneous lesions, arthritis, and uveitis up to visual loss, thrombosis, and neurological affection [1, 2].

Balance is a complex process with a multisystem interaction including the ocular, neurological, vestibular, and

musculoskeletal systems. Accordingly, balance is ultimately affected in BD due to eye, joints, and neurological insults with subsequent body unsteadiness and increased rate of falls [3].

Falls are one of the most serious problems in patients with poor balance and the elderly. Falls have been estimated to affect 50% of elder people above 80, causing moderate to severe injury with subsequent hospitalization, high morbidities, and even death [4].

Fear of falling (FOF) is a continuous feeling of fear of falling, making the patients always worried about doing their daily activities effectively. Moreover, FOF may increase the rate of falls by its physical and psychological burden [5]. As the FOF and its determinant are significant risk factors for falls, it has been analyzed in depth for other autoimmune and musculoskeletal disorders such as rheumatoid arthritis and osteoarthritis [6]. Although BD has worse physical and psychological outcomes, until now, very limited studies have appointed the impaired balance and fall in BD.

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In the present study, we aimed to analyze the risk of falls and FOF in patients of BD. Moreover, we studied the risk of falls and FOF in BD with disease activity and damage. This will give a chance for the development of fall prevention programs designed specifically for BD.

## Materials and methods

It is a cross-sectional study.

### Study groups and sample size

This study was conducted on patients with BD fulfilling the International Criteria for Behçet's Disease (ICBD) [7]. Patients were recruited by simple random technique from a list of registered patients. Based on that fear of fall among patients with BD which was 43.3% [3], sample size was calculated to be 64 patients using OpenEpi software, at confidence level 95% and power of study 80%, during period from October 2022 to May 2023. Written informed consent was obtained from all participants.

### Exclusion criteria

Patients with serious comorbidities such as cancer, severe cardiovascular disease, and mental illness were excluded. Also, older patients  $\geq 60$  years old were excluded from the study to eliminate the effect of age on the risk of falls and FOF in this study.

### Data collection and procedures

1. Basic demographics and clinical parameters were collected from the patient's history and clinical examination including general, musculoskeletal, and neurological examination. Laboratory data and current medications were also reported.
2. Assessment of disease activity by Behçet's Disease Current Activity Form (BDCAF) [8] and the disease severity was assessed by Behçet's Damage Index (BDI) [9]. Additionally, the patients were asked about the patients global assessment (PGA), ranging from 0 to 100 with 0 being the best and 100 being the worst. Higher scores represent worse global health [10].
3. *History of falls*: Also, patients were asked about the history and the number of falls within the last 12 months. Falls were defined as sudden loss of upright position and hitting of any part of the body to the floor.
4. *Fear of falling*: It was assessed using the Arabic version of the Falls Efficacy Scale-International (FES-I) in both groups. The FES-I is a self-report questionnaire, providing information about the level of fear from falls during the activities of daily living. The questionnaire contains 16 items scored on a 4-point scale (1 = not at all concerned to 4 = very concerned)

providing a total score ranging from 16, indicating the absence of concern, to 64 which is an extreme concern. The internal consistency (Cronbach's  $\alpha$ ) of the FES-I (Ar) total score was recorded as 0.92 [11].

5. *Balance assessment*: The studied group was evaluated for their balance and stability using the Berg Balance Scale (BBS). The BBS was originally developed for the assessment of postural control and is widely used in many fields of rehabilitation. It is performed using a 5-point ordinal scale to score the participant's performance in 14 given tasks. The maximum score of the BBS is 56, and a score below 40 indicates a fall risk of nearly 100% [12]. The internal consistency of the Arabic version of BBB was 0.91 [13].

### Statistical analysis

Data analysis was performed using the software SPSS (Statistical Package for the Social Sciences) version 26. Categorical variables were described using their absolute frequencies and were compared using the chi-square test, fisher exact, and Monte Carlo tests when appropriate. To compare ordinal data between two groups, chi-square for the trend test was used. The Shapiro–Wilk test was used to verify assumptions for use in parametric tests. Quantitative variables were described using their means and standard deviations or median and interquartile range according to their types. To compare quantitative data between two groups, the independent sample *t*-test (for normally distributed data) and Mann–Whitney test (for non-normally distributed data) were used. Binary logistic regression was used to identify independent risk factors associated with certain health problems. The level of statistical significance was set at  $P \leq 0.05$ . A highly significant difference was present if  $P \leq 0.001$ .

### Results

This study included 64 patients with BD with mean age 35.69 years ( $\pm 8.91$ ). About 69% of them were males. Concerning organ affected, 87.5%, 60.9%, 39.1%, 32.8%, and 23.4% had eye, mucocutaneous, musculoskeletal, neurological, and vascular affection, respectively. Arthritis and arthralgia prevailed in 32.8% and 28.1% of studied patients respectively. Median disease duration was 8 years. Median BDI and BDCAF were 7 and 2, respectively. About 66% had history of falls with median number of fall in last 12 months which was 1.5. Median FES-I was 35, this score is considered as a cut-off point to discriminate between high and low levels of FOF, and 48.4% had scores  $> 35$  which was considered in current study as higher level of FOF (Table 1).

**Table 1** Baseline data of the studied patients ( $n=64$ )

Variable	Behcet patients ( $n=64$ )
<b>Age (year): mean <math>\pm</math> SD</b>	35.69 $\pm$ 8.91
<b>Sex: N (%)</b>	
Female	20 (31.3%)
Male	44 (68.8%)
<b>Disease duration(year): median (IQR)</b>	8 (5.5–12)
<b>BMI (kg/m<sup>2</sup>): mean <math>\pm</math> SD</b>	25.67 $\pm$ 4.06
<b>System affected: N (%)</b>	
Musculoskeletal	25 (39.1%)
Mucocutaneous	39 (60.9%)
Eye	58 (87.5%)
Neurological	21 (32.8%)
Cardiovascular	11 (17.2%)
Vascular	15 (23.4%)
GIT	1 (1.6%)
SNHL or vestibular disorders	11 (17.2%)
Pulmonary	2 (3.2%)
Renal	3 (4.7%)
Others	25 (39.1%)
<b>Clinical presentation: N (%)</b>	
Arthralgia	18 (28.1%)
Arthritis	21 (32.8%)
Pathergy	15 (23.4%)
Mouth ulcer	24 (37.5%)
Genital ulcer	13 (20.3%)
Erythema nodosum	8 (12.5%)
Skin pustules/acne	8 (12.5%)
Active uveitis	13 (20.3%)
Retinal vasculitis	11 (17.2%)
Headache	10 (15.6%)
Deep venous thrombosis	13 (20.3%)
Superficial thrombophlebitis	14 (21.9%)
<b>History of fall (last 12 months)</b>	42 (65.6%)
<b>Number of fall in last 12 months: median (IQR)</b>	1.5 (1–2.25)
<b>Disease activity (BDCAF)</b>	
Active	35 (54.6%)
Inactive	29 (45.4%)
<b>BDCAF score: median (IQR)</b>	2 (1–3)
<b>BDI score: median (IQR)</b>	7 (5–10.75)
<b>FES-I score (0–64): median (IQR)</b>	35 (30–48) > 35 (31 (48.4%))
<b>BBS score (0–56): median (IQR)</b>	38 (26–46.5)

BBS Berg Balance Scale, FES-I Falls Efficacy Scale-International, BDCAF Behcet Disease Current Activity Form, BDI Behcet damage index, SNHL sensorineural hearing loss

### Predictors of the risk of falls among BD patients

In studying the relationship between the history of falls and clinical parameters of BD patients, the patients were

divided according to the history of falls into two groups: fallers and non-fallers. There were significantly higher levels of BMI ( $P=0.007$ ), disease duration ( $P=0.015$ ), BDCAF ( $P<0.001$ ), FES-I ( $P<0.001$ ), PGA-100 ( $P<0.001$ ), and the use of biological therapy ( $P=0.036$ ) between fallers than non-fallers, while the BBS was significantly lower in the faller group ( $P<0.001$ ). Moreover, there was a significantly higher degree of total BDI score in the faller group ( $P<0.001$ ) and some BDI domains including musculoskeletal, eye, neurological, and ENT ( $P=0.016$ ,  $P=0.016$ ,  $P=0.004$ ,  $P=0.011$ ), respectively. As regards disease activity, there were significant relations between fallers with arthritis ( $P=0.003$ ) and active neurological affection ( $P=0.004$ ) than non-fallers. On the other hand, there was nonsignificant relation between the history of falls and either age, gender, other BDI domains, laboratory data, or other therapeutic options (Table 2).

### Predictors of high levels of fear of falls among BD patients

Patients of BD were classified according to the FES-I median score of 35 into two groups: patients with high levels of FOF and low levels of FOF. There were significant relations between high levels of FOF and a previous history of falls ( $P<0.001$ ), BDCAF ( $P<0.001$ ), total BDI ( $P<0.001$ ), the neurological domain of BDI ( $P=0.041$ ) and PGA-100 ( $P<0.001$ ), active arthritis ( $P=0.041$ ), active uveitis ( $P=0.03$ ), and active neurological affection ( $P=0.022$ ). Patients with high levels of FOF showed higher levels of these parameters compared to patients with low FOF; however, the balance scale was significantly lower in the high-level group ( $P<0.001$ ). On the other hand, there was nonsignificant relation between FOF and either age, gender, other BDI domains, laboratory data, or other therapeutic options (Table 3).

Regarding the multivariate regression analysis of factors associated with a positive history of falls, higher BBS was found to significantly and independently decrease the risk of falls ( $AOR=0.79$ ,  $P=0.005$ ); however, lower disease duration was found to nonsignificantly decrease the risk ( $AOR=0.769$ ,  $P=0.088$ ). Additionally, a high total BDI score ( $P=0.009$ ) and the use of biological therapy ( $P=0.035$ ) were found to significantly increase the risk of falls by 2.364- and 15.807-folds, respectively. As regard factors associated with higher levels of fear of falls, higher BBS was found to significantly and independently decrease the risk of FOF ( $AOR=0.904$ ,  $P=0.039$ ), while increased PGA nonsignificantly increased risk by 1.044-folds (Table 4).

**Table 2** Relation between the history of falls and the studied parameters in Behcet's patients

	Non-fallers N = 22 (%)	Fallers N = 42 (%)	$\chi^2$	P
<b>Male gender</b>	14 (63.6%)	30 (71.4%)	0.408	0.523
<b>Married</b>	14 (63.6%)	29 (69%)	0.192	0.661
<b>Age</b>	31.5 ± 7.65	34.1 ± 9.35	−1.119 <sup>b</sup>	0.267
<b>BMI</b>	25.91 ± 3.52	29.67 ± 6.09	−2.765 <sup>b</sup>	<b>0.007*</b>
<b>Disease duration</b>	6.5 (3.75–9.25)	9 (7–13)	−2.44	<b>0.015*</b>
<b>BDCAF (total)</b>	1 (0.75–2)	2 (1–3)	−3.636 <sup>a</sup>	<b>&lt;0.001**</b>
<b>Main systems activity</b>				
Arthritis	2 (9.1%)	19 (45.2%)	8.557	<b>0.003*</b>
Uveitis	6 (13.6%)	7 (45.4%)	1.003	0.317
Neurological affection	3 (9.1%)	19 (21.4%)	Fisher	<b>0.004*</b>
<b>BDI (total)</b>	4 (2.75–5)	10 (6–12.25)	−5.168 <sup>a</sup>	<b>&lt;0.001**</b>
<b>Organ damaged in BDI</b>				
Musculoskeletal	4 (18.2%)	21 (50%)	Fisher	<b>0.016*</b>
Mucocutaneous	10 (45.5%)	29 (69%)	3.376	0.066
Eye	16 (72.7%)	40 (95.2%)	Fisher	<b>0.016*</b>
Neuro-Behcet	2 (9.1%)	19 (45.2%)	Fisher	<b>0.004*</b>
Cardiovascular	2 (9.1%)	9 (21.4%)	Fisher	0.304
Vascular	3 (86.4%)	12 (28.6%)	Fisher	0.226
GIT	1 (4.5%)	0 (0%)	Fisher	0.344
SNHL/vestibular disorders	0 (0%)	11 (26.2%)	Fisher	<b>0.011*</b>
Pulmonary	0 (0%)	2 (4.8%)	Fisher	0.542
Renal	0 (0%)	3 (7.1%)	Fisher	0.545
Others	5 (22.7%)	20 (47.6%)	3.758	0.053
<b>PGA (0–100)</b>	30 (10–40)	60 (50–80)	−4.898§	<b>&lt;0.001**</b>
<b>FES-I score (0–64)</b>	29.5 (18.75–34)	46 (34–51.25)	−4.825§	<b>&lt;0.001**</b>
<b>BBS (0–56)</b>	48 (41.75–54.25)	31 (20–39.25)	−5.319§	<b>&lt;0.001**</b>
<b>BBS categories</b>				
High	0 (0%)	8 (19%)		
Moderate	19 (86.4%)	11 (26.2%)	1.532 <sup>c</sup>	0.216
Low	3 (13.6%)	23 (54.8%)		
<b>Laboratory</b>				
ESR	23.5 (13.75–36.5)	17 (10–29)	−1.401§	0.161
CRP	5.75 (3.05–11.75)	4.75 (2.3–12.25)	−0.283§	0.777
<b>Medications</b>				
Analgesia	4 (18.2%)	10 (23.8%)	Fisher	0.755
NSAIDs	3 (13.6%)	12 (28.6%)	Fisher	0.226
Steroids	15 (68.2%)	35 (83.3%)	1.939	0.164
Azathioprine	15 (68.2%)	22 (52.4%)	1.478	0.224
Cyclosporine	0 (0%)	3 (7.1%)	Fisher	0.545
Cyclophosphamide	1 (4.5%)	8 (19%)	Fisher	0.147
Colchicine	14 (63.6%)	29 (69%)	0.192	0.661
Biological therapy	6 (27.3%)	23 (54.8%)	4.403	<b>0.036*</b>
Biosimilar	1 (4.5%)	3 (7.1%)	Fisher	>0.999

BBS Berg Balance Scale. BDCAF Behcet Disease Current Activity Form. BDI Behcet damage index. NSAIDs nonsteroidal anti-inflammatory drugs, PGA a patient global assessment, SNHL sensorineural hearing loss

\*  $P \leq 0.05$  is statistically significant

\*\*  $P \leq 0.001$  is statistically highly significant

<sup>a</sup> Data is represented as median (interquartile range) and compared using Mann–Whitney test

<sup>b</sup> data is represented as mean ± SD and compared using independent sample *t*-test,  $\chi^2$  chi-square test

<sup>c</sup> chi-square for trend test

**Table 3** Relation between the fear of falls and the studied parameters in Behcet's patients

	Lower levels fear of falls N = 33 (%)	Higher levels fear of fall N = 31 (%)	$\chi^2$	p
<b>Male gender</b>	22 (66.7%)	22 (71%)	0.138	0.711
<b>Positive history of fall</b>	14 (42.4%)	28 (90.3%)	6.256	<b>&lt;0.001**</b>
<b>Age</b>	32.64 ± 8.44	33.81 ± 9.33	−0.527 <sup>b</sup>	0.6
<b>BMI</b>	27.24 ± 5.44	29.35 ± 6.24	−1.447 <sup>b</sup>	0.135
<b>Disease duration</b>	7 (5–10.5)	9 (7–13)	−1.429 <sup>a</sup>	0.153
<b>BDCAF (total)</b>	1 (1–2)	2 (1–3)	−3.643 <sup>a</sup>	<b>&lt;0.001**</b>
<b>Main systems activity</b>				
Arthritis	7 (21.2%)	14 (45.2%)	4.159	<b>0.041*</b>
Uveitis	3 (9.1%)	10 (32.3%)	Fisher	<b>0.03*</b>
Neurological affection	7 (21.2%)	15 (48.4%)	5.232	<b>0.022*</b>
<b>BDI (total)</b>	5 (4–8)	10 (5–13)	−3.54 <sup>a</sup>	<b>&lt;0.001**</b>
<b>Organ damaged in BDI</b>				
Musculoskeletal	10 (30.3%)	15 (48.4%)	2.196	0.138
Mucocutaneous	18 (54.5%)	21 (67.7%)	1.169	0.28
Eye	27 (81.8%)	29 (93.5%)	Fisher	0.259
Neuro-Behcet	7 (21.2%)	14 (45.2%)	4.159	<b>0.041*</b>
Cardiovascular	5 (15.2%)	6 (19.4%)	0.198	0.656
Vascular	6 (18.2%)	9 (29%)	1.049	0.306
GIT	0 (0%)	1 (3.2%)	Fisher	0.484
SNHL/vestibular disorders	3 (9.1%)	8 (25.8%)	Fisher	0.103
Pulmonary	1 (3%)	1 (3.2%)	Fisher	>0.999
Renal	1 (3%)	2 (6.5%)	Fisher	0.607
Others	10 (30.3%)	15 (48.4%)	2.196	0.138
<b>PGA (0–100)</b>	30 (20–50)	70 (50–80)	−5.216 <sup>a</sup>	<b>&lt;0.001**</b>
<b>BBS (0–56)</b>	45 (38–53)	26 (19–36)	−5.358 <sup>a</sup>	<b>&lt;0.001**</b>
<b>BBS categories</b>				
High	1 (3%)	7 (22.6%)		
Moderate	23 (69.7%)	7 (22.6%)	0.224 <sup>c</sup>	0.636
Low	9 (27.3%)	17 (54.8%)		
<b>ESR</b>	19 (14.5–32.5)	17 (8–29)	−1.372 <sup>a</sup>	0.17
<b>CRP</b>	5 (3.55–9.5)	4.3 (2–15)	−0.188 <sup>a</sup>	0.851
<b>Medications</b>				
Analgesia	5 (15.2%)	9 (29%)	1.802	0.179
NSAIDs	7 (21.2%)	8 (25.8%)	0.188	0.665
Steroids	25 (75.8%)	25 (80.6%)	0.223	0.663
Azathioprine	19 (57.6%)	17 (58.1%)	0.002	0.968
Cyclosporine	1 (3%)	2 (6.5%)	Fisher	0.607
Cyclophosphamide	3 (9.1%)	6 (19.4%)	Fisher	0.296
Colchicine	19 (57.6%)	24 (77.4%)	2.855	0.091
Biological therapy	13 (39.4%)	16 (56.1%)	0.963	0.326
Biosimilar	1 (3%)	3 (9.7)	Fisher	0.347

BBS Berg Balance Scale. BDCAF Behcet Disease Current Activity Form. BDI Behcet damage index. NSAIDs nonsteroidal anti-inflammatory drugs. PGA a patient global assessment. SNHL sensorineural hearing loss

\*  $P < 0.05$  is statistically significant

\*\*  $P \leq 0.001$  is statistically highly significant

<sup>a</sup> Data is represented as median (interquartile range) and compared using Mann–Whitney test

<sup>b</sup> Data are represented as mean ± SD and compared using an independent sample *t*-test.  $\chi^2$  chi-square test.

<sup>c</sup> Chi-square for trend test

**Table 4** Binary regression analysis of factors associated with falls and fear of falls among BD patients

Case	Predictors	B	P	AOR	95% CI	
					Lower	Upper
History of falls	Disease duration	−0.262	0.088	0.769	0.569	1.040
	BDI	0.860	<b>0.009*</b>	2.364	1.235	4.525
	Berg Balance Scale (BBS)	−0.235	<b>0.005*</b>	0.790	0.672	0.930
	Biological therapy	2.760	<b>0.035*</b>	15.807	1.211	206.386
Fear of fall	(PGA)1–100	0.043	0.067	1.044	0.997	1.094
	Berg Balance Scale (BBS)	−0.101	<b>0.039*</b>	0.904	0.821	0.995

AOR adjusted odds ratio. CI confidence interval. BBS Berg Balance Scale. BDI Behçet damage index. PGA a patient global assessment

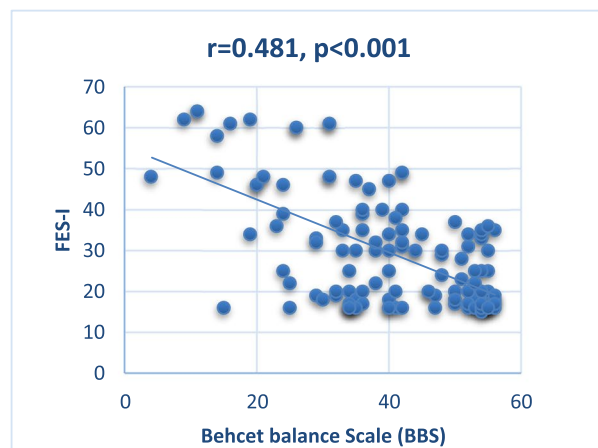
\*  $P < 0.05$  is statistically significant

### Correlation between FES-I and the studied parameters

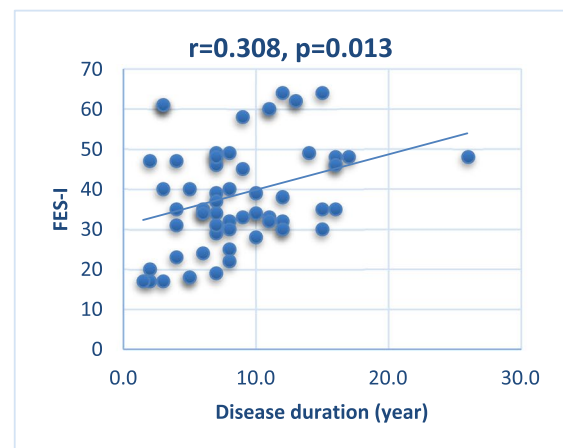
Significant positive correlations were detected between FES-I score and disease duration ( $r = 0.308$ ,  $P = 0.013$ ), total BDI ( $r = 0.542$ ,  $P < 0.001$ ), and BDCAF ( $r = 0.446$ ,  $P < 0.001$ ), while there was a significant negative correlation between FES-I and the BBS ( $r = -0.481$ ,  $P < 0.001$ ) (Fig. 1).

### Discussion

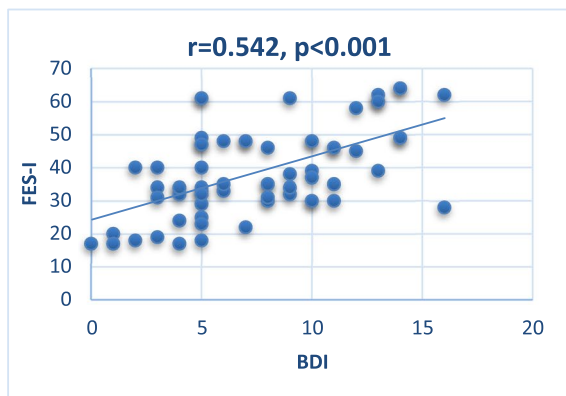
BD is an inflammatory vasculitic disorder affecting many systems in the body such as the mucocutaneous, musculoskeletal, ocular, neurological, and vascular systems [14]. Accordingly, BD patients may develop a high degree of instability and balance impairment with



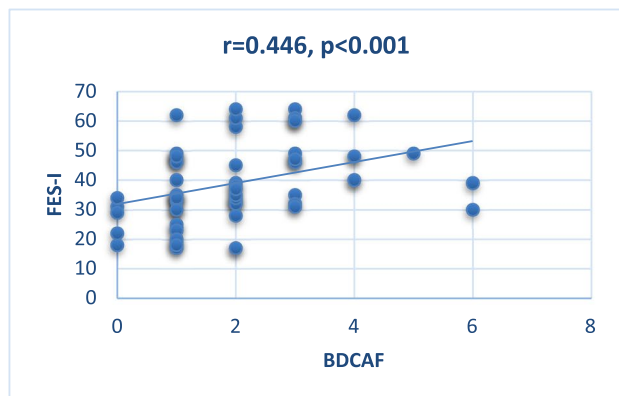
**a:** A significant *negative* correlation



**b:** A significant *positive* correlation



**c:** A significant *positive* correlation



**d:** A significant *positive* correlation

**Fig. 1** **a** The correlation between FES-I and Berg Balance Scale (BBS) in patients with BD. **b** The correlation between FES-I and disease duration in patients with BD. **c** The correlation between FES-I and BDI in patients with BD. **d** The correlation between FES-I and BDCAF in patients with BD



subsequent increased risk of falls and poor quality of life [15]. In the current study, we evaluated the risk of falls and FOF in patients of BD compared to healthy controls and their relations with the disease activity, permanent damaged systems, and balance assessment in BD patients.

In the current study, a history of falls in BD patients within the faller group showed a significant relation with higher levels of BMI, disease duration, BDCAF (especially arthritis and active neurological symptoms), FES-I, and PGA-100 scores than non-fallers. However, the BBS was significantly lower in the fallers than in the non-faller group. Similarly, Uzkeser et al. found a significant correlation between the fall risk in BD patients and some of the disease activity parameters including the presence of arthritis, VAS, and total BDCAF score [16].

Moreover, there was a significant relation between faller group in BD patients and total score of Behcet's Damage Index (BDI), especially in musculoskeletal, eye, neurological, hearing loss, and vestibular disorders. Bakhshaei et al. and Ahmed had reported that hearing loss and dizziness were the fourth most common presentation among the different clinical presentations of BD patients [17, 18].

Vasculitis of BD affects vestibular system in its peripheral and central parts; also, high-frequency hearing loss was found in 24 to 55% of BD patients. Abdel Baki et al. reported that high-frequency audiometry has a role in hearing loss detection in BD patients as well as the conventional pure-tone audiometry. Moreover, abnormal cervical vestibular-evoked myogenic potential (cVEMP) was found in 92% of BD patients, making cVEMP test valuable in evaluation of vestibular functions. Also, auditory-evoked potentials and otoacoustic emissions were found to be valuable in early detection of hearing abnormalities in BD patients [19, 20].

In this study, BD patients with high levels of FOF showed significantly higher BDCAF (especially arthritis, active uveitis, and neurological manifestations), PGA-100, and lower BBS compared to patients with low levels of fear of falls. In contrary with Uzkeser et al., we found no difference in the risk of falls among patients with uveitis and patients without uveitis [16].

FOF was significantly higher in patients with a previous history of falls and patients with neurological manifestations. Another study by Akyol et al., who studied FOF and fall risk in rheumatoid arthritis, stated that FOF and FES-I were significantly higher, while balance scores were lower, in rheumatoid patients than controls [5]. These findings were attributed to the multisystem

involvement in rheumatic patients especially affection of the musculoskeletal, neurological, ocular, and vascular systems with subsequent poor balance and increased fall [21].

Moreover, the FES-I score showed a significant positive correlation with BD activity and damage parameters like disease duration, total BDI, BDCAF, and a negative correlation with the BBS. In fact, FOF is a multifactorial syndrome caused by the interaction of physiological, physical, and psychological factors in adults [22]. Moreover, Fruya et al. stated that increased disability and impaired general health were associated with a high incidence of FOF [23]. In our study, balance impairment due to high disease activity and damage was an independent significant risk factor for FOF in BD patients ( $AOR=0.904$ ,  $P=0.039$ ).

To the best of our knowledge, this is the first study to evaluate the relationship between the risk of falls and FOF in BD and BD organ damage. The total BDI score was found to be higher in patients with a history of falls and patients with high levels of fear of falls. The musculoskeletal, eye, and neurological systems damage in addition to SNHL and vestibular disorders were significantly associated with falls in BD patients; however, only the neurological damage showed significant relation with FOF in BD patients. This can be explained by Celenay et al., who stated that the central nervous system is crucial for postural control and body balance. It works in coordination with motor, sensory, vestibular, and ocular systems to maintain body posture, movement, and balance [24].

Regarding medication usage, we found a significant relation between the history of falls and the use of biological drugs. This can be explained by the long disease duration with high activity and subsequent damage affecting the ocular, musculoskeletal, and neurological systems, thus warranting the treatment by biologics, in patients with a history of falls. On the other hand, Uzkeser et al. reported no relation between the risk of falls in BD patients and the use of medications like colchicine, steroids, and azathioprine [16].

Moreover, the multivariate regression analysis of factors associated with previous falls in our patients showed that impaired balance, long disease duration, high BDI, and the use of biologics were the most fundamental risk factors for falls in BD patients.

One of the limitations of our study is the subjective nature of data collection from the studied groups about the history of falls. More objective methods and investigations like visual and auditory brainstem-evoked potential could not be done, and we recommend doing them in future studies. The relatively small sample size

may be another drawback; however, we recommend larger studies with different ethnic groups' enrolment in future studies. One of the strengths of the current study is evaluating the relation between BD damage and the history of falls and FOF in BD patients. Moreover, we studied the risk factors for falls and FOF in BD to help in developing a fall prevention program specific to BD patients.

## Conclusion

Arthritis and active neurological affection are significantly related to falls and FOF; also, FOF is significantly related to active uveitis. Impaired balance, long disease duration, and high disease damage score are significant risk factors for falls and FOF in BD. Strategies for the prevention of falls and managing FOF should be considered a crucial part of BD patients' care.

## Abbreviations

BBS	Berg Balance Scale
BD	Behçet's disease
BDCAF	Behçet's Disease Current Activity Form
BDI	Behçet's Damage Index
cVEMP	Cervical vestibular-evoked myogenic potential
FES-I	Falls Efficacy Scale-International
FOF	Fear of falling
PGA	Patient's global assessment
SNHL	Sensorineural hearing loss

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## Authors' contributions

All authors contributed. D, R, and D, collecting the clinical data of the patients, A did statistical analysis, and all shared in the writing process.

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## Availability of data and materials

We approve the availability of our data upon request.

## Declarations

### Ethics approval and consent to participate

An official permission was obtained from Institutional Review Board (No. ZU-IRB#9826-4-10-2022) at Faculty of Medicine, Zagazig University Hospitals, and from the Rheumatology & Rehabilitation. The study has been carried out in accordance with the Code of Ethics of the World Medical Association (Declaration of Helsinki 1964) for studies involving humans. A written informed consent was obtained from the participants.

### Consent for publication

Not applicable.

### Competing interests

The authors declare that they have no competing interests.

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