Influence of Vitamin D Status on Fatigue in Ankylosing Spondylitis

Rawdha Tekaya[1,2], Ons Hamdi[1,2], Ines Jemmali[2,3], Aicha Ben Tekaya[1,2], Leila Rouached[1,2], Olfa Saidane[1,2], Selma Bouden[1,2], Kahena Bouzid[2,3], Ines Mahmoud[1,2], Leila Abdelmoula[1,2]

[1] *Department of Rheumatology, Charles Nicolle Hospital, Tunis, Tunisia*
[2] *Faculty of Medicine of Tunis, University Tunis el Manar, Tunis, Tunisia*
[3] *Department of Biochemistry, Charles Nicolle Hospital, Tunis, Tunisia*

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Abstract- Fatigue is a common symptom in ankylosing spondylitis. Hypovitaminosis D is one of the factors influencing fatigue during inflammatory rheumatisms. This study aimed to determine the influence of vitamin D deficiency on fatigue in ankylosing spondylitis. In this cross-sectional study, 40 patients with ankylosing spondylitis and 40 patients suffering from low back pain were recruited. Clinical and laboratory data, including vitamin D dosage, disease activity, functional impairment, and quality of life, were evaluated using specific and validated scores. Fatigue was assessed by the FACIT-F score. Both groups of patients were compound of 27 men and 13 women with a mean of 43.55±12.26 years in the study group and 47.77±13.63 years in the case group, respectively. Ankylosing spondylitis was active according to the $ASDAS_{CRP}$ score in 67.5% of cases. All patients were suffering from fatigue with a mean FACIT-F score of 21.13. Severe levels of fatigue were noted in 50% of cases. 92.5% of patients were vitamin D deficient with a mean vitamin D of 16.57±7.15 ng/mL. Factors associated with fatigue were: female gender (P=0.05), spinal pain (P<0.001), enthesitis (P<0.001), disease activity (P<0.001), functional impairment (P<0.001), and quality of life (P<0.001). However, smoking was the only factor related to vitamin D deficiency (P=0.05). Vitamin D level was not correlated with fatigue (r= -0.02, P=0.91). In our study, vitamin D status did not seem to have an impact on fatigue in patients with ankylosing spondylitis.

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Keywords: Ankylosing spondylitis; Fatigue; Vitamin D; Low back pain

Introduction

Ankylosing spondylitis (AS) is a chronic rheumatic disease that affects mostly the sacroiliac joints and the spine. In addition to pain and stiffness, fatigue is a major clinical feature of AS (1-3). It is a frequent symptom that affects up to 50 to 65% of patients with AS (4,5). Yet it has been often ignored by health professionals (1-3). In fact, fatigue in AS results from various factors that can involve socio-demographic components, psychological factors (6-8), and disease activity (9,10). Elsewhere, the influence of vitamin D deficiency on fatigue levels has been reported in various chronic inflammatory diseases, e.g., systemic lupus erythematosus, rheumatoid arthritis, fibromyalgia, multiple sclerosis, and cancer (11-16).

Vitamin D deficiency has been associated with AS (17-19). In fact, some studies have demonstrated a significant negative correlation between vitamin D deficiency and disease activity in AS (20-22). However, to our knowledge, the relationship between hypovitaminosis D and fatigue during AS has not been evaluated. Little data is known on the prevalence of fatigue and its association with vitamin D deficiency (23).

The aim of this study was to determine the influence of vitamin D deficiency on fatigue in AS and to assess the fatigue levels in patients with AS.

Materials and Methods

Study design and patients

Our cross-sectional study recruited 40 patients with AS and 40 patients suffering from low back pain,

Corresponding Author: O. Hamdi
Department of Rheumatology, Charles Nicolle Hospital, Tunis, Tunisia
Tel: +21625744436, Fax: +21625744436, E-mail address: onshamdi25@outlook.fr

compiled from Charles Nicole Hospital's rheumatologic department over a period of seven months between April and October 2016 (best sunny season in our country). The inclusion criteria in the AS group were patients over the age of 18 meeting the New York modified criteria. The inclusion criteria in the low back pain group were an age over 18 in patients having mechanical low back pain evolving for more than six months. The study was approved by the local medical ethics committee and all patients gave their written informed consent for the study.

Investigated variables

Sociodemographic data and characteristics of rheumatic disease were collected, insufficient sun exposure was defined as follows: outdoors duration exposure less than 15 minutes, wearing hats or sails, sunscreen.

AS group specific data was collected (clinical details including activity scores illness (ASAS Disease Activity Score: $ASDAS_{CRP}$ (24), Bath AS Disease Activity Index: BASDAI (9)), functional disability (Bath AS Functional Index score: BASFI (25)), evaluation of enthesopathy (MASES score) and quality of life (Health Assessment Questionnaire: HAQ (26), AS Quality Of Life: ASQOL (27)) and laboratory findings including vitamin D dosage).

We also collected specific data of the low back pain group (clinical features as well as functional disability (the EIFEL questionnaire) (28), quality of life (HAQ) and laboratory data).

Fatigue was assessed by FACIT-F score (Functional Assessment of Chronic Illness Therapy-Fatigue scale) (FACIT-Fatigue) in both groups of patients.

Definition of variables

Deficit in vitamin D was defined for a vitamin D rate ≤10 ng/mL. An insufficient rate was defined for a vitamin D rate between 10 and 30 ng/mL.

Fatigue was considered severe if the FACIT-F score is <20, moderate for a scale between 20 and 40 and low if the score is ≥40.

Statistical analysis

Statistical analysis was performed using the Statistical Package for the Social Sciences software (SPSS). Descriptive data are presented as mean+/-SD when referring to quantitative variables and as absolute frequencies and percentages when referring to qualitative ones.

The variance analysis (ANOVA) was used to compare the averages. The percentages were compared by the Pearson Chi2 test or the Fisher test if the Chi2 was not applicable.

Univariate logistic regressions were performed to compare the two groups of patients, the low back pain group of patients being the control group. The study of the correlation between the different parameters of the groups was carried out by the Pearson correlation coefficient (r), which varies from (-1) (perfect negative correlation) to (+1). The significance threshold in all the statistical tests was set at 0.05.

Results

There were eighty patients in our study subdivided into two groups. Both groups of patients were compound of 27 men and 13 women with an average age of 43,55 years±12,26 for the study group and an average age of 47,77 years±13,63 for the control group. For both groups, insufficient sun exposure was observed in 20% of the cases. There were no statistically significant differences in terms of demographic and clinical features between the study and the control groups.

Disease characteristics in the study group

The mean age at onset in the AS group was 30.07±11.50 years. The mean disease duration was 13.45±8.7 years. Fifty percent of the patients were smokers AS was active in 65% of cases according to the BASDAI and the $ASDAS_{CRP}$ scores with a mean BASDAI of 4.69±2.60 and a mean $ASDAS_{CRP}$ of 2.57±0.97. A significant functional disease impact was noted in 67.5% of cases with a mean BASFI score of 5.55±3.21. An Impairment of the quality of life was recorded in 50% of the patients according to the ASQOL score and in 42.5% with the HAQ. All patients were suffering from fatigue. A severe fatigue level was noted in 37.5% of cases, a moderate level in 42.5% of cases, and a low level of fatigue in only 20% of cases. Twenty percent of patients had vitamin D deficiency, and 72.5% had an insufficient vitamin D level.

Factors associated with fatigue

Fatigue level, assessed by the FACIT-F score, was similar in both groups (P=0.17). A significant correlation was found between the FACIT-F score and the female gender in both groups; however, the female gender was strongly associated with severe fatigue in the control group only (P<0.001). Spinal pain was correlated with FACIT-F score (P<0.001) in both groups. In the study group, MASES score was significantly correlated with the FACIT-F score (r= -0.68, P<0.001) with an influence

of severe fatigue on the intensity of the pain (*P*=0.003). There was also a significant correlation between disease activity scores (BASDAI and $ASDAS_{CRP}$) and FACIT-F score (*P*<0.001). Logistic regression showed that BASDAI was the strongest predictor of severe fatigue (*P*=0.001). The other factors related to the fatigue were the functional disability, assessed in both groups respectively by the BASFI and EIFEL scores (*P*<0.001), and the quality of life (HAQ and ASQOL) (*P*<0.001). Table 2 summarizes the influence of the different parameters studied on the fatigue level assessed by the FACIT-F score in both groups.

Factors associated with vitamin D

There is a significant difference between the two groups in vitamin D with a lower rate in the control group (*P*=0.001). In both groups, smoking was significantly associated with vitamin D. Table 3 summarizes the influence of the different parameters studied on vitamin D in both groups.

Fatigue and vitamin D

Vitamin D level was not correlated with fatigue level (r= -0.02, *P*=0.91). In addition, vitamin D deficiency did not affect the degree of fatigue in the AS patients (*P*=0.13). Also, severe fatigue was not correlated with vitamin D (*P*=0.84). A statistically significant correlation was found between vitamin D and FACIT-F score in the low back pain group (r= +0.37, *P*=0.02).

Table 1. Clinical and laboratory findings in both groups

Variable		Study group	Control group	*P*
Age (years)		43.55 ± 12.26	47.77 ± 13.63	0.57
Disease duration (years)		13.45 ± 8.70	6.07 ± 5.92	
Schöber index (cm)		2.58 ± 1.60	3.27 ± 1.27	
MASES score		6.70 ± 4.50	-	
BASDAI		4.69 ± 2.60	-	
$ASDAS_{CRP}$		2.57± 0.97	-	
BASFI		5.55 ± 3.21	-	
ASQOL		9.03 ± 6.11	-	
HAQ		0.96 ± 0.71	0.75 ± 0.46	
EIFEL		-	14.05 ± 5.45	
Calcium (mmol/L)		2.32 ± 0.09	2.35 ± 0.13	
Serum Phosphate (mmol/L)		1.07 ± 0.17	1.10 ± 0.17	
Alkaline Phosphatase (PAL) (U/L)		87.07 ± 21.35	72.69 ± 25.98	
Albumin (g/L)		42.13 ± 2.65	43.62 ± 1.91	
Vitamin D	**Mean rate (ng/mL)**	16.57 ± 7.15	12.04 ± 4.84	0.001
	Deficiency	8 patients (20%)	16 patients (40%)	
	insufficiency	29 patients (72.5%)	24 patients (60%)	
FACIT-F score	**FACIT-F average**	21.13 ± 14.47	25.40 ±13.36	0.17
	Severe fatigue	15 patients (37.5%)	20 patients (50%)	
	Moderate fatigue	17 patients (42.5%)	14 patients (35%)	
	Low fatigue	8 patients (20%)	6 patients (15%)	
Male/Female		27/13	27/13	
Spinal pain		38 patients (95%)	-	
Enthesopathy		33 patients (82.5%)	-	

Table 2. Influence of the studied parameters on the fatigue level in both groups

FACIT-F	AS group	Back pain group
Age	*P*=0.19	*P*=0.16
Female gender	*P*=0.05	*P*=0.006
Smoking	*P*=0.66	*P*=0.37
Disease duration	*P*=0.38	*P*=0.34
Spinal pain	*P*<0.001	*P*=0.05
Enthesitis	*P*=0.001	--
BASDAI	*P*<0.001	--
$ASDAS_{CRP}$	*P*<0.001	--
Functional disability	*P*<0.001	*P*<0.001

Table 3. Influence of the studied parameters on vitamin D levels

Vitamin D	AS group	Back pain group
Age	*P*=0.71	*P*=0.71
Female gender	*P*=0.13	*P*=0.03
Smoking	*P*=0.05	*P*=0.03
Disease duration	*P*=0.96	*P*=0.63
Spinal pain	*P*=0.92	*P*=0.08
Enthesitis	*P*=0.91	--
BASDAI	*P*=0.93	--
$ASDAS_{CRP}$	*P*=0.96	--
Functional disability	*P*=0.91	*P*=0.18

Table 4. Results of major studies on the influence of age and sex on fatigue levels in ankylosing spondylitis

Authors/ year	Country	Number of patients	Fatigue measuring instrument	Age	Gender
Dernis-Labous *et al.*, (29) 2003	France	639	Q1 BASDAI	*P*>0.05	*P*=0.01
Da Costa *et al.*, (30) 2004	Canada	66	Q1 BASDAI	*P*>0.05	*P*>0.05
Dagfinrud *et al.*, (31) 2005	Norway	152	Q1 BASDAI SF-36 vitality	*P*>0.05	*P*<0.001
Hamdi *et al.*, (32) 2007	Tunisia	110	Q1 BASDAI SF-36 vitality	*P*>0.05	*P*=0.014
Aissaoui *et al.*, (33) 2012	Morocco	110	Q1 BASDAI MAF	*P*>0.05	*P*=0.004
Alkan *et al.*, (34) 2012	Turkey	110	Q1 BASDAI MAF	*P*>0.05	*P*=0.014
Haywood *et al.*, (35) 2014	United Kingfom	612	Q1 BASDAI	*P*>0.05	*P*>0.05
Schneeberg *et al.*, (36) 2015	Argentina	64	FSS	*P*>0.05	*P*>0.05
Gossec *et al.*, (37) 2016	France	486	Q1 BASDAI	*P*>0.05	*P*=0.05
E Mogard *et al.*, (38) 2019	Sweden	940	Q1 BASDAI	-	*P*<0.001
Our study (2017)	Our department	40	Q1 BASDAI FACIT-T	*P*=0.9	*P*=0.05

Q1 BASDAI: the first question of BASDAI, SF-36 Vitality: Short form-36 Vitality, FSS: Fatigue severity scale, MAF: Multidimensional assessment of fatigue

Table 5. Results of studies that assessed the correlation between spinal pain and fatigue

Authors/ year	Country	Number of patients	Pain measuring instrument	Correlation with fatigue
Van Tubergen *et al.*, (8) 2002	*Netherlands*	*812*	*VAS fatigue*	*P=0.011*
Dernis-Labous *et al.*, (29) 2003	*France*	*639*	*VAS fatigue*	*P<0.001*
Revicki *et al.*, (39) 2011	*USA*	*397*	*VAS fatigue*	*P=0.013*
Bodur *et al.*, (40) 2011	*Turkey*	*962*	*VAS fatigue*	*P<0.001*
Aissaoui *et al.*, (33) 2012	*Morocco*	*110*	*VAS fatigue*	*P<0.001*
Cho *et al.*, (41) 2013	*South-Korea*	*36*	*VAS fatigue*	*P<0.05*
Haywood *et al.*, (35) 2014	*United Kingdom*	*612*	*VAS fatigue*	*P<0.001*
Bianchi *et al.*, (5) 2014	*Brazil*	*1492*	*VAS fatigue*	*P=0.13*
Rintek Madsen (42) 2018	*Denmark*	*107*	*VAS fatigue*	*P=0.05*
Connolly *et al.*, (43) 2019	*Ireland*	*50*	*VAS fatigue*	*P=0.001*
Our study (2017)	*Our department*	*40*	*VAS fatigue*	*P<0.001*

VAS: Visual analog scale

Table 6. Results of studies that assessed the correlation between disease activity, functional Impairment, and fatigue in ankylosing spondylitis

Authors/ year	Country	Number of patients	Correlation with BASDAI	Correlation with BASFI
Van Tubergen (8) 2002	Netherlands	812	*P*<0.001	*P*=0.018
Dagfinrud *et al.*, (31) 2005	Norway	152	*P*<0.001	*P*<0.001
Hamdi *et al.*, (32) 2007	Tunisia	110	*P*<0.001	*P*=0.033
Revicki *et al.*, (39) 2011	USA	397	*P*<0.001	*P*<0.001
Bodur *et al.*, (40) 2011	Turkey	962	*P*<0.001	*P*<0.001
Aissaoui *et al.*, (33) 2012	Morocco	110	*P*<0.001	*P*<0.001
Haywood *et al.*, (35) 2014	United Kingdom	612	*P*<0.001	*P*<0.001
Stebbing *et al.*, (44) 2014	New Zeland	67	*P*<0.001 $ASDAS_{CRP}$: *P*<0.05	
Bianchi *et al.*, (5) 2014	Brazil	1492	*P*<0.001	*P*<0.001
Bedaiwi *et al.*, (45) 2015	Canada	681	*P*<0.001 $ASDAS_{CRP}$: *P*<0.001	*P*<0.001
Gossec *et al.*, (37) 2016	France	486	*P*<0.001 $ASDAS_{CRP}$: *P*<0.001	*P*<0.001
Rintek Madsen (42) 2018	Denmark	107	*P*= -0.08	*P*=0.03
Connolly *et al.*, (43) 2019	Ireland	50	*P*=0.001	*P*=0.002
Our study (2017)	Our department	40	*P*<0.001 $ASDAS_{CRP}$: *P*<0.001	*P*<0.001

Table 7. Results of studies on the relationship between disease activity and vitamin D levels during ankylosing spondylitis

Authors/ year	Country	Number of patients	Correlation with BASDAI score	Correlation with $ASDAS_{CRP}$ score
Arends *et al.*, (46) 2011	Netherlands	128	*P*>0.05	*P*>0.05
Braun-Moscovici *et al.*, (47) 2011	Israel	121	*P*=0.57	--
Cai *et al.*, (48) 2015	China	533	*P*=0.06	--
Urruticoechea-Arana *et al.*, (49) 2015	Spain	738	*P*=0.04	
Hmamouchi *et al.*, (50) 2016	France	700	*P*<0.05	*P*<0.05
Klinberg *et al.*, (51) 2016	Sweden	203	*P*=0.82	*P*=0.82
Mitulescu *et al.*, (52) 2016	Romania	34	*P*>0.05	*P*>0.05
Gula Z *et al.*, (53) 2018	Poland	40	*P*=0.38	*P*=0.38
Kocyigit BF *et al.*, (54) 2018	Turkey	76	*P*=0.294	*P*=0.424
Kolahi S *et al.*, (55) 2019	Iran	86	*P*=0.969	
Our study (2017)	Our department	40	*P*>0.05	*P*>0.05

Discussion

In this study, we demonstrated that vitamin D status did not seem to have an impact on fatigue in patients with ankylosing spondylitis.

Our results showed that most patients, AS and low back pain patients, suffered from fatigue, which was severe in more than half of cases. Fatigue was related to the female gender: AS group and low back pain group (respectively P=0.05, P=0.006). Factors related to fatigue in the AS group were: spinal pain (P<0.001), enthesopathy (P<0.001), disease activity (P<0.001), functional disability (P<0.001), and quality of life (P<0.001). We also demonstrated the major prevalence of hypovitaminosis D in AS patients (92.5%). However, smoking was the only factor related to the vitamin D levels in both groups (respectively in AS group: P=0.05, low back pain group: P=0.03).

This study has strengths and weaknesses. To our knowledge, this is the first study exploring the impact of vitamin D status on fatigue in AS patients. Moreover, the study of fatigue in AS patients is interesting given the high prevalence of this symptom during this condition. However, this symptom remains largely underestimated in the evaluation of patients in current practice. Our patients were recruited from outpatient examinations. Therefore, our sample is representative of patients consulting in general hospitals in our country.

However, this study has some limitations: the low number of patients in both groups, which limits the detection of differences between the groups; some parameters that may influence vitamin D levels have not been studied, such as individual daily sun exposure, calcium and vitamin D rations.

Factors associated with fatigue

In this study, all patients experienced fatigue, which level was severe according to the FACIT-F in 50% of cases. These findings are consistent with those of Van Tubergen *et al*., in a study of 812 patients with AS and found a severe level of fatigue in 53% of cases (8). In most studies, age was not considered to be a factor correlated with fatigue in AS (2,3,7,31-37). Our results were consistent with the literature data, where this parameter was not correlated with fatigue (P=0.9).

Female gender was associated with a more severe level of fatigue in the majority of studies (27,23,32-34, 37). Ward *et al.*, found that women were three times more likely than men to experience severe fatigue in AS (3). In our study, significant association was found between the female gender and the presence of fatigue (P=0.05), however no association was found between the level of severity of fatigue and the female gender. Our findings were consistent with the results of other studies (7,9,31). Table 4 summarizes the main studies assessing the influence of demographic factors on fatigue in patients with AS.

Various studies reported the impact of smoking on disease activity and on the Impairment of the quality of life in AS patients. But no association was found between smoking and fatigue in AS patients (38,56).

Similarly, no association was found between fatigue and the duration of the disease (7,8,29-35,36,57). In our study, smoking and disease duration were not predictive of fatigue (respectively P=0.66, P=0.37). Spinal pain is the most frequently mentioned factor having an impact on fatigue in studies (2,4,5,7,8,29,33-35,39,44,57,). This can be explained by the inflammatory pain leading to multiple nocturnal awakening, thus deteriorating the quantity and quality of sleep and generating significant daytime fatigue (3). In our study, and in accordance with the literature data, we found a highly significant correlation between spinal pain and fatigue severity (P<0.001). Table 5 shows the results of studies that assessed the correlation between spinal pain and fatigue in AS.

Several studies found a correlation between enthesitis assessed by the MASES score and fatigue (4,37,42-45,58,59). Our study also showed a significant association between MASES and fatigue: The higher the MASES, the more severe the level of fatigue was (P=0.003).

Disease activity, assessed by the BASDAI score, is one of the major factors significantly correlated with fatigue, as demonstrated in several studies (2,4,8,7,30,32,33,36,40). In fact, a Tunisian study conducted by Hamdi *et al*., showed that the higher the disease activity gets, the more important the level of perception of fatigue is (32). The association between fatigue and disease activity is also found by applying the $ASDAS_{CRP}$ score (37,44,45). Our results were consistent with those of the literature. There was a significant correlation between FACIT-F score and disease activity scores: BASDAI and $ASDAS_{CRP}$ (r= -0.89, P<0.001 and r= -0.72, P<0.001 respectively). However, the logistic regression showed that BASDAI was the strongest predictor of the severity level of fatigue (P=0.001) while $ASDAS_{CRP}$ did not influence the severity level of fatigue (P=0.86).

Functional impairment, assessed by BASFI score, is considered an important fatigue factor by several authors

(2-5,7,30,31,33,35,39,45,57). Multiple regression analysis used in a study conducted by Turan *et al.*, showed that BASFI was the most significantly correlated factor with fatigue (37). This result was also found in our study, where a statistically significant correlation was noted between BASFI and FACIT-F. Moreover, in the multivariate analysis, we found that functional impairment was considered the second most predictive factor of severe fatigue after the BASDAI score. Table 6 summarizes the results of studies that assessed the correlation between disease activity, functional Impairment, and fatigue in AS.

A significant correlation between the impaired quality of life, assessed by HAQ and ASQOL, and fatigue were reported (5,8,35-37,39,43,44,59). The results of our study were consistent with those of the literature as we found a significant correlation between FACIT-F and ASQOL (r= -0.885, $P<0.0001$) and between FACIT-F and HAQ (r= -0.755, $P<0.0001$).

Factors associated with vitamin D deficiency

Our results showed that the majority of patients with AS were deficient in vitamin D (92.5%) (vitamin D<30 ng/mL). These findings exceeded the rates found in the literature, with a prevalence of hypovitaminosis between 40% and 80% (60,22).

In most studies, age was not associated with vitamin D deficiency (46,51,52,61,62). Our results were consistent with the literature since age was not a factor influencing the vitamin D levels ($P<0.71$). While some studies showed a statistically significant correlation between the female sex and the vitamin D status in AS patients (49,51), others disproved this association (22,46,47,63,64). In our study, no association was found between female gender and vitamin D levels ($P=0.13$). This could be explained by the fact that women, who accounted for one-third (32.5%) of the study population, were all vitamin D deficient, thus creating a statistical confusion bias.

Klinberg *et al.*, found a statistically significant correlation between smoking and vitamin D deficiency in AS patients ($P<0.001$) (51).

Some authors suggest that vitamin D is negatively correlated with the disease duration (51,60), but some others demonstrated that disease duration and vitamin D were not correlated (22,46,49,64). As for our study, no correlation was found between disease duration and vitamin D status ($P=0.96$).

Kolahi *et al.*, did not find a significant correlation between vitamin D and spinal pain during AS ($P=0.67$) (60). However, three studies found a statistically negative correlation between vitamin D and spinal pain (64-6). We did not find this association in our study ($P=0.92$).

Few studies documented the relation between enthesopathy and vitamin D levels during AS. Three studies found no correlation between those two parameters (53,55,66). The results of our study are consistent with these results, we found no correlation between MASES score and vitamin D rate ($P=0.91$).

It has been considered that disease activity, assessed by BASDAI score, to be the most significantly correlated factor with vitamin D deficiency during AS (22,46,50-52,61,62,67). This association between disease activity and vitamin D level is also demonstrated using the $ASDAS_{CRP}$ score (50). However, several other studies did not find this association (20,47,48,51-55,60,64,65,67). As for our results, like activity, assessed by both BASDAI and $ASDAS_{CRP}$ scores, was not correlated with either vitamin D levels ($P=0.93$ and $P=0.96$, respectively) or vitamin D deficit ($P=0.95$ and $P=0.26$, respectively). Table 7 shows the results of studies on the relationship between disease activity and vitamin D levels during AS.

The functional impairment, assessed by BASFI score, was found to be an important factor influencing vitamin D in several studies (21,22,67). In contrast, other studies considered that functional impairment was not associated with vitamin D deficiency (46,51,52,54,55,63,). This result was also found in our study, where no significant correlation was found between BASFI score and vitamin D levels ($P=0.91$).

Vitamin D deficiency was found to be an influencing factor with a negative impact on the quality of life of patients with inflammatory diseases (11,64,67-69). In our study, there was no correlation between vitamin D levels and quality of life assessed by both HAQ and ASQOL scores (respectively $P=0.66$, $P=0.97$).

Fatigue and vitamin D

Concerning chronic inflammatory rheumatisms, few studies assessed the impact of vitamin D on fatigue during rheumatoid arthritis (11,69), and to our knowledge, no studies assessed the impact of vitamin D on fatigue during AS. Our study was the first to assess the impact of vitamin D on fatigue levels in AS patients. We found no statistically significant correlation between vitamin D and FACIT-F score ($P=0.91$). Moreover, vitamin D deficiency did not affect the fatigue severity ($P=0.07$). These results can be explained by the high prevalence of hypovitaminosis D in the study group, where 92.5% of cases had a level of vitamin D<30 ng/mL.

In this study, Vitamin D status did not seem to influence the level of fatigue in AS. Further studies with

a larger number of patients and systematic dosage of vitamin D could lead to a better understanding of the relationship between fatigue and vitamin D.

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