The effects of pre-obesity on quality of life, disease activity, and functional status in patients with ankylosing spondylitis

Seyma Toy,1 Davut Ozbag,2 Zuhal Altay1
1Department of Physical Therapy and Rehabilitation, Inonu University Faculty of Medicine, Malatya, Turkey
2Department of Anatomy, Inonu University Faculty of Medicine, Malatya, Turkey

ABSTRACT

OBJECTIVE: This study was an investigation of effects of pre-obesity on clinical characteristics and quality of life in patients with ankylosing spondylitis (AS).

METHODS: Total of 28 AS patients and 30 age- and sex-matched healthy controls were included in the study. Patients and controls with any systemic inflammatory disease and/or cognitive and mental problems were excluded. Disease activity and functional capacity were measured using the Bath Ankylosing Spondylitis Disease Activity Index and Bath Ankylosing Spondylitis Functional Index. For quality of life assessment, 36-Item Short Form Health Survey was used in both groups, and AS group also responded to Ankylosing Spondylitis Quality of Life questionnaire.

RESULTS: There was no significant difference in sociodemographic characteristics between AS patients and healthy controls (p>0.05). Mean quality of life scores were significantly lower in the pre-obese AS patients compared with controls (p<0.05). Functional capacity was positively and significantly associated with body mass index (BMI) (p=0.024) and disease activity was significantly associated with female gender (p=0.011).

CONCLUSION: Increased BMI in patients with AS is factor that affects quality of life, disease activity, and functional capacity. Multidisciplinary rehabilitation programs will support improved quality of life for pre-obese patients with AS.

Keywords: Ankylosing spondylitis; body mass index; pre-obesity; quality of life.

Ankylosing spondylitis (AS) is important autoimmune disease that is the prototype of spondyloarthritis group of diseases, and particularly affects the musculoskeletal system [1]. Anatomical changes resulting in vertebral ankylosis lead to typical kyphotic deformity in patients with AS [2]. Kyphotic deformity causes reduced angle of vision and difficulty performing daily life activities, such as looking across the street while walking, communicating, driving a car, walking downhill, and main-
Numerous features of the course of AS, including pain, limitation of movement, functional loss, and deterioration of well-being, have negative effect on the patient’s quality of life [5]. As in many chronic diseases, there may also be social and economic consequences for patients with AS. Environmental factors are also of great importance to quality of life. Social support, family support, suitable work conditions, and minimizing fatigue are important for these patients. It is also known that there is connection between psychological condition and the course and clinical findings of AS. Deteriorating psychiatric condition causes AS to clinically progress more rapidly [6]. Among patients with AS, risk of permanent work disability is 3 times greater than those of similar age and gender in general population [7].

Role of adipose tissue in AS has not been widely investigated; however, some indirect results suggest that there is connection between excess adipose tissue and inflammation in AS [8]. Weakening of skeletal muscles and decreased muscular function and physical inactivity lead to change in body composition. Due to reduction in quantity of lean (non-fatty) tissue in AS, total fatty tissue is more prominent [9].

Fat deposit centers in the body cause center of gravity to shift toward the front in comparison with healthy-weighted individuals, which then adds mechanical strain and stress to structures behind the center of gravity [10]. Body mass index (BMI) is the most commonly used method of evaluating obesity. An individual’s weight in kilograms is divided by the square of height in meters \(\text{weight (kg) / height (m)}^2\). BMI correlation with quantity of body fat measured directly with densitometer is quite good [11].

In the literature, there are indirect prospective studies regarding relationship between BMI and AS; however, relationship to quality of life, disease activity, and functional condition has not been evaluated. For this reason, the main objective of this study was to assess quality of life, functional level, and disease activity of pre-obese patients with AS and compare results with healthy individuals.

**MATERIALS AND METHODS**

Our case-control study sample consisted of 28 patients diagnosed with AS by specialist physicians according to the modified New York Criteria for AS (Group 1) and 30 healthy individuals (Group 2). Number of participants was determined as result of power analysis performed by department of biostatistics. Study was conducted in the Physical Therapy and Rehabilitation Unit of Turgut Ozal Medical Center, Inonu University, after receiving approval (number 2013/121) from the Human Ethics Committee of Inonu University. The patients and healthy controls were informed about the study and all study participants provided written informed consent. Criteria for participation for both groups were age in range of 25 to 55 years, BMI in range of 25 to 30 (pre-obese), and having no cognitive or mental problems.

For Group 1, diagnosis of AS based on modified New York Criteria was criterion for inclusion in the study. Individuals who had undergone surgery related to AS and those with additional systemic disease, visual, or cognitive problems were excluded. Demographic data of participants were recorded. Measurement of height was performed with sensitivity of 0.1 cm using standard steel stadiometer while participants were barefoot. Measurement of weight was performed using Tanita BC-418 Segmental Body Composition Analyzer (Tanita Corp., Tokyo, Japan). World Health Organization BMI classification, Bath AS Disease Activity Index (BASDAI), and Bath AS Functional Index (BASFI) were employed to assess individuals according to study criteria. Both groups completed 36-Item Short Form Health Survey (SF-36) and patients with AS also responded to AS Quality of Life Questionnaire (ASQoL). Developed to evaluate disease activity, BASDAI is questionnaire consisting of 6 questions associated with 5 major symptoms of AS (fatigue, spinal pain, joint pain/swelling, localized sensitivity/susceptibility areas, and morning stiffness) [12–15]. If BASDAI result is \(\geq 4\), it is then evaluated as high disease activity [16]. ASQoL questionnaire asks patients to answer 18 questions with “yes” or “no,” and number of affirmative responses is used to...
calculate score between 0 and 18; lower scores suggest better quality of life [17].

The quality of life scale most frequently used in the field of medicine, SF-36 form, consists of 36 items that evaluate health in terms of physical and mental aspects in 8 scaled sections [18].

**Statistical analysis**

Data were analyzed using IBM SPSS Statistics for Windows, Version 22.0. software (IBM Corp., Armonk, NY, USA). In group comparisons, Mann-Whitney U-test and Kruskal-Wallis test were used. Following Kruskal-Wallis test, Conover method was used for paired comparison. In group comparisons of categorical data, chi-square test with Yates correction and Fisher’s exact test were used. Significance level was determined to be p<0.05.

**RESULTS**

Demographic characteristics of Group 1 and Group 2 are provided in Table 1.

| Socio-demographic features                  | Group 1 Patient population (n=28) | Group 2 Control group (n=30) | p     |
|---------------------------------------------|-----------------------------------|------------------------------|-------|
| Age (years)                                 | 40.64±11.4                        | 43.8±9.4                     | 0.251 |
| Gender                                      |                                   |                              |       |
| Female                                      | 8                                 | 12                           |       |
| Male                                        | 20                                | 18                           | 0.523 |
| Body mass index                             | 27±3.4                            | 27.2±3.2                     | 0.279 |
| Educational status                          |                                   |                              |       |
| Primary school                              | 8                                 | 8                            |       |
| High school                                 | 10                                | 11                           | 0.987 |
| University                                  | 10                                | 11                           |       |
| Occupational status                         |                                   |                              |       |
| Housewife/student/unemployed                | 7                                 | 9                            | 0.913 |
| Artisan/laborer                             | 7                                 | 7                            |       |
| Civil servant                               | 14                                | 14                           |       |

SD: Standard deviation.

### Table 1. Demographic characteristics of patients with ankylosing spondylitis and healthy controls

| Tests                  | Mean±SD | Value range |
|------------------------|---------|-------------|
| BASDAI                 | 4.78±2.1| 1.6–6.7     |
| BASFI                  | 4.87±2.8| 0–6.2       |
| ASQoL                  | 10.5±5.095| 0–18       |

BASFI, BASDAI, and ASQoL score data can be seen in Table 2. Mean BASFI value of group with BMI of 25 to 27 was 2.9±1.1, whereas mean BASFI of the group with BMI of 27.1 to 29.9 was 6.45±2.3 (p=0.024) (Table 3). ASQoL results revealed only 39.3% of patients had score of 9 or less (Figure 1). When the patients with AS were evaluated in terms of gender, a statistically significant difference was seen in women’s BASDAI values.
Results indicated that healthy individuals had significantly higher score in all of the quality of life criteria in comparison with the pre-obese patients with AS (Table 5). Although the SF-36 test results revealed better quality of life in the patients whose BMI was in range of 25 to 27 compared with those whose BMI was between 27.1 and 29.9, no statistically significant relationship was observed (Table 6).

**DISCUSSION**

AS is chronic inflammatory disease with broad clinical spectrum and unknown etiology. It primarily affects young men, and is characterized by apparent inflammation in the spinal joints and neighboring structures, causing progressive bone fusion in the vertebrae [19, 20]. The disease leads to serious impairment in at least one-third of cases. Influences on psychological state, such as pain in the vertebrae and joints, reduced physical activity and spinal mobility, joint stiffness/involvement, fatigue, and depression may worsen physical findings [21]. Our study was designed to evaluate effect of pre-obesity in patients with AS on quality of life, disease activity, and functional condition/status. Since 33.7% of society (38.2% of males and 29.3% of females) is pre-obese, according to 2014 data of the Turkish Statistical Institute, and as we were of the opinion that obesity and morbid obesity would already have reduced quality of life, we incorporated pre-obese patient population into our study [22]. Based on study results, we came to conclusion that pre-obesity led to increase in disease activity of AS patients, deterioration of functional condition, and significant decline in quality of life compared with healthy individuals.

Studies have reported that age, gender, and duration of disease affect the course of the disease as well as metrological indices [23].

Review of the literature yielded mean age of AS patients in 1 study [24] of 37.0±9.7 years, and another study reported 67% of the patients were male with mean age of 38±13 years [25]. Mean age of the patients with AS in our study proved to be 40.64±11.4 years; 28.6% of our participants were female and 71.4% of them were male. In recent
studies, female/male ratio reported has ranged between 1/10 and 1/3 [26]. In the present study, female/male ratio was determined to be 2/5. Patient population in the present study was consistent with the literature in terms of age and gender.

When AS symptoms are evaluated in terms of gender, in female patients this disease courses more insidiously; it progresses slowly and more moderately, starting in the form of peripheral joint involvement [27]. In our study, as in the literature [27],

| Table 5. Evaluation of SF-36 test results of the AS patients and control group |
|-----------------------------|-----------------------------|-----------------------------|
| Sub-groups                  | AS patients (n=28) Mean±SD  | Control group (n=30) Mean±SD |
| Physical function           | 35.07±11.5                  | 50.12±7.3                   |
| Difficulty in physical role | 34.11±8.6                   | 48.01±8.9                   |
| Pain                        | 36.42±7.8                   | 46.81±6.7                   |
| General health              | 37.04±8.1                   | 48.76±7.3                   |
| Vitality                    | 43.07±7.04                  | 48.61±4.6                   |
| Difficulty in social role   | 37.22±11.5                  | 49.6±7.6                    |
| Difficulty in emotional role| 34.37±10.6                  | 47.21±9.3                   |
| Psychological health        | 41.4±9.1                    | 50.4±7.8                    |

| Table 6. Comparison of SF-36 test results in the AS group according to BMI categories |
|-----------------------------------------------|-----------------------------|-----------------------------|
| Group                                          | n  | Mean±SD  | p     | Value range |
| Physical function                              |    |          |      |             |
| BMI 25–27                                      | 14 | 37.25±6.1| 0.194 | 10–100      |
| BMI 27.1–29.9                                  | 14 | 28.85±4.9|       |             |
| Difficulty in physical role                    |    |          |      |             |
| BMI 25–27                                      | 14 | 35±6     | 0.164 | 0–100       |
| BMI 27.1–29.9                                  | 14 | 28±4.9   |       |             |
| Pain                                           |    |          |      |             |
| BMI 25–27                                      | 14 | 37.5±6.5 | 0.603 | 10–100      |
| BMI 27.1–29.9                                  | 14 | 35.55±6.3|       |             |
| General health                                 |    |          |      |             |
| BMI 25–27                                      | 14 | 37.05±7.1| 0.210 | 20–97       |
| BMI 27.1–29.9                                  | 14 | 33.6±6.5 |       |             |
| Vitality                                       |    |          |      |             |
| BMI 25–27                                      | 14 | 44.35±8.5| 0.734 | 25–100      |
| BMI 27.1–29.9                                  | 14 | 42.15±8.3|       |             |
| Difficulty in social role                      |    |          |      |             |
| BMI 25–27                                      | 14 | 35.4±6.9 | 0.603 | 0–100       |
| BMI 27.1–29.9                                  | 14 | 30.8±5.1 |       |             |
| Difficulty in emotional role                   |    |          |      |             |
| BMI 25–27                                      | 14 | 34.55±6.8| 0.77  | 0–100       |
| BMI 27.1–29.9                                  | 14 | 24.75±4.9|       |             |
| Psychological health                           |    |          |      |             |
| BMI 25–27                                      | 14 | 41.4±7.5 | 0.62  | 0–80        |
| BMI 27.1–29.9                                  | 14 | 34.5±6.3 |       |             |

AS: Ankylosing spondylitis; BMI: Body mass index; SD: Standard deviation.
BASDAI score of women was significantly higher than that of men (p=0.011). We are of the opinion that disease activity in women was higher due to fact that most of the women who participated in our study were housewives and had been exposed to more physical strains and stresses at home. Separately, we must also consider influences such as hormonal changes in women due to their menstrual cycle, the fact that women are more susceptible to trauma, and that they are often more able to express their complaints as factors in higher scores.

In their study in which 101 patients with AS responded to SF-36 quality of life survey, Ozgul et al. reported that subsections affected most were difficulty in physical role, evaluation of general health, and pain [28]. Turan et al. stated that SF-36 subgroups most affected by AS were physical function, physical role, and emotional role in a study they conducted [29]. Ward et al. [30] evaluated 175 patients diagnosed with AS and found that quality of life of those whose educational level was low was worse in 7 out of 8 fields of SF-36.

In our study, there was significant decrease in quality of life in all subsections of SF-36 in the pre-obese patients with AS when compared with the healthy controls. We believe this could be explained by the fact that it is outcome of mechanical factor that increases along with obesity.

Yilmaz et al. [31] reported in their study that high BASDAI, BASFI, and BASMI scores had caused all subgroup scores of SF-36 to decline, while causing ASQoL scores to rise significantly. ASQoL is valuable tool in evaluating effect of interventions performed on patients with AS. In our study, unlike several studies in the literature, we used ASQoL index to evaluate quality of life of patients with AS. ASQoL score of pre-obese patients with AS revealed that quality of life was poor for 60.3% of our patients.

When we compared ASQoL scores in 2 subgroups based on BMI and sub-groups of female and male patients, we found no significant difference.

While in the literature there are numerous evidence-based studies conducted for the purpose of minimizing pain, spinal stiffness, fatigue, and restriction in joint movement, which are among the symptoms of AS, as well as to increase functioning, there is very limited number of studies that examine BMI and AS. There are studies [32, 33] regarding the fact that visceral adiposity increase in AS raises cardiovascular risks, and it was reported that during 1- or 2-year period following tumor necrosis factor (TNF) alpha therapy, early abdominal obesity increased visceral adipose tissue in patients with AS [32]. It was also reported that in patients who received TNF alpha therapy there was significant correlation between visceral adipose tissue and body fat and disease activity [34]. In studies in which body composition in AS was evaluated, changes within fat and muscle mass compared with normal controls were identified [35]. Another study reported that epicardial fat thickness was significantly increased in patients with AS compared with healthy controls [36].

Retrospective European study of spondyloarthropathy in 155 individuals who were treated with infliximab (Remicade; Janssen Biotech, Inc., Horsham, PA, USA) evaluated the patients in groups defined as normal, pre-obese, and obese according to BMI, and results of 6-month infliximab treatment revealed significant difference between groups in terms of visual analogue scale responses, though no significant difference was observed in their BASDAI scores [37].

Durcan et al. [38] reported in a study conducted with 46 patients with AS that BASFI score within group with mean BMI of 27.4 (67.5%) proved to be 4.7, whereas BASFI score in group with normal mean BMI was 2.5. BASDAI score in group with mean BMI of 27.4 was 4.8, while in the other group it was found to be 2.9. In another study, significant correlation was found between body fat and BMI and BASMI. In a study conducted in Turkey [39], quantity of central/peripheral fat and quantity of upper/lower-half body fat in patients with AS were found to be significantly high, and anthropometric measurements of the AS patients were reported to be different from those of healthy individuals. In contrast, Rubio et al. reported that BMI and AS-DAS score were not related [40].

In our study, we separated the patients into 2
subgroups with mean BMI of 25 to 27 and 27.1 to 29.9, and we found that BASFI results within group with greater BMI were significantly higher (p=0.024). Separately, since BASDAI in our pre-obese AS patients was ≥4 (4.78±2.1), this score suggests severe disease activity.

Even though BMI increase in patients with AS is identified with medical treatments and mobility restriction stemming from pain, more remains to be clarified; however, we can assume that greater BMI will lead to additional physical complaints over time. Our study suggests that while specifying treatment strategies for patients with AS, taking BMI into consideration, trying to bring it to normal level, and implementing specially planned, extensive, and multidisciplinary rehabilitation program for patients will promote improved quality of life for patients with AS.

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REFERENCES

1. Kaya T, Karatepe GA, Günaydın R, Ürper S. Ankillozanspondilit’i oğullarda hastalık aktivitesinin fonksiyonel durum ve yaşam kalitesini belirlemekdeki rolü. Archives of Rheumatology, 2006;21:9-12
2. Vergara ME, O’Shea FD, Inman RD, Gage WH. Postural control is altered in patients with ankylosing spondylitis. Clin Biomech (Bristol, Avon) 2012;27:334–40.
3. Aydog E, Depedibi R, Bal A, Eksioglu E, Unlü E, Cakci A. Dynamic postural balance in ankylosing spondylitis patients. Rheumatology (Oxford) 2006;45;445–8.
4. Bostan EE, Borman P, Bodur H, Barça N. Functional disability and quality of life in patients with ankylosing spondylitis. Rheumatol Int 2003;23:121–6.
5. Russel AS. Ankylosing spondylitis: history. In: Klippel JH, Dieppe PA, editors. 2nd ed. Rheumatology. St Louis: Mosby;1994. p. 14:1–2.
6. Barlow JH, Macey SJ, Struthers GR. Gender, depression, and ankylosing spondylitis. Arthritis Care Res 1993;6:45–51.
7. Boonen A, Chorus A, Miedema H, van der Heijde D, Landewé R, Schouten H, et al. Withdrawal from labour force due to work disability in patients with ankylosing spondylitis. Ann Rheum Dis 2001;60:1033–9.
8. Briot K, Gossec L, Koltsa S, Dougados M, Roux C. Prospective assessment of body weight, body composition, and bone density changes in patients with spondyloarthropathy receiving anti-tumor necrosis factor-alpha treatment. J Rheumatol 2008;35:855–61.
9. Toussirot E, Grandclément E, Gaugler B, Michel F, Wendling D, Saas P, et al. Serum adipokines and adipose tissue distribution in rheumatoid arthritis and ankylosing spondylitis. A comparative study. Front Immunol 2013;4:453.
10. Corbeil P, Simonneau M, Rancourt D, Tremblay A, Teasdale N. Increased risk for falling associated with obesity: mathematical modeling of postural control. IEEE Trans Neural Syst Rehabil Eng 2001;9:126–36.
11. Garrow JS, Webster J. Quetelet’s index (W/H2) as a measure of fatness. Int J Obe 1985;9:147–53.
12. Sieper J, Rudwaleit M, Baraliakos X, Brandt J, Braun J, Burgos-Vargas R, et al. The Assessment of SpondyloArthritis international Society (ASAS) handbook: a guide to assess spondyloarthritis. Ann Rheum Dis 2009;68 Suppl 2:ii1–44.
13. Ahmadi K, Wilson C, Tiwana H, Binder A, Ebringer A. Antibodies to Klebsiella pneumoniae lipopolysaccharide in patients with ankylosing spondylitis. Br J Rheumatol 1998;37:1330–3.
14. Haywood KL, Garratt AM, Jordan K, Dziedzic K, Dawes PT. Spinal mobility in ankylosing spondylitis: reliability, validity and responsiveness. Rheumatology (Oxford) 2004;43:750–7.
15. Machado P, Landewé R, Lie E, Kvien TK, Braun J, Baker D, et al. Ankylosing Spondylitis Disease Activity Score (ASDAS): defining cut-off values for disease activity states and improvement scores. Ann Rheum Dis. 2011;70:47–53.
16. Garrett S, Jenkinson T, Kennedy LG, Whitelock H, Gaisford P, Calin A. A new approach to defining disease status in ankylosing spondylitis: the Bath Ankylosing Spondylitis Disease Activity Index. J Rheumatol 1994;21:2286–91.
17. Doward LC, Spoorenberg A, Cook SA, Whalley D, Helliwell PS, Kay LJ, et al. Development of the ASQoL: a quality of life instrument specific to ankylosing spondylitis. Ann Rheum Dis 2003;62:20–6.
18. Sieper J, Braun J, Rudwaleit M, Boonen A, Zink A. Ankylosing spondylitis: an overview. Ann Rheum Dis 2002;61 Suppl 3:iii8–18.
19. Van Der Linden S, Van Der Heijde D, Braun J. Ankylosing spondylitis. In: Haris ED, Budd RC, Firestein GS, Genovese MC, editors. Kelley’s textbook of rheumatology. 7th ed. Philadelphia: Elsevier/ Saunders;2005: p:1125–39.
20. Arnett FC. Ankylosing spondylitis. In: Koopman WJ. Editor. Arthritis and Allied Conditions: A Textbook of Rheumatology. 13th ed. Baltimore : Williams & Wilkins; 1997. p. 1197–208.
21. Lim HJ, Moon YI, Lee MS. Effects of home-based daily exercise therapy on joint mobility, daily activity, pain, and depression in patients with ankylosing spondylitis. Rheumatol Int 2005;25:225–9.
22. http://www.tuik.gov.tr/PreHaberBultenleri.do?id=18854 (access date: 5 April 2017).
23. Will R, Edmunds L, Elswood J, Calin A. Is there sexual inequality in ankylosing spondylitis? A study of 498 women and 1202 men. J Rheumatol 1990;17:1649–52.
24. Ozdemir O. Quality of life in patients with ankylosing spondylitis: relationships with spinal mobility, disease activity and functional status. Rheumatol Int 2011;31:605–10.
25. Ibn Yacoub Y, Amine B, Laatiris A, Abouqal R, Hajaj-Hassouni N. Health-related quality of life in Moroccan patients with ankylosing spondylitis. Clin Rheumatol 2011;30:673–7.
26. Feldtkeller E, Khan MA, van der Heijde D, van der Linden S, Braun J. Age at disease onset and diagnosis delay in HLA-B27 negative vs. positive patients with ankylosing spondylitis. Rheumatol Int 2003;23:61–6.
27. Roussou E, Sultana S. Spondyloarthritis in women: differences in disease onset, clinical presentation, and Bath Ankylosing Spondylitis Disease Activity and Functional indices (BASDAI and BASFI) between men and women with spondyloarthritides. Clin Rheumatol 2011;30:121–7.
28. Ozgül A, Peker F, Taskaynatan MA, Tan AK, Đınçer K, Kalyon TA. Effect of ankylosing spondylitis on health-related quality of life and different aspects of social life in young patients. Clin Rheumatol 2006;25:168–74.
29. Turan Y, Duroğlu MT, Cerrahoglu L. Quality of life in patients with ankylosing spondylitis: a pilot study. Rheumatol Int 2007;27:895–9.
30. Ward MM. Health-related quality of life in ankylosing spondylitis: a survey of 175 patients. Arthritis Care Res 1999;12:247–55.
31. Yılmaz O, Tutoğlu A, Garip Y, Özcan E, Bodur H. Health-related quality of life in Turkish patients with ankylosing spondylitis: impact of peripheral involvement on quality of life in terms of disease activity, functional status, severity of pain, and social and emotional functioning. Rheumatol Int 2013;33:1159–63.
32. Hmamouchi I, Roux C, Paternotte S, Kolta S, Dougados M, Briot K. Early increase of abdominal adiposity in patients with spondyloarthritis receiving anti-tumor necrosis factor-α treatment. J Rheumatol 2014;41:1112–7.
33. Sari I, Demir T, Kozaci LD, Akar S, Kavak T, Birlik M, et al. Body composition, insulin, and leptin levels in patients with ankylosing spondylitis. Clin Rheumatol 2007;26:1427–32.
34. Aydın M, Aydin F, Yüksel M, Yıldız A, Polat N, Akıl MA, et al. Visceral fat reflects disease activity in patients with ankylosing spondylitis. Clin Invest Med 2014;37:E186.
35. Briot K, Gossec L, Kolta S, Dougados M, Roux C. Prospective assessment of body weight, body composition, and bone density changes in patients with spondyloarthropathy receiving anti-tumor necrosis factor-alpha treatment. J Rheumatol 2008;35:855–61.
36. Üstün N, Kurt M, Atıcı N, Yaşız E, Güler H, Turhanoğlu A. Increased Epicardial Fat Tissue Is a Marker of Subclinical Atherosclerosis in Ankylosing Spondylitis. Arch Rheumatol 2014;29:267–72.
37. Ortvayani S, Allanore Y, Tubach F, Forien M, Gardette A, Pasquet B, et al. Body mass index influences the response to infliximab in ankylosing spondylitis. Arthritis Res Ther 2012;14:R115.
38. Durcan L, Wilson F, Conway R, Cunnane G, O’Shea FD. Increased body mass index in ankylosing spondylitis is associated with greater burden of symptoms and poor perceptions of the benefits of exercise. J Rheumatol 2012;39:2310–4.
39. Okçu MZ, Yardımcı S, Çomoğlu S. Body fat percent and fat distribution parameters in rheumatic diseases. J Back Musculoskelet Rehabil 2002;16:57–61.
40. Rubio Vargas R, van den Berg R, van Lunteren M, Ez-Zaitouni Z, Bakker PA, Dağfinurad H, et al. Does body mass index (BMI) influence the Ankylosing Spondylitis Disease Activity Score in axial spondyloarthritis?: Data from the SPACE cohort. RMD Open 2016;2:e000283.