Research Article ISSN 2639-944X

Journal of Medical - Clinical Research & Reviews

A Latent Class Analysis of Physical Activity of Patients with Ankylosing Spondylitis Based on Health Promotion Model: A Cross-Sectional Study

Heng-Ying Fang[1#], Ying-Hua Pan[2#], Yu-Hua Deng[2], Yue Ding[2], Hui-Ting Gu[2], Xin-Xin Hu[2], Mu Liu[2], Rui-Chong Wang[2], Wen-Jie Zou[3] and MeiFen Zhang[3*]

[1]*Department of Nursing, The Third Affiliated Hospital, Sun Yat-sen University, Guangzhou 510600, China.*

[2]*Department of Rheumatology, The Third Affiliated Hospital, Sun Yat-sen University, Guangzhou 510600, China.*

[3]*School of Nursing, Sun Yat-sen University, Guangzhou 510080, China.*

[#]*These authors contribute equally to this work.*

[*]Correspondence:

Meifen Zhang, School of Nursing, Sun Yat-Sen University, No.74, Zhongshan Road II, Guangzhou, Guangdong, China, E-mail: zhmfen@mail.sysu.edu.cn.

Received: 20 Mar 2023; **Accepted:** 22 Apr 2023; **Published:** 26 Apr 2023

Citation: Heng-Ying F, Ying-Hua P, Yu-Hua D, et al. A Latent Class Analysis of Physical Activity of Patients with Ankylosing Spondylitis Based on Health Promotion Model: A Cross-Sectional Study. J Med - Clin Res & Rev. 2023; 7(4): 1-7.

ABSTRACT

Background: *Physical activity helps to prevent deformities and to complete training programs, and is therefore benefit to improve the rehabilitation and prognosis of patients with ankylosing spondylitis (AS). This study aims to identify potential factors affecting the physical activity of patients with AS to provide insights for the clinical strategies.*

Methods: *A cross-sectional primary data analysis was performed. Exploratory latent category analysis (LCA) was used to identify subgroups of physical activity of AS patients. Logistic regression analysis was used to explore the influencing factors of physical activity.*

Results: *Two potential subgroups (high physical activity-no sedentary and low physical activity-sedentary) were identified. Patients with higher education were more sedentary and less active, and was more likely accompanied with lower level of physical activity. The higher the ankylosing spondylitis functional index, the lower level of physical activity. High education degree and high disease function index were risk factors for low physical activity.*

Conclusions: *Avoiding sedentary behavior and controlling the disease function index are of clinical implication to improve the physical activity of AS patients and to subsequently the recovery of the disease.*

Keywords

Physical activity, Latent class analysis, Nursing, Ankylosing spondylitis.

Summary Statement

What Is Already Known About This Topic?

Severe complications of AS patients, such as joint deformities, do harm to the patients' daily living. Strengthening the management of physical activity helps to improve the clinical outcome of patients with AS. Guidelines suggest that physical exercises improve the condition of AS patients, but it is difficult for patients to complete the entire exercise treatment. Physical activity is affected by several factors with heterogeneity of individuals. The use of regular methods to mine influencing factors results in weak individualization and insufficient pertinence. Latent class analysis can be used in clinical practice to classify patients into different classes, and is thereby able to identify potential influencing factors. However, latent class analysis has not been applied in the discovery of factors affecting the physical activity of patients with AS.

What This Paper Adds?

- Populations can be discovered and identified through latent class analysis based on health promotion models. AS patients

can be divided into high physical activity-no sedentary and low physical activity- sedentary groups.
- Analysis of patients in different groups discloses the factors affecting physical activity.

The Implications of This Paper?

- It is beneficial to improve the physical activity of AS patients by intervening the sedentary behavior and reducing the disease function index, which can be used in clinical practice to prevent joint deformities, and to improve prognosis.
- Latent class analysis is helpful to effectively identify different classes of disease in the population, and can be used to develop other fields of identification of influencing factors for different countries and themes.

Introduction

Ankylosing spondylitis (AS), a chronic inflammatory disease with unknown etiology, is a genetic and heritable disease. The heritability of AS can be as high as 90% [1]. Scoliosis, kyphosis, and hip deformity are the main clinical manifestations of AS patients. The prevalence of spinal fractures in AS patients varies between 10% in Europe and 17% in North America. Spinal cord injury (SCI) is more likely observed in patients with spinal fracture [2], and occurs in 19-91% of AS patients, leading to higher mortality and complication rates [3]. As a result, AS patients are unable to take care of themselves. Management of AS patients includes medication, non-pharmaceutical and surgical treatments. Besides, it has been well demonstrated that non-drug exercise rehabilitation therapy, such as joint mobilization training, Pilates, Baduanjin, was helpful to improve the outcome of patients with AS [4].

Physical activity refers to physical activity that occurs due to a significant increase in energy expenditure due to skeletal muscle contraction [5], which is helpful to disease rehabilitation, such as reduction of pain and morning stiffness, improvement of spinal function and quality of life [6]. Physical activity is affected by many factors, such as personal education, perceived barriers and self-efficacy [7]. Weekly physical activity consumption of patients with high disease activity index was much lower than that of patients with low disease activity index [8]. Maximizing self-efficacy might enhance physical activity and relieve pain [9]. Physical activity in AS patients is attributed to the psychological activities and the outcome of rehabilitation exercise [10]. It is documented that physical activity gradually decreases after the patients were discharged [11]. Adherence to post-discharge physical activity may interfere the progression of AS [12]. Studies exploring the physical activity trajectory of patients with AS and its influencing factors can urge patients to perform physical activities according to the therapeutic plan which is conducive to better prognosis of AS patients. However, rare studies focus on the factors affecting physical activity of AS patients.

In this study, we intended to identify potential characteristics affecting the physical activity of patients with AS, using latent class analysis (LCA) in health promotion model. Two potential subgroups (high physical activity-no sedentary and low physical activity- sedentary) were identified. Education and the disease functional index were two important factors that contribute to the physical activity in AS. Thus, our data provide references for targeted and individualized interventions in the clinal management of patients with AS.

Review Methods

Aim

The goal of this study is to conduct latent class analysis to reveal influencing factors contributing to physical activity in AS patients.

Design

Cross-sectional, descriptive-correlational study was performed to describe the level of physical activity in AS patients by Latent class analysis, and to discover the relationship between physical activity and the influencing factors of AS disease.

Sample/Participants

One hundred and eighty patients with AS in the Department of Rheumatology and Immunology of a Grade A Hospital in Guangzhou from January 2020 to December 2020 were included in our study.

Inclusion criteria

- Comply with the New York criteria revised in 1984 and diagnosed as ankylosing spondylitis;
- Patients whose conditions have been relieved through outpatient or inpatient treatment;
- Understand the purpose, procedures and content of the study, voluntarily participate in the trial and sign an informed consent form;
- Able to use Mandarin or Cantonese proficiently, and be able to communicate effectively with researchers.

Exclusion criteria

- Direct or indirect relationship with the researchers;
- Fibromyalgia, local pain caused by compression of the lumbar or cervical spine, accompanied by nerve root or other moderate to severe pain, which may be related to ankylosing spondylitis;
- Confusion in related pain evaluation or self-evaluation;
- Combined with dysfunction of important organs.

Data Collection

Before the survey, the researcher introduced the purpose, significance and principle of confidentiality of the survey to the respondents, and informed them with the requirements and precautions for filling in the questionnaire. If they are unable to fill the forms by themselves due to physical impairment or unable to read, the researcher assisted them to complete. A unified instruction was used to answer the questions of the survey subjects, and all questionnaires were distributed and collected on the spot. A total of 180 questionnaires were included in this survey and all of them were validly collected.

Ethical Considerations

All research procedures were approved by the Medical Ethics Committee of XXX. Participants are informed of the research goals, voluntary participation, and confidentiality terms regarding their personal information. In addition, the patients' written informed consent forms were obtained.

Data Analysis

Statistical Description: All data are uniformly coded. Demographic and disease characteristics of the sample, physical activity and other variables at four time points are statistically described. Statistical analysis was performed with SPSS 25.0. Frequency, percentage, mean standard deviation were used to describe general information of ankylosing spondylitis, international physical activity, disease data, self-perceived exercise barriers and benefits, and self-efficacy.

Analysis of the Characteristics of Different Subgroups of Physical Activity: statistical analysis using Mplus7.0 software, based on TI time point data, using exploratory latent category analysis (LCA) to identify the subgroup characteristics of AS patients. The characteristic elements to be identified include physical activity Level, disease-related symptoms, perceived benefits/barrierss of physical activity, and self-efficacy. First, since the phenotype is determined in a data-driven method, we require at least 10% of the sample for each category to ensure a meaningful interpretation of the category and limit possible errors in its estimation. Second, the posterior probability of subgroup members is generated by the LCA model. The maximum probability method assigns each subject to one of the subgroups. Bayesian information, Mendel-Rubin (VLMR) test and bootstrap likelihood ratio test (BLRT) posterior fitting statistics and clinical reasoning were used to determine the optimal number of classifications. For sample-corrected BIC (aBIC), the smaller the statistical value, the better the model fit: Entropy is used to evaluate the accuracy of model classification, and the closer to one, the more accurate the classification. Once the ideal number of classes is determined, the class-specific proportions of each factor included are used to describe and explain the summary of each class. Finally, *Spearman* correlation is used to analyze the correlation of international physical activity, disease data, and physical activity. Use multiple linear regression analysis to explore the influencing factors of international physical activity, disease data, and physical activity.

Demographic Survey

The general information questionnaire is designed by the researcher, including: age, education level, occupational status, and whether there is a family history of ankylosing spondylitis.

Survey Tool

Physical Activity Measurement Tool

The International Physical Activity Questionnaire (IPAQ), which was developed by the International Physical Activity Measurement Working Group in 2001, is a self-report questionnaire for patients. Subjects are asked to recall and fill in various physical activities performed in the last 7 days. The types of physical activities include (1) Work-related activities outdoors (paid work, volunteer activities, doing farm work or studying); (2) Housework activities (inside and outside the house); (3) Entertainment activities; (4) Daily work transportation (Whether to go to work by bicycle, motorcycle, train or other means of transportation); (5) The time spent sitting during rest is measured separately, such as the time spent reading, watching TV, visiting friends and chatting, etc. The calculation method of physical activity behavior is weekly physical activity MET-mins/week=MET level×activity time.

The results can be divided into: (1) Active activity (severe physical activity ≥ 3 days/week, cumulative ≥ 1500 MET-minutes/week; or Combination of walking, moderate physical activity and heavy physical activity ≥7 days/week, cumulative ≥3000MET-minutes/week); (2) Light activity (severe physical activity ≥3 days/week, daily ≥20 minutes; or moderate physical activity and walking ≥ 4 days/week, daily ≥ 30 minutes; or heavy physical activity ≥ 5 days/week, cumulative ≥ 600 MET-minutes/week).

Disease-Related Symptoms Questionnaire

(1) Bath Ankylosing Spondylitis Disease Activity Index (BASDAI): BASDAI is an international general index that reflects the disease activity of ankylosing spondylitis, which consists of 6 questions and evaluates symptoms of fatigue, axial and peripheral joint pain, morning stiffness and Tendon end pain of the past 1 week. The first 5 questions are completed by the VAS method, with a score of 0-10 points. The last question is scored according to the duration of morning stiffness. Duration of 0, 30, 60, 90, 120 minutes or more are assigned 0, 2.5, 5, 7.5, and 10 points, respectively. The total score is the average score of 6 items, with a range of 0-10 points. The higher the score, the more active the disease is. (2) Bath Ankylosing Spondylitis Functional Index (BASFI): BASFI is an international general index reflecting the comprehensive physical function of ankylosing spondylitis. There are 10 questions in total. The questions mainly involve dressing, standing, fetching, walking and other daily activities. Each question is recorded using the VAS method, with a score of 0-10. The total score is the sum of all 10 questions. The higher the score, the worse the function.

Perceived Physical Activity Benefits/Barriers Measurement

Exercise Benefits/Barriers Scale (EBBS) was compiled by American scholar Sechrist and others, containing 43 items including 29 exercise benefits items and 14 exercise barrier items to evaluate the participants' perceived benefits of participating in exercise and factors that hinder their participation in exercise. The exercise benefit score is 29 to 116 points, the barrier score is 14 to 56 points, and the total score is 43 to 172 points. The higher the score, the higher the perception of exercise benefits and the lower the perception of exercise barriers.

Measurement of Exercise Self-Efficacy

The Exercise Self-Efficacy Scale (ESES), developed by Kroll

Equals in 2007, is used to measure the confidence of patients with spinal cord injury to persist in exercise. The scale contains 18 items to measure the individual's confidence to participate in regular exercise in various situations such as the environment, the influence of others, competitive needs and inner feelings. The score range is 0-100 points. The higher the score, the higher the self-efficacy of the respondent.

Results

General Information of Survey Subjects and Their Perceived Benefits of Exercise and Current Status of Physical Activity

A total of 180 patients with AS were included in this study. The age ranged from 13 to 72 (29.92 ± 8.55) years old, with 80 people (44.4%) above the average age and 100 people (55.6%) below. Thirty-eight cases (21.1%) were below college education and 142 cases (78.9%) obtained college degree or above. One hundred and twenty-six patients (70.0%) were employed, and 54 patients (30.0%) were unemployed. Total score of weekly physical activity ranged 0-4763 (146.69 ± 410.49) points. Exercise benefits score is 52-116 (88.03 ± 12.75) points, and the exercise barrier score is 14-66 (38.85 ± 6.67) points. The exercise self-efficacy score is 0-97.22 (50.91 ± 17.80) points.

Results of Latent Class Analysis Related to Physical Activity in AS Patients

The total score of the physical activity scale for patients with AS is converted into 0 or 1. For item 1 (work week physical activity time), the original scores of 0-2373 MET-minutes/week were converted into 0, and the scores of 2374-4746 MET-minutes/week were converted into 1. For item 2 (Traffic Weekly Physical Activity Time), the original score of 0-144 MET-minutes/week was converted into 0, and the score of 145-288.4 was converted into 1 point. For item 3 (Housework weekly physical activity time), the total score of 0-288 MET-minutes/week was converted into 0, and the score of 289-576 MET-minutes/week was converted into 1. For item 4 (sports exercise weekly physical activity time), the original score of 0-375 MET-minutes/week was converted into 0 points, and the score of 376-749.7 MET-minutes/week was converted into 1 point. For item 5 (amount of time per week in sitting posture), the total score original score 0-12 h/week was converted into 0, score of 13-24 h/week was converted into 1. For item 6 (Amount of Sleep Time Per Week), the original score of 0-14 points was converted to 0, and the score of 15-24 h/week was converted to 1. For the exercise benefit/barrier scale, the original score of 29-58 h/week for exercise benefit items was converted into 0, and the scores of 59-116 points was converted into 1. The original score of 14-28 points for exercise barriers items was converted into 0, and the score of 29-56 points was converted into 1. The original scores of 0-50 points for each item of self-efficacy were converted into 0, and the scores of 51-100 points were converted into 1 point. Although the phenotype is determined in a data-driven method, we required at least 10% of the sample for each category to ensure a meaningful interpretation of the category and limit possible errors in its estimation.

Our data fit a total of two latent category models (Table 1). As the number of model categories increases, BIC increases. When the two categories are retained, the BIC value reaches minimum. The Entropy value is ideal, and both LMR and BLRT reach significant levels. While retaining three latent category models, the BIC starts to increases and the conditional probability of the second category is relatively small. The conditional probability distribution of the two Latent class analysis among the six indicators in the physical activity table were shown in Figure 1. Class 1 includes 138 cases (76.7%). This category has a higher probability of scoring in each physical activity, so it is named the high physical activity-low sedentary time group. Class 2 includes 42 cases (23.3%), and most items in this category are at a low level, but item 5 (weekly sitting time) and item 6 (weekly sleep time) had higher score probabilities. Therefore, Class 2 was named the low physical activity-high sedentary time group.

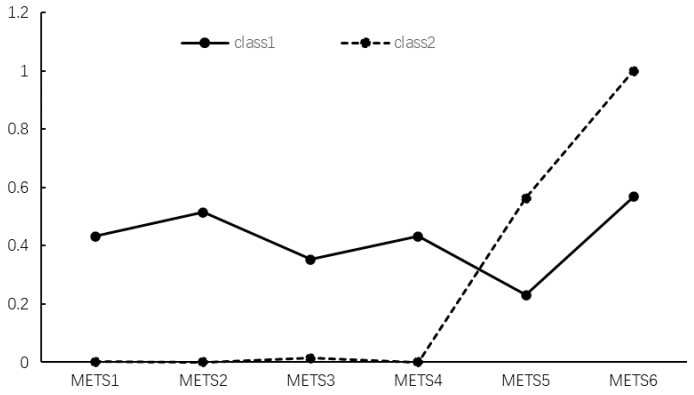

Figure 1: Conditional probability distribution of 2 latent classes on each item of physical activity related to benefits/barriers and self-efficacy Questionnaire.

Analysis of Patients' Characteristics in Two Potential Physical Activity Categories

Patients were divided into two groups according to the result of Latent class analysis. The Education level of AS patients were significantly different. Patients with higher education were more sedentary and less active, and was more likely accompanied with lower level of physical activity (Z=-2.776, P=0.006). Furthermore, the higher the AS functional index, the lower level of physical activity (Z=-1.855, P=0.06). No statistically significant differences were identified between other features and physical activity in the two groups (Table 2).

Multivariate Analysis of Latent Class Analysis of Physical Activity

Logistic regression analysis was performed to determine the independence of variables statistically significant in univariate analysis. Education of Bachelor degree or above was converted into 2 points, high school education was converted into 1 point, junior high school education or below was converted into 0 point. The original BASFI score of 51-100 points was converted into 1 point, and the original score of 0-50 points was converted into 0 points. The results showed that education level (OR=2.236,

Table 1: Latent class model fit indicators for Physical activity related to benefits/barriers and self-efficacy.

class	K	Log(L)	AIC	BIC	ABIC	entropy	BLRT	LMR	Class Probability		
1	6	-689.179	1390.357	1409.515	1390.513						
2	13	-666.275	1358.55	1400.059	1358.888	0.829	<0.001	<0.001	0.76667	0.23333	
3	20	-660.873	1361.746	1425.606	1362.266	0.698	0.6	0.6753	0.62222	0.23333	0.14444

Note: K is the number of estimated parameters.

Table 2: Analysis of different characteristics of patients with ankylosing spondylitis in two potentially physical activity-related categories (case (percentage, %)).

		class1 (n=156)	class2 (n=24)	Z	p
Sex	Male	118 (85.5)	37 (88.1)	0.18	0.671
	Female	20 (14.5)	5 (11.9)		
Age		30.2 ± 8.6	29.0 ± 8.3	0.788	0.432
History	Yes	33 (23.9)	8 (19.0)	0.433	0.51
	No	105 (76.1)	34 (81.0)		
Progress		7.8 ± 6.9	7.6 ± 5.9	0.177	0.859
Education	Junior high school and below	35 (25.4)	3 (7.1)	-2.776	0.006
	High school	49 (35.5)	14 (33.3)		
	Bachelor degree and above	54 (39.1)	25 (59.5)		
Occupation	On-the-job	100 (72.5)	26 (61.9)	1.71	0.191
	Other	38 (27.5)	16 (38.1)		
Marriage	Married	78 (56.5)	25 (59.5)	0.119	0.731
	Other	60 (43.5)	17 (40.5)		
Incomes	≤3000	29 (21.0)	9 (21.4)	-0.697	0.486
	3001-6000	50 (36.2)	13 (31.0)		
	6001-10000	33 (23.9)	8 (19.0)		
	≥10001	26 (18.8)	12 (28.6)		
Medicine	Non-steroidal anti-inflammatory drugs	47 (34.1)	20 (47.6)	3.268	0.195
	Biologics	81 (58.7)	21 (50.0)		
	Other	10 (8.4)	1 (2.4)		
BMI		22.5 ± 3.6	22.4 ± 4.5	0.118	0.906
BASFI		12.2 ± 18.2	18.3 ± 20.2	-1.855	0.045
BASDI		3.9 ± 5.4	5.6 ± 6.0	-1.822	0.07
EBBSYI		84.6 ± 20.6	82.0 ± 13.6	0.787	0.432
EBBSZH		40.8 ± 16.1	39.6 ± 10.6	0.442	0.659
EBBSZF		125.4 ± 19.6	121.6 ± 14.0	1.164	0.246
ESES		933.2 ± 333.6	833.6 ± 291.7	1.741	0.083

Table 3: Multivariate analysis of Latent class analysis of physical activity related to ankylosing spondylitis.

	Regression coefficiens	Standard error	Wald	p	OR	OR95% CI	
Constant	-3.378	0.728	21.526	<0.001	0.256		
EDU	0.805	0.269	8.923	0.003	2.236	1.319	3.790
BASFI	0.020	0.009	4.769	0.029	1.021	1.002	1.040

P=0.003) and BASFI (OR=1.021, *P*=0.029) were independent risk factors affecting physical activity in patients with AS (Table 3).

Discussion

Physical activity has been implicated in the treatment efficacy of rheumatic disease. In this study, two groups were identified based on indicators of physical activity, including time at work, transportation, housework, and weekly time in sitting position: high physical activity-low sedentary time group (physical activity time accumulated at 3180- 6360 MET-minutes/week, sitting time <12 hours/week) and low physical activity-high sedentary time group (physical activity time <3180-MET-minutes/week, sitting time >12 hours/week). We further found that education and the disease functional index were two independent risk factors for physical activity in AS.

Patients in the high physical activity-low sedentary time group, accounting for 76.7% of survey subjects, are of high physical activity time in the four dimensions of daily work, daily traffic, daily life and exercise. Medical staff should pay attention to the physical activity trajectory of patients in this group to carry out home exercise supervision and guidance. About 23.3% of patients enrolled in our study belongs to the low physical activity-high sedentary time group. Insufficient physical activity and sedentary behavior may increase risks of many diseases. Due to the construction of the Department of Rheumatology and Immunology

and the publicity of AS, increased awareness and compliance of patients with AS contribute to enhancement of physical activity. Wearable technology assistance and comprehensive family supports may help the patients in this group to improve physical activity [13].

Clinical guidelines in the management of AS recommend the combination of drug therapy and non-drug therapy (mainly exercise rehabilitation), which is a promising strategy to improve the prognosis of patients with AS [14]. Non-drug therapy helps to maintain normal physiological posture, to enhance cardiopulmonary function, to prevent joint deformity, to increase joint mobility, to enhance muscle strength, and thereby to relieve the disease symptoms and to improve the quality of life [15,16]. Sedentary time reduces activity time and the total amount of physical activity, resulting in less time for non-drug therapy and a decrease in treatment efficacy. High-intensity leisure-time physical activity helps reduce fat mass [17]. Moderate-intensity physical activity inhibits the progression of osteoarthritis [18]. To date, the optimal sedentary time for AS patients has not been determined. Excessive physical activity can cause fatigue and excessive contraction of joints, which affects the recovery of joint function. Further investigations are required to determine the intensity and duration of physical activity.

Our data indicated that the higher education level, the lower physical activity in AS patients (OR=2.236). AS patients with higher educational background are engaged in lighter physical activities and long sedentary time. Work pressure in high-educated people increases sedentary time and reduces physical activity. Medical staff should adopt individualized rehabilitation guidance according to the educational status of AS patients.

The pathological feature of AS is sacroiliitis, which may affect the lumbosacral, hip joints, sternum and ribs. As a consequence, AS patients are not able to exercise as healthy individuals [19]. BASFI has been used in a number of studies to evaluate the functional capacity for specific physical activities [20]. Altan and colleagues found that BASFI index decreased in 24 weeks after the patient's physical activity increased [21]. In this study, we identified the physical function index as a impact factor of the physical activity in AS, and found that BASFI score was a risk factor for physical activity in AS patients (OR=1.021). Physical functioning in AS is affected not only by structural damage, but also by disease activity [22]. A decreased inflammatory index indicates that the disease is effectively controlled. Physical activity, part of daily life, can reduce the production of inflammatory antibodies through antigen-antibody reaction mechanism. On the other hand, physical activity can promote the recovery of body functions [23].

Limitations of our study include the followings. First, the data collection tool is a self-reported questionnaire, which may cause deviations in the evaluation of physical activity. Second, the non-experimental, descriptive design of the current research limits the exploration of the relationship between patients' physical activity, disease-related symptoms, disease benefits/barriers, and self-efficacy. Future studies should apply longitudinal research designs to dynamically and thoroughly investigate the above relationships.

Conclusions

Taken together, our data reveal a potential association between the physical activity of Chinese AS patients and the educational background and disease functional index. Higher educational level and higher disease functional index were associated with less physical activity. Medical staff should pay attention to the physical activity of AS patients with different characteristics to improve the physical activity and the recovery of disease. Future investigation should bridge the physical activity trajectories, motor self-perception, and self-efficacy in AS patients by longitudinal surveys.

Funding

This study was supported by the Medical Research Fund of Guangdong Province, China (A2020127) and the joint funding of Natural Science Foundation of Guangdong Province and Hengrui medicine Medicine Co Ltd (2021A1515220110).

References

1. Brown MA, Kenna T, Wordsworth BP. Genetics of ankylosing spondylitis insights into pathogenesis. Nat Rev Rheumatol. 2016; 12: 81-91.
2. Tu PH, Liu ZH, Yeap MC, et al. Spinal cord injury and spinal fracture in patients with ankylosing spondylitis. BMC Emerg Med. 2022; 22: 73.
3. Vosse D, Feldtkeller E, Erlendsson J, et al. Clinical vertebral fractures in patients with ankylosing spondylitis. J Rheumatol. 2004; 31: 1981-1985.
4. Hsieh LF, Chuang CC, Tseng CS, et al. Combined home exercise is more effective than range-of-motion home exercise in patients with ankylosing spondylitis a randomized controlled trial. Biomed Res Int. 2014: 398190.
5. O Dwyer T, O Shea F, Wilson F. Decreased health-related physical fitness in adults with ankylosing spondylitis: a cross-sectional controlled study. Physiotherapy. 2016; 102: 202-209.
6. Xie Y, Yang KH, Lyu Q, et al. Practice guideline for patients with ankylosing spondylitis/spondyloarthritis. Zhonghua Nei Ke Za Zhi. 2020; 59: 511-518.
7. Mathew Joseph N, Ramaswamy P, Wang J. Cultural factors associated with physical activity among U.S. adults An integrative review. Appl Nurs. 2018; 42: 98-110.
8. Fongen C, Halvorsen S, Dagfinrud H. High disease activity is related to low levels of physical activity in patients with ankylosing spondylitis. Clin Rheumatol. 2013; 32: 1719-1725.
9. Mihalko SL, Cox P, Beavers DP, et al. Effect of intensive diet and exercise on self-efficacy in overweight and obese adults with knee osteoarthritis The IDEA randomized clinical trial. Transl Behav Med. 2019; 9: 227-235.

10. Rasmussen JO, Primdahl J, Fick W, et al. Physical activity in people with axial spondyloarthritis and the impact of overall attitudes barriers and facilitators A cross-sectional study. Musculoskeletal Care. 2020; 18: 510-518.
11. Kamata A, Kara Y, Patarapichayatham C, et al. Evaluation of Analysis Approaches for Latent Class Analysis with Auxiliary Linear Growth Model. Front Psychol. 2018; 9: 130.
12. Su JM, Cui LF, Yang WH, et al. Ideal physical activity in association with incident ankylosing spondylitis a community-based prospective cohort study. Clin Exp Rheumatol. 2021; 39: 73-78.
13. Zagar, I, Delimar V, Cota S, et al. The Impact of Disease Activity on Quality of Life, Fatigue, Functional Status and Physical Activity in Patients with Ankylosing Spondylitis. Psychiatr Danub. 2021; 33; 1278-1283.
14. Van der Heijde D, Ramiro S, Landewe R. update of the ASAS-EULAR management recommendations for axial spondyloarthritis. Ann Rheum Dis. 2017; 76: 978-991.
15. Tanasescu M, Leitzmann MF, Rimm EB, et al. Exercise type and intensity in relation to coronary heart disease in men. JAMA. 2022; 288: 1994-2000.
16. Pedersen BK, Saltin B. Exercise as medicine - evidence for prescribing exercise as therapy in 26 different chronic diseases. Scand J Med Sci Sports. 2015; 25: 1-72.
17. Waller B, Munukka M, Rantalainen T, et al. Effects of high intensity resistance aquatic training on body composition and walking speed in women with mild knee osteoarthritis: a 4-month RCT with 12-month follow-up. Osteoarthritis Cartilage. 2017; 25: 1238-1246.
18. Castrogiovanni P, Di Rosa M, Ravalli S, et al. Moderate Physical Activity as a Prevention Method for Knee Osteoarthritis and the Role of Synoviocytes as Biological Key. Int J Mol Sci. 2019; 20.
19. Taurog JD, Chhabra A, Colbert RA. Ankylosing Spondylitis and Axial Spondyloarthritis. N Engl J Med. 2016; 374: 2563-2574.
20. Saracoglu I, Kurt G, Okur EO, et al. The effectiveness of specific exercise types on cardiopulmonary functions in patients with ankylosing spondylitis a systematic review. Rheumatology International. 2017; 37: 409-421.
21. Altan L, Korkmaz N, Dizdar M, et al. Effect of Pilates training on people with ankylosing spondylitis. Rheumatol Int. 2012; 32: 2093-2099.
22. Magrey M, Ritchlin C. Measuring outcomes in ankylosing spondylitis: pearls and pitfalls. Curr Opin Rheumatol. 2019; 31: 109-117.
23. Sarac DC, Bayram S, Tore NG, et al. Association of Core Muscle Endurance Times with Balance Fatigue Physical Activity Level and Kyphosis Angle in Patients with Ankylosing Spondylitis. J Clin Rheumatol. 2022; 28: 135-140.