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Factors Associated With Adherence to a Supervised Exercise Intervention for Osteoarthritis: Data From the Swedish Osteoarthritis Registry

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Objective. To explore how lifestyle and demographic, socioeconomic, and disease-related factors are associated with supervised exercise adherence in an osteoarthritis (OA) management program and the ability of these factors to explain exercise adherence.

Methods. A cohort register-based study on participants from the Swedish Osteoarthritis Registry who attended the exercise part of a nationwide Swedish OA management program. We ran a multinomial logistic regression to determine the association of exercise adherence with the abovementioned factors. We calculated their ability to explain exercise adherence with the McFadden R^2.

Results. Our sample comprises 19,750 participants (73% female, mean ± SD age 67 ± 8.9 years). Among them, 5,862 (30%) reached a low level of adherence, 3,947 (20%) a medium level, and 9,941 (50%) a high level. After a listwise deletion, the analysis was run on 16,685 participants (85%), with low levels of adherence as the reference category. Some factors were positively associated with high levels of adherence, such as older age (relative risk ratio [RRR] 1.01 [95% confidence interval (95% CI) 1.01–1.02] per year), and the arthritis-specific self-efficacy (RRR 1.04 [95% CI 1.02–1.07] per 10-point increase). Others were negatively associated with high levels of adherence, such as female sex (RRR 0.82 [95% CI 0.75–0.89]), having a medium (RRR 0.89 [95% CI 0.81–0.98] or a high level of education (RRR 0.84 [95% CI 0.76–0.94]). Nevertheless, the investigating factors could explain 1% of the variability in exercise adherence (R^2 = 0.012).

Conclusion. Despite the associations reported above, the poorly explained variability suggests that strategies based on lifestyle and demographic, socioeconomic, and disease-related factors are unlikely to improve exercise adherence significantly.

INTRODUCTION

In osteoarthritis (OA), exercise is considered a first-line intervention by international clinical practice guidelines (1,2) due to its ability to improve symptoms and levels of functionality (3,4). Exercise positively affects body weight, lipid metabolism, glycemic control, and systemic inflammation, preventing and treating OA-related chronic diseases (5). Despite these benefits, adherence to exercise in OA is suboptimal (6,7).

Adherence is described by the World Health Organization (WHO) as "the extent to which a person's behavior, taking medication, following a diet, and/or executing lifestyle changes, corresponds with agreed recommendations from a health care provider" (8). Poor adherence to exercise can severely compromise its long-term effectiveness, limiting its benefits (9). Considering the rising prevalence (10) and economic burden of OA (11), identifying factors associated with exercise adherence is fundamental to creating specific interventions to improve it.

Several elements have been hypothesized to be associated with exercise adherence, including lifestyle and demographic, socioeconomic, and disease-related factors (12–17). However, evidence on this topic arises mainly from other chronic conditions than OA, qualitative studies whose aims are not to generalize knowledge, as well as studies with small samples (12–19).

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SIGNIFICANCE & INNOVATIONS

- Though exercise is a first-line intervention in osteoarthritis (OA), levels of exercise adherence among people with OA are suboptimal. Several elements have been hypothesized to be associated with exercise adherence, including lifestyle and demographic, socioeconomic, and disease-related factors in conditions other than OA.
- Analyzing real-world data from a first-line intervention provided nationwide in Swedish primary care, we found that high levels of adherence were positively associated with increased age, frequent pain, walking difficulties, and higher levels of self-efficacy. Conversely, high levels of adherence were negatively associated with female sex, higher body mass index, and high socioeconomic positions. However, these factors could explain 1% of the exercise variability.
- In OA, strategies based on lifestyle and demographic, socioeconomic, and disease-related factors are unlikely to improve exercise adherence significantly. Therefore, to improve adherence significantly, we need to consider other elements.

Moreover, the WHO has stated that the combination of different factors, rather than a single one, determines adherence (8). In contrast, the abovementioned studies focused primarily on single factors and their measures of mean association with adherence (e.g., odds ratio). Relying just on measures of association corresponds to an abstraction that does not take into account the variability of individual-level effects (20).

Therefore, we aimed to investigate the associations between lifestyle and demographic, socioeconomic, and disease-related factors with adherence to supervised exercise as a part of an OA management program delivered nationwide in Swedish primary care. Furthermore, we aimed to investigate these factors' ability to explain exercise adherence variability.

MATERIALS AND METHODS

Study design and setting. This study is a cohort register-based study on individual-level data retrieved from the Swedish Osteoarthritis Registry (SOAR; for data on the OA management program) and the Longitudinal Integration Database for Health Insurance and Labour Market Studies (LISA) administered by Statistics Sweden (for data on socioeconomic positions). These data sets were merged using personal identity numbers unique to all citizens in Sweden.

SOAR includes data from approximately 195,000 people with OA who attended an OA management program provided nationwide by the Swedish health care system (21,22). This program has already been thoroughly described elsewhere (23,24). Briefly, it is composed of 2 parts: education and exercise. The education part is mandatory, while the exercise part is optional. The education part is based on 3 sessions that revolve around the pathophysiology of the disease and its self-care management. The first 2 sessions are mandatory and held by a physiotherapist. The third is optional and held by a person with OA, trained as an OA communicator. The exercise (optional) part starts with an individual encounter with a physiotherapist to tailor the exercise program to the participants' needs and characteristics. At this point, participants can decide whether to exercise at home or with a physiotherapist. Those who decide to exercise with a physiotherapist are offered the opportunity to attend 12 sessions over 6 to 8 weeks (2 sessions/week) following OA Swedish clinical practice guidelines (25). LISA provides socioeconomic data such as cohabitation, institutionally based education level, employment, income, and residential area (26). The research was conducted in respect of the Declaration of Helsinki and reported following the Strengthening the Reporting of Observational studies in Epidemiology guidelines. Ethical approval was obtained from the Swedish Ethics Committee (Dnr: 2019-02570).

Population. The study cohort comprises all the participants in the SOAR with a first registration (baseline) between 2012 and 2015. We included only those who started the exercise group sessions supervised by the physiotherapists after the initial encounter with them. We selected participants with knee or hip OA who were recorded in the SOAR only once.

Variables. The level of adherence to the supervised exercise part, reported in the SOAR, is the dependent variable of this study. This is a predetermined categorical variable recorded by the physiotherapists and stratified on the number of sessions participants attended (low levels of adherence: 1–6 training sessions; medium levels of adherence: 7–9 training sessions; or high levels of adherence: 10–12 sessions). In this study, high levels of adherence represent >80% of the adherence with the recommended interventions (12 sessions) (25), which is typically considered a satisfactory level of adherence (27). The collected independent variables are reported hereafter and divided as demographic and lifestyle characteristics, socioeconomic characteristics, and disease-related characteristics.

Demographic and lifestyle characteristics. Participants' demographic and lifestyle characteristics were reported by the participants themselves at the baseline and recorded in the SOAR. These characteristics were assigned sex at birth (binary variable: male/female), age (continuous variable), body mass index (BMI; continuous variable computed from self-reported height and weight), weekly physical activity (continuous variable: hours) that was assessed with the question "How active are you during a regular, typical week?" (21), and health-related quality of life (HRQoL; continuous variable: EuroQol 5-domain instrument visual analog scale [EQ-5D VAS]). In the EQ-5D VAS, the respondents reported their perceived HRQoL on a VAS scale that scored from 0 (the worst possible) to 100 (the best possible). The EQ-5D VAS is part of the EQ-5D scale (28).

Socioeconomic characteristics. Each socioeconomic position indicator from the year before the enrollment to the SOAR was considered for the analysis. In particular, the following socioeconomic position factors were retrieved and categorized: living alone (binary variable: living alone/living with someone), institutionally based education level (categorical variable: low [primary school: 0–9 years], medium [secondary school up to postsecondary education <3 years: 10–14 years], or high [postsecondary education: ≥15 years]), employment (binary variable: employed/retired-unemployed), residential area (categorical variable: rural/suburban/urban) and the net income.

Residential area was classified based on the Swedish Association of Local Authorities and Regions classification of Swedish municipalities. Specifically, rural areas are smaller towns/urban areas and rural municipalities, suburban areas are medium-sized towns (≥40,000 inhabitants) and municipalities near medium-sized towns, and urban areas are large cities (≥200,000 inhabitants) and municipalities near large cities (29). The individual yearly net income was categorized into quartiles based on the sample income distribution: lowest income quartile (<146,500 Swedish krona [SEK]), second income quartile (146,501–198,100 SEK), third income quartile (198,101–278,800 SEK), and highest income quartile (>278,800 SEK) (29).

Disease-related characteristics. The physiotherapists recorded the index joint (categorical variable: hip or knee) (21), namely, the joint with OA. They assessed this variable based on the participant's medical history, symptoms, and clinical assessment. In the case of multiple joints with OA, the most symptomatic joint was considered the index joint for the treatment. The participants self-recorded the numbers of painful joints (continuous variable); their desire for surgery (binary variable: yes/no) that was assessed by asking them: "Are your knee/hip symptoms so severe that you wish to undergo surgery?" (21); their pain intensity (ordinal variable: 0–10 on a numeric rating scale [NRS] [30]) in their index joint; their pain frequency (binary variable: infrequent pain [less than every week], frequent pain [almost every day]) that was assessed with the question: "How often do you have pain in your knee/hip" (21); their fear of movement (binary variable: yes/no) that was assessed with the question "Are you afraid your joints will be injured by physical training/activity?"; the Charnley score (categorical variable: A = unilateral hip or knee OA, B = bilateral hip or knee OA, C = multiple joint OA or some other condition) that categorizes people with OA into 3 classes based on the diseases that affect walking ability (31); and arthritis-specific self-efficacy (continuous variable: 10–100, pain and symptoms on the Arthritis Self-Efficacy Scale [ASES], using the Swedish version of the scale) (32). The ASES scale is a reliable instrument that assesses patients' arthritis-specific self-efficacy, namely, their beliefs about their ability to perform a specific task and cope with OA (33). The full version is composed of 3 subscales: 1) self-efficacy pain scale (5 items), 2) function scale (9 items), and 3) other symptoms scale (6 items). Participants indicate to what extent they feel confident they can do the tasks reported in the items from 10 (very uncertain) to 100 (very certain). In the SOAR, only 1) and 3) were adopted and combined as suggested in the scale instruction (33).

Statistical analysis. Descriptive statistics are reported as mean ± SD and absolute and percentage frequencies. A multivariable exploratory analysis was performed to identify which independent variables were independently associated with exercise adherence in the SOAR (34). Multivariable exploratory analyses detect patterns and identify relationships between the independent variables and the outcome (34–36).

Since the proportional odds assumption was not met, an ordered logistic regression could not be performed. Hence, we ran a multinomial logistic regression with a listwise deletion (Stata function mlogit) to determine the association between the independent variables and the adherence to exercise. No missing data were reported in the outcome (adherence). Less than 1% of the data on socioeconomic characteristics was missing, primarily due to an error during the data upload process in LISA. Missing data on demographic and lifestyle and disease-related characteristics in the SOAR are most likely a result of a mistake by the physiotherapists responsible for uploading the data at the local unit. Hence missing data in both registers could be considered missing completely at random, introducing no or minimal bias in our analysis.

The selection of the variables in the model was informed by previous literature on exercise adherence in other chronic pain conditions (12–17) and the evidence for action on adherence by the WHO (8). Then, the variables were clustered in demographic and lifestyle, socioeconomic, and disease-related groups, following the dimensions proposed by the WHO (8). The multicollinearity assumption between continuous variables was tested, and none of the continuous variables was highly correlated. The relative risk ratio (RRR) of being in medium level of adherence or high level of adherence with respect to low level of adherence and 95% confidence intervals (95% CIs) were estimated for each covariate in the model. For the variables HRQoL and arthritis-specific self-efficacy, the RRR is presented as a 10-point change in their scales.

Finally, the ability of the models to explain the variability of exercise adherence was calculated with the McFadden R^2 statistic (Stata function fitstat). McFadden R^2 measures the ability of a model to explain the variance of dependent variables on a convenient 0–100% scale. In particular, this value highlights how much of the variance in the dependent variable (adherence) can be explained by the independent variables collectively. We calculated McFadden R^2 for the model with all variables included (full model).

Afterward, we excluded 1 set of variables from the model and calculated the difference between McFadden R^2 with the full model. A higher difference would indicate a higher contribution of the variables set into the explanatory power of the full model. The analysis was done through Stata 17.

RESULTS

Between January 1, 2012 and December 31, 2015, 46,905 people with OA were recorded in the SOAR. However, we excluded 7 participants who had joints other than hip and knee as their first cause of pain, 27,147 who did not perform any supervised exercise sessions, and 1 for attending the program more than once. Hence, 19,750 participants with knee (69%) and hip (31%) OA were included in this study (73% female, mean ± SD age 67 ± 8.9 years). Figure 1 shows the participants' selection process. Table 1 presents the characteristics of the entire sample and stratified by the levels of adherence. Specifically, 5,862 (30%) reached a low level of adherence, 3,947 (20%) a medium level, and 9,941 (50%) a high level.

After the listwise deletion, the multinomial logistic regression was run on 16,685 individuals (85%), using low levels of adherence as the reference category (Table 2). Overall, excluded participants (n = 3,065) had similar characteristics to the ones included in the analysis (see Supplementary Table 1, available on the *Arthritis Care & Research* website at http://onlinelibrary.wiley.com/doi/10.1002/acr.25135). We found that female sex (RRR 1.13 [95% CI 1.02–1.27]), living with someone (RRR 1.21 [95% CI 1.10–1.32]), and an increase of 1 number of joints with OA (RRR 1.06 [95% CI 1.01–1.10]) were positively associated with achieving medium levels of adherence. Conversely, an increase in an hour of weekly physical activity (RRR 0.98 [95% CI 0.96–0.99]), living in an urban area (RRR 0.87 [95% CI 0.78–0.98]), and being employed (RRR 0.82 [95% CI 0.72–0.93]) were negatively associated with achieving medium levels of adherence.

An increase of 1 year in age (RRR 1.01 [95% CI 1.01–1.02]), having frequent pain (RRR 1.13 [95% CI 1.02–1.25]), having walking difficulties (RRR 1.12 [95% CI 1.01–1.24]), and having a 10-point increase on the ASES (RRR 1.04 [95% CI 1.02–1.07]) were positively associated with high levels of adherence. By contrast, female sex (RRR 0.82 [95% CI 0.75–0.89]), an increase of 1 point in BMI (RRR 0.99 [95% CI 0.98–0.99]), living in a suburban (RRR 0.79 [95% CI 0.73–0.86]) or an urban area (RRR 0.78 [95% CI 0.71–0.86]), being employed (RRR 0.71 [95% CI 0.64–0.78]),

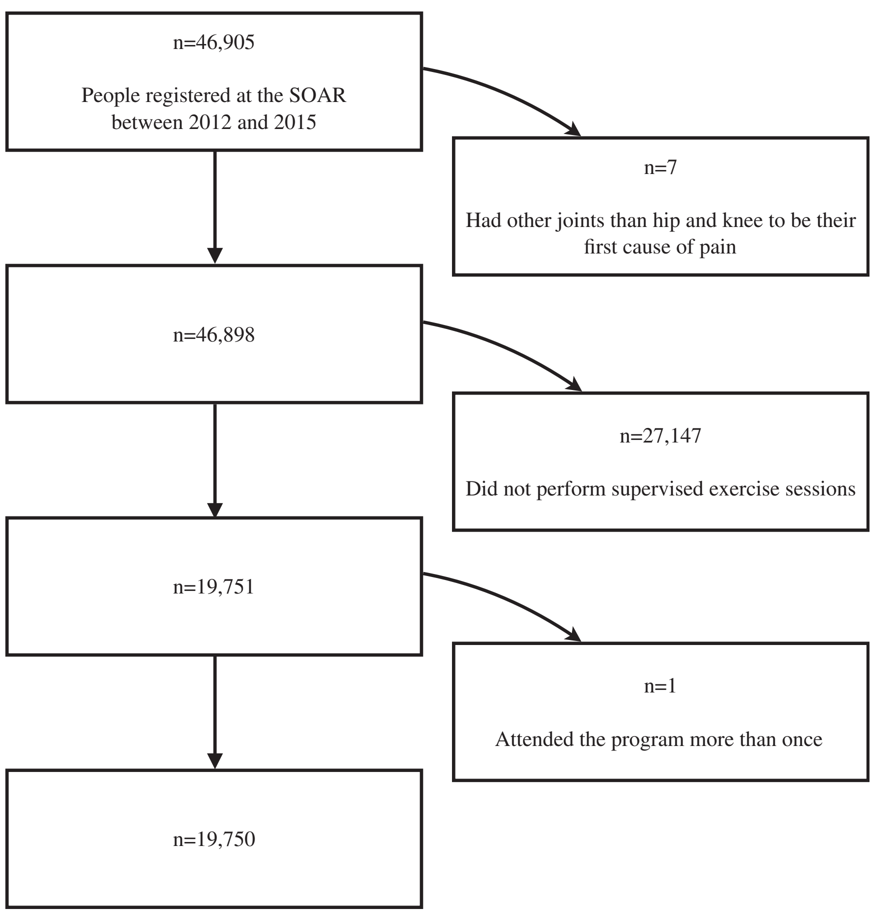

Figure 1. Selection of the study population. SOAR = Swedish Osteoarthritis Registry.

Table 1. Descriptive statistics*

Variables	Total sample (n = 19,750)	Level of adherence: Low (n = 5,862)	Medium (n = 3,947)	High (n = 9,941)
Demographic and lifestyle characteristics				
Assigned sex at birth	n = 19,750	n = 5,862	n = 3,947	n = 9,941
Male	5,421 (27.45)	1,519 (25.91)	925 (23.44)	2,977 (29.95)
Female	14,329 (72.55)	4,343 (74.09)	3,022 (76.65)	6,964 (70.05)
Age	n = 19,750	n = 5,862	n = 3,947	n = 9,941
Mean ± SD	66.86 ± 8.94	65.87 ± 9.39	66.47 ± 9.01	67.60 ± 8.57
Body mass index	n = 19,381	n = 5,735	n = 3,867	n = 9,779
Mean ± SD	27.56 ± 4.76	27.73 ± 4.90	27.75 ± 4.89	27.43 ± 4.63
HRQoL (EQ-5D VAS, 0–100)	n = 17,933	n = 5,317	n = 3,592	n = 9,024
Mean ± SD	65.82 ± 19.22	65.84 ± 19.37	65.74 ± 19.35	65.85 ± 19.07
Weekly physical activity, hours	n = 18,050	n = 5,364	n = 3,606	n = 9,080
Mean ± SD	4.11 ± 2.53	4.14 ± 2.53	4.03 ± 2.49	4.13 ± 2.54
Socioeconomic characteristics				
Institutionally based education level	n = 19,699	n = 5,862	n = 3,938	n = 9,918
Low	4,331 (21.99)	1,170 (20.02)	795 (20.19)	2,366 (23.86)
Medium	9,843 (49.97)	2,962 (50.69)	2,007 (50.96)	4,874 (49.14)
High	5,525 (28.05)	1,711 (29.28)	1,136 (28.85)	2,678 (27.00)
Income quartile	n = 19,738	n = 5,858	n = 3,945	n = 9,935
Lowest	4,942 (25.04)	1,345 (22.96)	1,022 (25.91)	2,575 (25.92)
Second	4,936 (25.01)	1,393 (23.78)	982 (24.89)	2,561 (25.78)
Third	4,929 (24.97)	1,517 (25.90)	976 (24.74)	2,436 (24.52)
Highest	4,931 (24.98)	1,603 (27.36)	965 (24.46)	2,363 (23.78)
Area of living	n = 19,738	n = 5,858	n = 3,945	n = 9,935
Rural	6,047 (30.64)	1,667 (28.46)	1,180 (29.91)	3,200 (32.21)
Suburban	8,252 (41.81)	2,435 (41.57)	1,708 (43.30)	4,109 (41.36)
Urban	5,439 (27.56)	1,756 (29.98)	1,057 (26.79)	2,626 (26.43)
Employment	n = 19,738	n = 5,858	n = 3,945	n = 9,935
Unemployed	12,244 (62.03)	3,275 (55.91)	2,394 (60.68)	6,575 (66.18)
Employed	7,494 (37.97)	2,583 (44.09)	1,551 (39.32)	3,360 (33.82)
Living alone	n = 19,738	n = 5,858	n = 3,945	n = 9,935
Living alone	7,754 (39.28)	2,411 (41.16)	1,457 (36.93)	3,886 (39.11)
Living with someone	11,984 (60.72)	3,447 (58.84)	2,488 (63.07)	6,049 (60.89)
Disease-related characteristics				
Worst joint	n = 19,750	n = 5,862	n = 3,947	n = 9,941
Hip	6,049 (30.63)	1,708 (29.14)	1,188 (30.10)	3,153 (31.72)
Knee	13,701 (69.37)	4,154 (70.86)	2,759 (69.90)	6,788 (68.28)
Pain intensity (NRS 0–10)	n = 19,686	n = 5,843	n = 3,935	n = 9,908
Mean ± SD	5.25 ± 1.83	5.23 ± 1.85	5.24 ± 1.87	5.26 ± 1.80
Pain frequency	n = 19,700	n = 5,842	n = 3,940	n = 9,918
Infrequent	3,436 (17.44)	1,100 (18.83)	723 (18.35)	1,613 (16.26)
Frequent	16,264 (82.56)	4,742 (81.17)	3,217 (81.65)	8,305 (87.34)
Number of painful joints	n = 19,750	n = 5,862	n = 3,947	n = 9,941
Mean ± SD	1.94 ± 1.29	1.95 ± 1.28	2.00 ± 1.32	1.91 ± 1.27
Charnley score	n = 19,735	n = 5,855	n = 3,946	n = 9,934
A	6,814 (34.53)	2,000 (34.16)	1,340 (33.96)	3,474 (34.97)
B	3,437 (17.42)	1,009 (17.23)	686 (17.38)	1,742 (17.54)
C	9,484 (48.06)	2,946 (48.61)	1,920 (48.66)	4,718 (47.49)
Walking difficulties	n = 19,651	n = 5,835	n = 3,932	n = 9,884
No	3,472 (17.67)	1,105 (18.94)	731 (18.59)	1,636 (16.55)
Yes	16,179 (82.33)	4,730 (81.06)	3,201 (81.41)	8,248 (83.45)
Fear of movement	n = 19,651	n = 5,821	n = 3,928	n = 9,902
No	16,562 (84.28)	4,871 (83.68)	3,303 (84.09)	8,388 (84.71)
Yes	3,089 (15.72)	950 (16.32)	625 (15.91)	1,514 (15.29)
Desire for surgery	n = 19,558	n = 5,798	n = 3,906	n = 9,854
No	14,936 (76.37)	4,441 (76.60)	3,017 (77.24)	7,478 (75.89)
Yes	4,622 (23.63)	1,357 (23.40)	889 (22.76)	2,376 (24.11)
ASES pain and symptoms (0–100)	n = 19,149	n = 5,660	n = 3,834	n = 9,655
Mean ± SD	65.54 ± 16.43	65.44 ± 16.54	65.51 ± 16.62	65.61 ± 16.28

* Values are the number (%) unless indicated otherwise. To calculate the missing values, subtract the number of participants listed in the second column (Total sample) from the total sample size of 19,750. ASES = Arthritis Self-Efficacy Scale; EQ-5D VAS = EuroQol 5-domain instrument visual analog scale; HRQoL = health-related quality of life; NRS = numeric rating scale.

Table 2. Association between exercise adherence and investigated factors (n = 16,685)*

Variables	*P*	RRR (95% CI for EXP[B])
Medium levels of adherence		
Assigned sex at birth		
Male (base category)	–	–
Female	0.03	1.13 (1.02–1.27)
Age	0.14	1.00 (0.99–1.01)
Body mass index	0.37	0.99 (0.99–1.01)
HRQoL (EQ-5D VAS, 0–100)†	0.57	0.99 (0.97–1.02)
Weekly physical activity, hours	0.02	0.98 (0.96–0.99)
Institutionally based education level		
Low (base category)	–	–
Medium	0.88	0.99 (0.88–1.12)
High	0.63	0.97 (0.84–1.11)
Income quartile		
Lowest (base category)	–	–
Second	0.71	0.98 (0.86–1.11)
Third	0.63	0.97 (0.84–1.11)
Highest	0.41	0.94 (0.81–1.09)
Area of living		
Rural (base category)	–	–
Suburban	0.27	0.94 (0.85–1.05)
Urban	0.02	0.87 (0.78–0.98)
Employment		
Unemployed (base category)	–	–
Employed	<0.01	0.82 (0.72–0.93)
Living alone		
Living alone (base category)	–	–
Living with someone	<0.01	1.21 (1.10–1.32)
Worst joint		
Hip (base category)	–	–
Knee	0.35	0.95 (0.86–1.05)
Pain intensity (NRS 0–10)	0.49	1.01 (0.98–1.04)
Pain frequency		
Infrequent (base category)	–	–
Frequent	0.80	0.98 (0.87–1.11)
Number of painful joints	0.01	1.06 (1.01–1.10)
Charnley score		
A (base category)	–	–
B	0.99	0.99 (0.97–1.15)
C	0.13	0.91 (0.81–1.03)
Walking difficulties		
No (base category)	–	–
Yes	0.93	0.99 (0.88–1.13)
Fear of movement		
No (base category)	–	–
Yes	0.49	1.04 (0.92–1.18)
Desire for surgery		
No (base category)	–	–
Yes	0.26	0.94 (0.83–1.05)
ASES pain and symptoms (0–100)†	0.29	1.02 (0.99–1.05)
High levels of adherence		
Assigned sex at birth		
Male (base category)	–	–
Female	<0.01	0.82 (0.75–0.89)
Age	<0.01	1.01 (1.01–1.02)
Body mass index	0.01	0.99 (0.98–0.99)
HRQoL (EQ-5D VAS, 0–100)†	0.18	0.98 (0.96–1.01)
Weekly physical activity, hours	0.79	0.99 (0.98–1.01)
Institutionally based education level		
Low (base category)	–	–
Medium	0.02	0.89 (0.81–0.98)
High	<0.01	0.84 (0.76–0.94)
Income quartile		
Lowest (base category)	–	–
Second	0.79	1.01 (0.91–1.13)
Third	0.61	1.03 (0.92–1.15)
Highest	0.95	1.00 (0.89–1.14)
Area of living		
Rural (base category)	–	–
Suburban	<0.01	0.79 (0.73–0.86)
Urban	<0.01	0.78 (0.71–0.86)
Employment		
Unemployed (base category)	–	–
Employed	<0.01	0.71 (0.64–0.78)
Living alone		
Living alone (base category)	–	–
Living with someone	0.29	1.04 (0.97–1.12)
Worst joint		
Hip (base category)	–	–
Knee	0.03	0.92 (0.85–0.99)
Pain intensity (NRS 0–10)	0.12	1.02 (0.99–1.04)
Pain frequency		
Infrequent (base category)	–	–
Frequent	0.02	1.13 (1.02–1.25)
Number of painful joints	0.50	1.01 (0.98–1.05)
Charnley score		
A (base category)	–	–
B	0.74	1.02 (0.91–1.14)
C	0.11	0.93 (0.84–1.02)
Walking difficulties		
No (base category)	–	–
Yes	0.03	1.12 (1.01–1.24)
Fear of movement		
No (base category)	–	–
Yes	0.93	1.00 (0.91–1.11)
Desire for surgery		
No (base category)	–	–
Yes	0.44	0.96 (0.88–1.06)
ASES pain and symptoms (0–100)†	<0.01	1.04 (1.02–1.07)

(Continued)

Table 2. (*Cont'd*)

* Low levels of adherence are the reference. 95% CI = 95% confidence interval; ASES = Arthritis Self-Efficacy Scale; EQ-5D VAS = EuroQol 5-domain instrument visual analog scale; HRQoL = health-related quality of life; NRS = numeric rating scale; RRR = relative risk ratio.
† RRR is reported as an increase of 10 points in the scale.

having a medium (RRR 0.89 [95% CI 0.81–0.98]) or a high level of institutionally based education (RRR 0.84 [95% CI 0.76–0.94]), and having the knee as the worst joint (RRR 0.92 [95% CI 0.85–0.99]) were negatively associated with high levels of adherence.

Finally, the McFadden R^2 of the full model suggested that participants' demographic and lifestyle characteristics, socioeconomic characteristics, and disease-related characteristics can explain approximately 1.2% of the variation in adherence. After we removed participants' demographic and lifestyle characteristics, socioeconomic characteristics, and disease-related characteristics alternatively, there was a difference in the McFadden R^2 with respect to the full model of 0.3%, 0.4%, and 0.2%, respectively. Disease-related characteristics had the most explanatory power, albeit the total explanatory ability of the full model was very small.

DISCUSSION

This study is the first to try to understand the relationship between demographic and lifestyle, socioeconomic, and disease-related factors, with the level of adherence to a face-to-face supervised exercise program for OA in a large sample of participants with this disease. Of the total sample, approximately 30% had low adherence levels, 20% had medium adherence levels, and 50% had high adherence levels. The distribution of adherence levels in our sample is consistent with that of participants in a similar Danish intervention (37) but differs from the distribution observed in an online version of the same intervention, which had a higher proportion of people with high levels of adherence than our sample (38). While several factors were associated with adherence, the full model could explain only 1% of the variability, which suggests that these factors are unlikely to have a tangible impact on adherence.

Regarding demographic and lifestyle factors, female sex was negatively associated with a high level of adherence. Previous evidence has indicated that women (with or without OA) might face societal expectations of household and caregiving responsibilities, experiencing greater difficulty finding time to exercise (39–43). However, in the digital version of this intervention, female sex suggested a positive association with high levels of exercise adherence (38), suggesting that digital interventions may be more convenient for females. Despite these findings, addressing the root causes of these disparities in exercise adherence is crucial, rather than focusing on exercise delivery mode to reduce this sex gap. However, our study only collected information on participants' assigned sex at birth, limiting the generalizability of our results to those individuals who are not cisgender. Therefore, further research is needed to explore the relationship between gender identity, sex, and exercise adherence in individuals with OA. In addition, participants' older age was positively associated with reaching a high level of adherence. Considering how exercise is delivered in this program, our result aligns with previous evidence where older adults adhered more to self-paced rather than moderate-intensity exercise (44). Finally, BMI was negatively associated with reaching high levels of adherence, which is consistent with previous evidence where people with high BMI are less keen on engaging in physical exercise (38,45).

Among the socioeconomic factors, people who lived in an urban or suburban area, were employed, and had medium or high levels of institutionally based education tended to exercise less than their counterparts. Similar results were found in the digital version of this intervention, where lower institutionally based education and living outside the largest Swedish cities were associated with higher adherence (38). These results contrast with the previous literature, where socioeconomic categories typically representing higher socioeconomic positions tended to adhere more to exercise (46,47). However, it is essential to consider that most of the data on adherence were retrieved from secondary analyses of randomized controlled trials (RCTs) (48). First, these studies were not designed to study adherence. RCTs per se tend to enhance adherence to treatment, which might create an overestimation of the factors related to adherence (49).

Second, in RCTs, people are volunteers who are selected following specific inclusion and exclusion criteria, which may fail to mirror the socioeconomic variability of the underlying population from which the sample is drawn (50). Moreover, we might not have reached the more socioeconomically disadvantaged groups, considering the higher socioeconomic positions of the SOAR sample compared to the general Swedish population (29). Finally, another explanation of this tendency is that people in lower socioeconomic positions seemed exposed to a more detrimental OA-disease burden than their higher counterparts (51). Severe symptoms can act as a motivator and drive exercise adherence (46,52). Those who experience a higher disease burden might be more motivated to follow exercise regimens. This phenomenon was also highlighted in our study when looking at the disease-related factors, as having frequent pain and walking difficulties were associated with high levels of adherence.

Moreover, self-efficacy was associated with exercise adherence, as per previous evidence (53), but with a modest RRR. Self-efficacy is characterized by a curvilinear (U-shaped) relationship between this construct and task accomplishment (54). People with low self-efficacy are likely to doubt their chance to accomplish a task, and those with a high-self efficacy might be characterized by complacency, inadequate preparation, and a focus on achieving task-related targets (54). Therefore, low and high levels of self-efficacy can lead to a similar outcome, namely, low adherence to a task (e.g., exercise). Considering the large cohort of our study, the effect of self-efficacy might be diluted due to the high variety of our population.

However, our model could explain just 1% of the variability, as indicated by the McFadden R^2. Thus, if we wanted to design an exercise intervention and understand which strategies to adopt to increase adherence, we should accept that demographic and lifestyle, socioeconomic, and disease-related factors are unlikely to improve adherence significantly, considering how little they explain adherence variability. This conclusion is further supported by the limited ability of similar factors to explain exercise adherence in the digital version of the intervention (38). Therefore, other factors should be taken into account.

The SOAR gathers real-world data from >500 different units throughout Sweden, with considerable variability among them. These contexts are characterized by specific contextual factors (e.g., structures' facilities, clinicians' communication style and ability to motivate patients, etc.) that affect people's outcomes via a placebo (or nocebo) response if positively (placebo) or negatively (nocebo) encoded by the brain via the so-called "mindsets" (55). Mindsets are "core assumptions about a domain or category that orient individuals to a particular set of attributions, expectations, and goals" (56,57). Preliminary evidence indicated that improving mindsets about exercise increased its adherence (57). Moreover, booster sessions, reminders, and behavioral change techniques can improve exercise adherence by increasing motivation to partake in exercise (58,59). These strategies seem to ground their efficacy on contextual factors as well (e.g., communication with the clinicians, feeling taken care of by them, etc.). Therefore, we can argue that contextual factors and the mindsets responsible for interpreting them are worth exploring in future studies to understand their relationship with exercise adherence.

Some limitations of this study need to be discussed. First, the observational nature of the study does not allow us to establish causality and draw any definitive conclusion on the relationship between exercise adherence and the investigated factors. Second, a few variables were not reported. However, as explained in the methods section, the missingness of our data could be considered to be completely at random, primarily due to an error during the data upload process in the registers, introducing no or minimal bias in our results. However, we recommend interpreting our results cautiously, as we could not verify the reason for the data missingness. Third, our results might not be reliably applied to other forms of exercise (e.g., unsupervised home exercise) due to the specific research question of our study. Finally, physical activity hours, the number of painful joints, and living alone were found to be associated with medium but not high levels of adherence. However, this result may be influenced by chance and could also be attributed to the ad hoc adherence categorization adopted in the SOAR. Bearing in mind the limits of this study, it is worth highlighting that we reported the results of roughly 20,000 people with OA, followed by physiotherapists in the Swedish national health care system who tailored their intervention to patients' needs and characteristics. The size and data quality of our study strengthen its clinical importance and relevance for research.

To conclude, strategies based on demographic and lifestyle, socioeconomic, and disease-related factors are unlikely to improve exercise adherence significantly. Other elements, such as mindsets and contextual factors, need to be investigated. Moreover, as booster sessions, reminders, and behavioral-change techniques seem to improve exercise adherence (58,59), we should also understand how they motivate people to partake in exercise. Considering the complexity of adherence and the types of treatments that have succeeded in improving it so far, there is a call for solutions that go beyond a one-size-fits-all approach, to accept human variability and uncertainty, and to foster tailored interventions for individuals.

AUTHOR CONTRIBUTIONS

All authors were involved in drafting the article or revising it critically for important intellectual content, and all authors approved the final version to be submitted for publication. Dr. Testa had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.

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