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Exploring the link between socioeconomic factors and rheumatoid arthritis: Insights from a large Austrian study

Mathias Ausserwinkler [a,b,*,1], Maria Flamm [c,2], Sophie Gensluckner [b,3], Kathrin Bogensberger [d,e,f,g,4], Bernhard Paulweber [b,5], Eugen Trinka [h,i,6], Patrick Langthaler [h,i,7], Christian Datz [j,8], Boris Lindner [k,9], Bernhard Iglseder [l,10], Elmar Aigner [b,11], Bernhard Wernly [b,c,12]

[a] Department of Internal Medicine, Elisabethinen Hospital Klagenfurt, Austria
[b] First Department of Medicine, Paracelsus Medical University, Salzburg, Austria
[c] Institute of General Practice, Family Medicine and Preventive Medicine, Center for Public Health and Healthcare Research, Paracelsus Medical University, Salzburg, Austria
[d] Ludwig Boltzmann Institute for Arthritis and Rehabilitation, Vienna, Austria
[e] Gastein Research Institute, Paracelsus Medical University, Salzburg, Austria
[f] Institute of Physiology and Pathophysiology, Salzburg, Austria
[g] Center for Physiology, Pathophysiology and Biophysics, Paracelsus Medical University, Salzburg, Austria
[h] Department of Neurology, Neurointensive Care and Neurorehabilitation, Member of the European Reference Network EpiCARE, Christian Doppler University Hospital, Centre for Cognitive Neuroscience, Paracelsus Medical University, Salzburg, Austria
[i] Neuroscience Institute, Paracelsus Medical University, Salzburg, Austria
[j] Department of Internal Medicine, General Hospital Oberndorf, Teaching Hospital of the Paracelsus Medical University, Salzburg, Austria
[k] Medical Department II-Center for diagnosis and treatment of rheumatic diseases, Klinik Hietzing, Vienna, Austria
[l] Department of Geriatric Medicine, University Hospital Salzburg (SALK-Campus CDK), Paracelsus Medical University, Salzburg, Austria

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ABSTRACT

Introduction: Austria, a country with a high standard of living and a well-developed healthcare system, still experiences socioeconomic status (SES) disparities that impact health outcomes. Rheumatoid arthritis (RA) is a chronic autoimmune disease associated with significant disability and comorbidities. While SES has been linked to RA prevalence and disease severity, its role in a high-income country like Austria remains underexplored. This study investigates the association between SES factors—education, income, employment status and migration background—and RA prevalence and outcomes.

Methods: This population-based study used data from the Paracelsus 10,000 cohort in Salzburg, Austria and a cross-sectional design. A total of 9256 participants aged 40–77 years were analyzed, including 289 individuals

* Corresponding author at: Department of Internal Medicine, Elisabethinen Hospital Klagenfurt, Austria.
E-mail addresses: mathias.ausserwinkler@gmx.at (M. Ausserwinkler), maria.flamm@pmu.ac.at (M. Flamm), s.gensluckner@salk.at (S. Gensluckner), kathrin.bogensberger@pmu.ac.at (K. Bogensberger), b.paulweber@salk.at (B. Paulweber), e.trinka@salk.at (E. Trinka), p.langthaler@salk.at (P. Langthaler), c.datz@kh-oberndorf.at (C. Datz), boris.lindner@gesundheitsverbund.at (B. Lindner), b.iglseder@salk.at (B. Iglseder), e.aigner@salk.at (E. Aigner), bernhard.wernly@pmu.ac.at (B. Wernly).
[1] 0009–0000-3353–8702
[2] 0000–0003-0816–6657
[3] 0009–0006-5008–7134
[4] 0900–0003-0828–655X
[5] 0000–0002-1609–4676
[6] 0000–0002-5950–2692
[7] 0009–0007-7226–8371
[8] 0000–0001-7838–4532
[9] 0009–0005-6049–0202
[10] 0000–0002-6132–8670
[11] 0000–0003-0310–0536
[12] 0000–0003-4024–0220

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Paracelsus 10,000
Autoimmune disease
Chronic inflammation
Public health
Migration background
Disease risk factors
Health Equity
Crosssectional study

diagnosed with RA based on the ACR/EULAR classification criteria. SES was assessed through self-reported education, income, employment status and country of birth. Logistic regression models were used to evaluate the association between SES and RA, adjusting for age, sex, metabolic syndrome, smoking and alcohol consumption.

Results: RA prevalence was significantly lower among individuals with higher education (OR = 0.55, 95 % CI: 0.37–0.82 for medium education; OR = 0.41, 95 % CI: 0.25–0.68 for high education). Lower household income correlated with higher RA prevalence. Employment disparities were evident, with RA patients exhibiting higher rates of unemployment and work disability.

Conclusion: Despite Austria's high standard of living, SES remains a key determinant of RA prevalence. Lower levels of education, income and employment are associated with higher rates of RA, highlighting the need for targeted public health interventions. Strengthening healthcare access, promoting early screening and offering economic support to vulnerable groups could be important steps toward reducing these disparities. Further research should explore the underlying mechanisms of this association and examine whether socioeconomic disparities also influence disease progression and patient outcomes.

Introduction

RA is a chronic systemic autoimmune disorder marked by persistent synovial inflammation, primarily targeting the joints and affecting approximately 1 % of the global population [1]. In addition to joint inflammation, RA is linked to various extra-articular complications and comorbid conditions, such as cardiovascular diseases and metabolic syndrome [2,3]. Despite the availability of multiple conventional and biological disease-modifying anti-rheumatic drugs, managing the disease can remain challenging, often requiring lifelong treatment. Disease effects can impact patients' socioeconomic circumstances [4–6]. These socioeconomic factors play a significant role in the management and outcomes of RA. Research has shown that lower socioeconomic status could be associated with higher disease activity, poorer treatment outcomes and increased mortality rates in RA patients [7,8]. Factors such as educational level, occupation, income and living area have been found to influence disease activity and risk [8]. Studies have revealed that patients from lower socioeconomic backgrounds face several challenges in managing their RA. These include delayed diagnosis, reduced access to specialized care and difficulties in adhering to treatment plans [9]. For instance, patients with lower income levels may experience delays in receiving a proper diagnosis, which can significantly impact disease progression and treatment efficacy [8]. Furthermore, socioeconomic status has been linked to work disability and income reduction among RA patients. These socioeconomic consequences can manifest early in the disease course and are influenced by factors such as age, gender, marital status and work disability [10]. This study was conducted in Austria, a high-income country with a well-developed healthcare system and strong social support structures. Despite these advantages, socioeconomic disparities could persist and influence health outcomes related to RA. While SES has been linked to RA prevalence and disease severity, its role in a high-income country like Austria remains underexplored [11].

Methods

Study population

Participants were randomly selected from the Austrian national registry of residents to ensure a representative sample of the general population. The cohort includes individuals aged 40–77 years who underwent baseline assessments between April 2013 and March 2020 [12–15]. Of approximately 56,600 invitation letters distributed, 10,044 individuals participated, yielding a response rate of 17.7 %. The analysis is based on data collected within a cross-sectional study design. For this analysis, 9256 participants were included, based on the availability of complete SES and RA data [16]. A total of 289 individuals (3.1 %) had confirmed RA, according to the American College of Rheumatology (ACR) and European League Against Rheumatism (EULAR) classification criteria [1]. SES was evaluated using educational attainment, household income, employment status, marital status, country of birth, religious affiliation and family structure. Education was classified according to the International Standard Classification of Education (ISCED) into low (ISCED 0–2), medium (ISCED 3–4), and high (ISCED 5–8). Household income was self-reported and categorized into seven predefined ranges, reflecting total yearly household earnings in euros.

Employment status was recorded as employed (full-time or part-time), unemployed, student, homemaker, retired or engaged in military or civil service. Marital and relationship status was classified as married or cohabiting, single, divorced or widowed. Country of birth was documented to assess migration status, early-life exposures and access to healthcare. The majority of participants (88 %) were native Austrian, with smaller proportions from Germany (4 %), the former Yugoslav states (3 %), Turkey (0.4 %) and other countries (5 %). Family structure was evaluated based on the number of children.

All participants underwent standardized clinical, laboratory and anthropometric assessments. Body mass index (BMI), abdomen circumference and bioelectrical impedance analysis (for a subset) were used to assess body composition. Blood samples were collected following overnight fasting and analyzed for lipid profiles (total cholesterol, LDL, HDL, triglycerides), glucose metabolism markers (fasting glucose, HbA1c), inflammatory markers (high-sensitivity C-reactive protein [hs-CRP]). Cardiovascular health was assessed using blood pressure measurements, electrocardiography (ECG) and Ankle-Brachial Index (ABI) measurements. Lifestyle factors, including medical history, medication use, smoking, alcohol consumption and physical activity, were assessed through structured interviews [17].

To clarify the rationale for variable selection and to illustrate the assumed causal relationships, a Directed Acyclic Graph (DAG) was constructed (Fig. 3). The DAG depicts how SES influences RA both directly and indirectly through mediating factors such as health literacy, lifestyle (e.g., smoking, physical activity), and underuse of healthcare services.

Statistical analysis

Descriptive statistics were applied to summarize the demographic, socioeconomic and clinical characteristics of the study population. Chi-square tests were performed to compare categorical variables between RA and non-RA groups. Logistic regression models with robust standard errors were used to calculate odds ratios (ORs) and 95 % confidence intervals (CIs) to determine the association between SES factors and RA risk. Odds ratios represent the odds of RA prevalence in exposed versus unexposed groups, with values < 1 indicating lower odds and values > 1 indicating higher odds in the exposed group. The models were structured to assess the relationship between educational attainment, income, employment status and RA prevalence with stepwise adjustments for demographic, metabolic and behavioral covariates. Three models were used in the analysis. Model I (unadjusted Model), Model II (adjusted for age and sex), Model III (adjusted for metabolic syndrome,

smoking status and alcohol consumption). To ensure the robustness of the findings, a sensitivity analyses by introducing interaction terms for key factors: metabolic syndrome, age, gender, alcohol consumption and smoking status was conducted. Given the known correlation between education and income, additional analyses were conducted including both SES variables simultaneously in combined models to assess their independent effects on RA prevalence.

Results

Participant characteristics

A total of 9256 participants were included in the analysis, of whom 289 (3.1 %) had a confirmed diagnosis of RA. The median age in the total cohort was 55 years (interquartile range [IQR]: 50–61 years), with RA patients being older than non-RA participants (59 years [IQR: 54–64] vs. 55 years [IQR: 49–61]). Participants aged 60–69 years made up 28 % of the total sample, whereas the proportion was higher among RA patients (40 %). The percentage of individuals aged 70 years or older was 7 % in the RA group, compared to 4 % in the non-RA group. Men comprised 49 % of the total cohort but were less prevalent among RA patients (33 %). High-sensitivity C-reactive protein (hs-CRP) levels were higher in RA patients (0.14 mg/dL vs. 0.11 mg/dL, $p < 0.001$) – Table 1, Fig. 2.

Table 1
presents a comparison of demographic data between individuals with and without RA, with corresponding p-values.

	Non RA	RA	p-value
	N = 8967	N = 289	
Age in years	55 (49–61)	59 (54–64)	< 0.001
Age (categorized)			< 0.001
Age 40–49	25 % (2238)	9 % (25)	
Age 50–59	43 % (3899)	44 % (128)	
Age 60–69	27 % (2464)	40 % (116)	
Age ≥ 70	4 % (352)	7 % (19)	
Male	49 % (4413)	33 % (94)	< 0.001
Female	51 % (4554)	67 % (195)	< 0.001
Height (cm)	171 (164–178)	167 (162–174)	< 0.001
Weight (kg)	76 (65–87)	77. (66–89)	0.26
BMI (kg / m²)	26 (23–29)	27. (24–31)	< 0.001
BMI categories			< 0.001
BMI < 18.5	1 % (94)	1 %. (2)	
BMI 18.5–24.9	41 % (3660)	33 % (94)	
BMI 25–29.9	39 % (3527)	33 % (95)	
BMI 30–34.9	14 % (1259)	23 % (67)	
BMI 35–39.9	3 % (300)	9 % (26)	
BMI ≥ 40	1 % (117)	2 %. (5)	
BMI ≥ 30 kg/m²	18 % (1641)	34 %. (98)	< 0.001
Waist circumference (cm)	93 (84–101)	95 (85–106)	0.001
HbA1c (%)	5.4 (5.3–5.6)	5.5 (5.3–5.7)	0.010
Coronary Artery Disease	2 % (169)	4 % (13)	0.002
Metabolic Syndrome	25 % (2179)	35 %. (100)	< 0.001
Smoking status			0.045
Never smoker	45 % (4043)	38 % (111)	
Previous smoking	37 % (3276)	43 %. (125)	
Current smoker	18 % (1648)	18 % (53)	
Alcohol in g/d	8 (2–18)	7 (2–16)	0.30

Socioeconomic characteristics and RA prevalence

Significant differences in socioeconomic characteristics were observed between RA and non-RA participants. Among RA patients, 17 % had lower education compared to 7 % in the non-RA group, while fewer RA patients had higher education (16 % vs. 23 %). A statistically significant association was observed between RA and lower education levels (Pearson chi² = 40.249, $p < 0.001$) – Fig. 1.

RA patients were more frequently found in the lower income groups. Among those with a yearly income of 12,000–24,000 €, 40 % had RA compared to 31 % in non-RA participants. In contrast, the proportion of individuals with a yearly income above 60,000 € was lower in RA patients (3 % vs. 6 %). This association was statistically significant (Pearson chi² = 20.32, $p = 0.002$) – Table 2.

Relationship status differed significantly between groups: married or cohabiting participants represented 63.7 % of the RA group and 62.3 % of non-RA participants. The proportion of divorced individuals was higher among RA patients (16.6 % vs. 13.3 %), while fewer RA patients were single (6.9 % vs. 11.8 %). The distribution of relationship status categories differed significantly between the groups (Pearson chi² = 14.433, $p = 0.025$).

A substantial difference was observed in employment status between RA and non-RA participants. Among RA patients, 47 % were employed at the time of the study, compared to 68 % in the non-RA group. This association was statistically significant (Pearson chi² = 66.172,

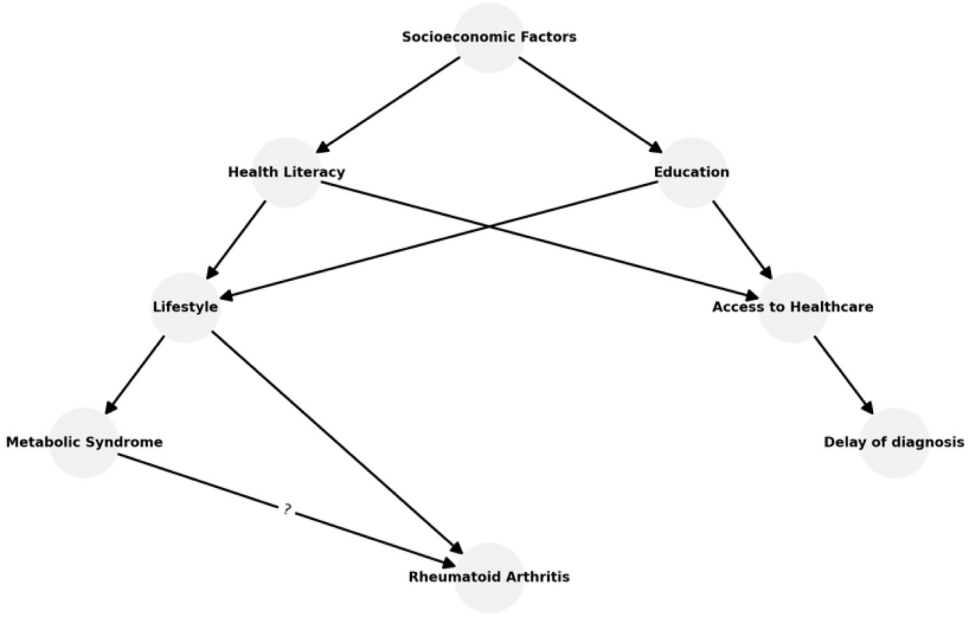

Fig. 3. illustrating the hypothesized causal pathways from SES to RA via mediating variables including education, lifestyle, health literacy and underuse of healthcare services.

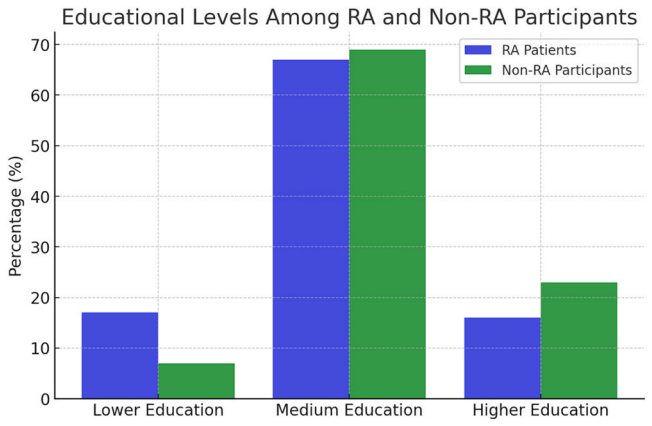

Fig. 1. shows the differences in percentage between RA and non-RA participants through their education level.

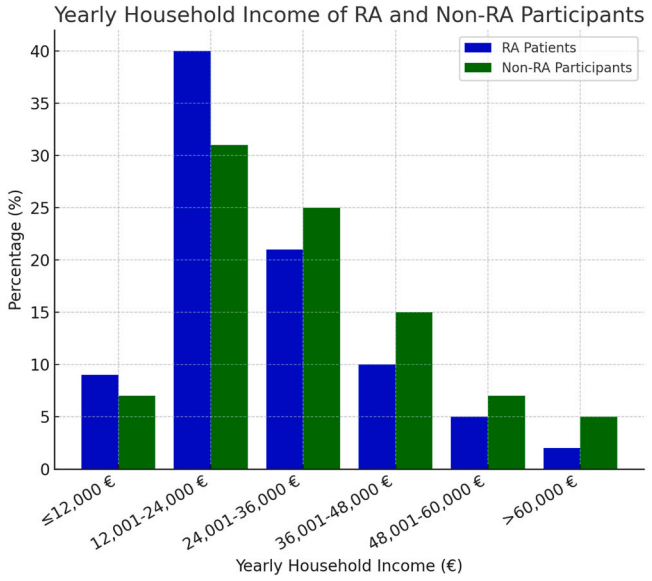

Fig. 2. shows the differences in percentage between RA and non-RA participants through their yearly income.

$p < 0.001$).

The majority of participants were born in Austria (88 %), but this proportion was lower among RA patients (80 %). The proportion of individuals born in the former Yugoslav states was higher in RA patients (7 % vs. 3 %). The association between country of birth and RA was statistically significant (Pearson $chi^2 = 27.753$, $p < 0.001$). The number of children per participant varied between RA and non-RA individuals – Table 2.

Clinical and lifestyle characteristics

Anthropometric measures showed that median BMI was higher in RA patients (27.0 kg/m^2 vs. 26.0 kg/m^2). The proportion of individuals with BMI 30.0 kg/m^2 or higher was 34 % in RA patients, compared to 18 % in non-RA individuals. Median waist circumference was higher in RA patients (95.0 cm vs. 93.0 cm).

Lifestyle factors showed that in our cohort 45 % of participants were never smokers, 37 % were former smokers and 18 % were current smokers. Among RA patients, the proportion of former smokers was higher (43 % vs. 37 %), while the percentage of never smokers was lower (38 % vs. 45 %). Alcohol consumption was similar between groups, with a median intake of 8 g/day in the total cohort and slightly lower levels in RA patients (7 g/day) – Table 1.

Table 2
presents a comparison of demographic, socioeconomic and health-related characteristics between individuals with and without RA, with corresponding p-values.

	Non RA	RA	p-value
Education level			<0.001
Lower education	7 % (664)	17 %. (49)	
Medium education	69 % (6232)	67 % (195)	
Higher education	23 % (2071)	16 % (45)	
Yearly Household income			0.002
≤12000 €	7 % (648)	9 %. (26)	
12,001–24,000 €	31 % (2760)	40 % (117)	
24,001–36,000 €	25 % (2251)	21 % (61)	
36,001–48,000 €	14 % (1224)	10 % (30)	
48,001–60,000 €	8 % (733)	5 % (15)	
> 60,000 €	6 % (537)	3 % (10)	
No information	9 %. (814)	10 % (30)	
Employment status			<0.001
No, unemployed	3 %. (236)	3 % (8)	
No, student	0 % (16)	0 % (0)	
No, civil/military service	0 % (1)	0 % (0)	
No, homemaker	2 % (182)	4 % (12)	
No, retired	26 % (2363)	46 % (133)	
Yes, employed	69 % (6169)	47 % (136)	
Relationship status			0.025
Married, living with spouse	62 % (5583)	64 % (184)	
Married, separated	1 % (123)	2 % (6)	
Committed relationship	8 % (710)	6 % (18)	
Single	12 % (1055)	7 % (20)	
Divorced	13 % (1189)	17 % (48)	
Widowed	3 % (255)	4 % (13)	
No information	1 % (52)	0 % (0)	
Number of children			0.85
1	19 % (1736)	16 % (47)	
2	23 % (2064)	21 % (60)	
3	40 % (3559)	41 % (119)	
4	14 % (1245)	17 % (48)	
5	3 % (272)	4 % (12)	
6	1 % (61)	1 % (3)	
7	0 % (11)	0 % (0)	
8	0 % (7)	0 % (0)	
9	0 % (3)	0 % (0)	
10	0 % (3)	0 % (0)	
11	0 % (1)	0 % (0)	
12	0 % (5)	0 % (0)	
Country of birth			<0.001
Austria	88 % (7890)	80 % (232)	
Germany	4 % (373)	4 % (11)	
Former Yugoslav states	3 % (244)	7 % (20)	
Turkey	0 % (39)	1 % (3)	
Other	5 % (421)	8 % (23)	
Austrian citizenship	93 % (8312)	88 % (254)	0.002

Multivariable analysis of education and RA

To quantify the associations between socioeconomic factors and RA prevalence, multivariable logistic regression analyses were performed using three sequential models. As this is a cross-sectional analysis, effect estimates are reported as odds ratios (ORs) with 95 % confidence intervals, estimated using logistic regression, reflecting associations with RA prevalence. ORs represent the odds of having RA in one group compared to the reference group, with values < 1 indicating lower odds and values > 1 indicating higher odds.

The protective effect of higher education remained consistent across all models. In the unadjusted analysis, medium education was associated with an OR of 0.55 (95 % CI: 0.37–0.82, $p < 0.001$) and higher education with an OR of 0.41 (95 % CI: 0.25–0.68, $p < 0.001$) compared to low education. These associations persisted after adjusting for age and sex (medium: OR = 0.48, 95 % CI: 0.36–0.65; higher: OR = 0.41, 95 % CI: 0.25–0.68, both $p < 0.001$) and in the fully adjusted model including metabolic syndrome, smoking, and alcohol consumption (medium: OR

= 0.51, 95 % CI: 0.38–0.69; higher: OR = 0.38, 95 % CI: 0.25–0.56, both $p < 0.001$) – Table 3.

Combined analysis of education and income

To examine the independent effects of education and income, we conducted additional analyses including both SES variables simultaneously. The correlation between education (ISCED) and household income was moderate (Spearman's rho = 0.26, $p < 0.001$). In the combined model adjusting for age and sex, education remained significantly associated with RA (Medium vs. Low education: OR=0.52, 95 % CI: 0.38–0.73, $p < 0.001$; High vs. Low education: OR=0.41, 95 %CI: 0.27–0.64, $p < 0.001$), while household income showed no significant associations with RA across all categories. In the fully adjusted model, the pattern remained similar with education showing stronger associations than income, suggesting that education level may be the more important SES predictor for RA in our population.

Sensitivity analyses

In the sensitivity analyses, the effects of metabolic syndrome, age, gender, alcohol consumption and smoking status on RA prevalence were examined. Individuals with metabolic syndrome had higher odds of RA (OR = 1.87, 95 % CI: 1.08–3.26, $p = 0.026$), but education remained protective, with no significant interaction between education level and metabolic syndrome. Higher education was consistently associated with lower RA prevalence across all age groups, with no interaction detected between education and age. Similarly, higher education remained strongly associated with lower RA prevalence, regardless of alcohol consumption (medium education: OR = 0.38, 95 % CI: 0.26–0.56, $p < 0.001$; higher education: OR = 0.26, 95 % CI: 0.16–0.43, $p < 0.001$). Alcohol consumption itself had no significant association with RA prevalence and no interaction was found between alcohol intake and education level. Furthermore, smoking did not alter the protective effect of education, indicating that the association between higher education and lower RA prevalence remains stable, regardless of smoking status.

Discussion

Our findings highlight the significant association between SES and the prevalence of RA. In this population-based cohort, individuals with lower educational attainment and lower household income exhibited a higher prevalence of RA, reinforcing the impression that socioeconomic disparities play an essential role in chronic disease burden. These findings align with prior studies demonstrating that lower SES is linked to increased RA prevalence, worse disease outcomes and higher mortality rates [7,18]. It is important to mention that Austria is a country with a high standard of living, characterized by a well-developed healthcare system and strong social support structures. Despite these advantages, socioeconomic disparities persist and can significantly impact health outcomes. Our study highlights how even in a high-income country, SES remains a crucial determinant of disease prevalence and outcomes.

One of the most striking findings in our study is the robust inverse relationship between educational attainment and RA risk. Participants with medium and high education levels had significantly lower RA prevalence rates than those with low education, even after adjusting for potential confounders such as sex, age, metabolic syndrome, smoking and alcohol consumption. Education serves as a proxy for health literacy, enabling individuals to better understand disease management, access healthcare resources and adopt healthier behaviors. This is consistent with previous reports showing that individuals with higher education levels are more likely to engage in preventive healthcare, adhere to treatment regimens and maintain healthier lifestyles, ultimately contributing to lower RA risk and better disease control [19]. Our combined analysis of education and income revealed that education appears to be the stronger predictor of RA prevalence compared to household income, potentially capturing pathways beyond economic resources, such as health literacy, health behaviors, and access to preventive care. This finding suggests that educational interventions and health literacy programs may be particularly effective in reducing RA disparities.

Income disparities emerged as a key feature related to RA prevalence in our cohort. Individuals with lower household income levels were overrepresented in the RA group. Lower income has been associated with delayed diagnosis, restricted access to specialized care and limited use of biologic disease-modifying anti-rheumatic drugs (bDMARDs) [20]. Financial constraints may also exacerbate disease burden by limiting access to healthier food options, safe environments for physical activity, and adequate housing, all of which have been implicated in RA risk and disease severity [7].

Employment status and work disability further illustrate the socioeconomic burden of RA. In our cohort, a significantly lower proportion of RA patients were employed compared to non-RA participants, with a substantially higher percentage of RA patients being retired or unemployed. These findings corroborate previous research indicating that RA is a major contributor to work disability, with many patients leaving the workforce prematurely due to pain, functional limitations, and fatigue [8]. Work disability not only reduces household income but also affects social integration and psychological well-being, compounding the adverse effects of RA. Early interventions that promote workplace accommodations and access to specialized care may mitigate these socioeconomic consequences [9,10].

From this point of view the relationship between SES and RA is complex and likely bidirectional. While lower education levels may contribute to increased RA risk through limited health literacy and access to care, RA itself can lead to work disability and financial strain. This is particularly relevant as education typically precedes disease onset, whereas employment status and income may be both a cause and a consequence of RA. To address the complexity of this relationship, we constructed a DAG illustrating SES as a central determinant influencing mediating factors such as lifestyle, health literacy and healthcare access, which in turn affect RA prevalence. This visual representation supports the view that adjusting for mediators (e.g., smoking, alcohol consumption, metabolic syndrome) may underestimate the total effect of SES on RA and helps justify the structure of our regression models.

Migration status and its association with RA prevalence also needs consideration. We observed that immigrants, particularly from the former Yugoslav states, had a higher RA prevalence than native-born participants. Also, previous studies have highlighted that immigrants from lower-income countries often face disparities in healthcare access [11].

Our study provides novel insights into the intersection of socioeconomic factors and RA; however, some limitations should be acknowledged. First, the cross-sectional nature of our study precludes causal inferences between SES indicators and RA prevalence. Longitudinal studies are needed to establish temporality and better understand how SES influences RA risk over time. Second, although our study benefits from a large sample size, the response rate of 17.7 % may introduce selection bias, potentially underrepresenting individuals with extreme

Table 3
presents the odds ratios (Rs) and 95 % confidence intervals (CIs) for the association between medium and high educational attainment and RA prevalence in all three models.

Model	Medium Education OR (95 % CI)	Higher Education OR (95 % CI)	p-value
Model I	0.42 (0.31–0.58)	0.29 (0.19–0.44)	< 0.001
Model II	0.52 (0.38–0.73)	0.40 (0.26–0.61)	< 0.001
Model III	0.55 (0.37–0.82)	0.41 (0.25–0.68)	< 0.001

SES conditions. Finally, self-reported income and educational data, while widely used in epidemiological studies, may be subject to reporting bias. Another key limitation of our study is the lack of detailed information on dosages and durations of the specific antirheumatic drugs. Furthermore, in this study, the proportion of patients diagnosed with RA was higher (3 %) than the anticipated prevalence, indicating a potential recruitment bias. This may be attributed to RA patients often perceiving themselves as medically underserved or underdiagnosed, thereby increasing their likelihood of participating in research. Similar findings have been reported in previous studies [21–23].

Despite these limitations, our findings underscore the need for targeted public health interventions that address socioeconomic disparities. Health policies should prioritize accessible and affordable rheumatologic care, early screening programs and patient education initiatives tailored to lower SES populations. Additionally, social support programs that improve employment retention, workplace flexibility and financial assistance for costly treatments could substantially reduce the socioeconomic burden of RA.

In conclusion, our study highlights the profound influence of socioeconomic factors on RA prevalence. Lower educational attainment, lower income and work disability are all strongly associated with RA, highlighting the need for comprehensive strategies that integrate medical, social and economic approaches to reduce the impact of this disease. Addressing these disparities is essential to improving health equity and ensuring optimal outcomes for all RA patients. Although Austria offers a high standard of living and comprehensive healthcare services, our findings emphasize that socioeconomic disparities still influence RA prevalence and disease burden. Strengthening healthcare access, promoting early screening and offering economic support to vulnerable groups could be important steps toward reducing these disparities. Further research should explore the underlying mechanisms of this association and examine whether socioeconomic disparities also influence disease progression and patient outcomes.

Statement of Ethics

All participants signed an informed consent and the study protocol was approved by the ethics committee of the country of Salzburg (415-E/1521/3–2012).

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Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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