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ORIGINAL ARTICLE

Evaluation of Performance of Different Disease Activity Scores in Rheumatoid Arthritis Patients

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ABSTRACT

Background: Rheumatoid arthritis (RA) causes significant damage to joints, impacting their functionality and reducing overall quality of life. Making informed therapeutic decisions and evaluating the effectiveness of treatments depend on accurately detecting disease activity. Therefore, the goal of this study was to evaluate the utility of various disease activity scores in a group of RA patients.

Methods: This study comprised 200 RA patients. Routine Assessment of Patient Index Data (RAPID3), Patient Activity Scale (PAS), Patient Activity Scale II (PASII), Disease Activity Score 28 erythrocyte sedimentation rate (DAS28-ESR) and DAS28-C-reactive protein (CRP), Clinical Disease Activity Index (CDAI), Simplified Disease Activity Index (SDAI) and modified Health Assessment Questionnaire (mHAQ) were assessed. Patient characteristics and medications were recorded.

Results: 200 patients with RA with mean age of 42.05 ± 10.27 years. ESR was significantly correlated with DAS28-ESR, DAS28-CRP, PAS, PASII, and RAPID3. Significant positive relations exist between CRP with DAS28-CRP, SDAI, and CDAI. Moreover, there was a substantial positive relation between all scores and swollen joint counts (SJC). All disease activity scores showed significant positive correlation in between them but there were insignificant relations between RAPID3 with DAS28-ESR and DAS28- CRP. DAS28-ESR and DAS28-CRP had good agreement in-between each other, but fair agreement exists between each of them with SDAI, CDAI, PAS and PASII. Also, there was good agreement between SDAI and CDAI but fair agreement between each of them with RAPID3 and there was non-significant agreement between each of them with PAS and PASII. Also, results showed significant very good agreement between PAS and PASII. According to RAPID3 there was fair agreement with DAS28-ESR, SDAI and CDAI. There were significant relations between the Patient-Reported Outcome Measures (PROMs) and mHAQ.

Conclusions: This study clarified that the composite disease indices (DAS28-ESR/CRP, CDAI and SDAI) and the PROMs (RAPID3, PAS and PASII), which have substantial associations with clinical and laboratory parameters of disease activity are highly efficient. It is advisable to use CDAI and PROMs in routine clinical practice, particularly where laboratory data are unavailable.

Keywords: Rheumatoid Arthritis; Disease Activity Scores; CDAI; PROMs; Performance

INTRODUCTION

The long-term inflammatory illness known as rheumatoid arthritis (RA) mostly affects synovial joints. It causes pannus development, articular tissue degradation, and synovial inflammation. Deformities and severe functional impairment may result from the disorder if it is not properly treated [1].

Therapy needs to begin as soon as feasible to control RA properly. Remission or low disease activity strategies have been emphasized as essential elements in the RA treatment

guidelines as they have been shown to improve patient outcomes and reduce complications [2, 3]. To achieve these treatment objectives, frequent evaluations of disease activity are required, utilizing various validated composite measures that are considered as the benchmark for impartial assessment [4].

Many disease activity ratings have been verified during the past decades and are widely used in clinical practice. The Disease Activity Score with 28-Joint Counts (DAS28), either using the erythrocyte sedimentation rate (ESR) or C-reactive protein (CRP), Simplified Disease Activity Index (SDAI), and Clinical Disease Activity Index (CDAI) are frequently employed as composite indices in RA evaluation [5, 6]. However, a joint count is necessary for these evaluations, and in everyday practice, both patients and physician may find this to be time-consuming [7]. As shared decision-making between physicians and patients gains more importance, there is a mounting requirement for practical and patient-centered tools to assess illness activities. Clinical disease activity indices and Patient-Reported Outcome Measures (PROMs) have been created to help with this monitoring [4]. Patients' perspectives, including disease status, treatment responses, and quality of life impact, are emphasized in PROMs. The Routine Assessment of Patient Index Data3 (RAPID3), the Patients Activity Scale (PAS), and the Patients Activity Scale-II (PAS-II) are frequently utilised PROMs in clinical studies and day-to-day patient care [8].

Since there is not a single, widely recognized gold standard index for prognostic, monitoring, or diagnostic purposes that can be applied to every patient, the intricacy of RA has led to the use of composite indices [9]. These indices incorporate various quantitative measures, facilitating clinical evaluations by minimizing measurement errors, offering objective assessment methods, and improving the evaluation of novel disease-modifying antirheumatic drugs (DMARDs) in clinical trials through analysis and interpretation [10]. There are scarce data regarding performance of PAS, PASII, RAPID3, DAS28-ESR\CRP, SDAI and CDAI in assessment of disease activity in patients with RA in Egypt. As a result, this work was planned to assess the efficacy of different disease activity tools for Egyptian RA patients.

METHODS

Participants:

This work included 200 RA patients fulfilling the 2010 American College of Rheumatology (ACR)/European League Against Rheumatism (EULAR) Classification criteria [11]. Patients with concomitant autoimmune rheumatologic disease, pregnancy, known HIV or hepatitis B/C infection, malignancy, endocrine dysfunction, psychological disorders or who proved uncooperative were excluded from the study. Approval was obtained from Mansoura University Research Ethics Committee (Code Number: MS. 21.10.1701). Every patient in the study signed an informed written consent.

Assessment:

A comprehensive diagnostic workup, including a detailed history assessment, extensive physical examination, laboratory tests including: erythrocyte sedimentation rate (ESR), C - reactive protein (CRP), anti-cyclic citrullinated peptide (Anti- CCP), Rheumatoid Factor (RF) and complete blood count (CBC), and X-rays of both hands and wrists were conducted for each patient. The activity of RA was determined using the following indices: DAS28-ESR [5], DAS28-CRP [12], SDAI [13], CDAI [14], RAPID3 [15], PAS and PASII [16]. These indices were measured using WEB-sites calculator [17].To assess the patient's physical function, the modified Health Assessment Questionnaire (mHAQ) was used [18].

Statistical analysis: Statistical package for social sciences (SPSS) version 27 was applied. Data were presented as mean and standard deviation (SD), median and range or as frequency and percentage (%). Kappa (K) agreement and Spearman's correlation were evaluated. P value < 0.05 is considered significant.

RESULTS

The RA patients' demographic and clinical data, along with laboratory analyses and radiographic erosion frequency, are detailed in Table 1. The disease activity scores are presented in Table 2. Table 3 showed the correlation between RA disease activity scores with clinical and laboratory data of patients. There was insignificant difference between the cases with different grades of disease activity as measured by DAS28-ESR, DAS28-CRP, CDAI, SDAI, PAS, and PASII regarding age, sex distribution, RF and anti-CCP positivity, and presence of radiographic erosion. A similar finding was found in relation to RAPID3, except for RF, as

the prevalence of positive RF was statistically significantly greater in the high disease activity group (Table 4). Remission was found only by DAS28ESR\CRP, other scores showed no patient with remission. DAS28-ESR showed significant correlations with DAS28-CRP, SDAI, CDAI, PAS and PASII. DAS28-CRP was also significantly correlated with SDAI, CDAI, PAS and PASII. SDAI was also significantly correlated with CDAI, PAS, PASII and RAPID3. CDAI was also significantly correlated with PAS, PASII and RAPID3. PAS was also significantly correlated with PASII and RAPID3. PASII was also significantly correlated with RAPID3. Cross agreement between different disease activity scores was presented in Table 5.

Table 1: Demographic, clinical data, laboratory analysis and prevalence of radiographic erosions of RA patients

Variables		**RA patients (N=200) Mean ±SD, N (%),Median (range)**
Age (Years)		42.05 ± 10.27
Sex	**Males / Females**	15 (7.5) / 185 (92.5)
Occupation	**Housewives (non-working) / Working**	183 (91.5) /17 (8.5)
Clinical data	**Disease duration (Years)**	7 (1 -25)
	Duration of morning stiffness (minutes)	62 (10 -149)
	Number of tender joints	4 (0 -9)
	Number of swollen joints	3 (0 -6)
	mHAQ	1 (0 - 3)
	Patient VAS	4 (3 - 6)
	Physician VAS	4 (3 - 6)
	Rheumatoid nodules	50 (25)
	Carpel tunnel syndrome	63 (31.5)
	Pleurisy	57 (28.5)
	ILD	28 (14)
	Sicca symptoms	21 (10.5)
	Gastritis	143 (71.5)
	Cutaneous vaculitis	26 (13)
Medications	**Corticosteroids**	148 (74)
	Methotrexate	126 (63)
	Hydroxychloroquine	111 (55.5)
	NSAIDS	82 (41)
	Leflunomide	58 (13)
	Sulfasalazine	27 (13.5)
	Biological	20 (10)
Laboratory analysis	**Hemoglobin (gm/dl)**	10.98 ± 2.48
	RBCs (10^6/mm^3)	4.02 ± 0.76
	WBCs (10^3/mm^3)	7.71 ± 2.57
	PLTs (10^3/mm^3)	287 (85- 507)
	Serum creatinine (mg/dl)	0.95 ± 0.27
	Serum bilirubin (mg/dl)	0.74 ± 0.21
	ALT (U/L)	25 (10 - 44)
	AST (U/L)	26 (10 - 49)
	ESR (mm/h)	53 (3- 156)
	CRP (mg/dl)	11 (1 - 123)
	Rheumatoid factor (Positive)	180 (90)
	Anti-CCP (Positive)	74 (37)
Radiographic erosions		13 (6.5)

RA= Rheumatoid Arthritis; mHAQ= modified Health Assessment Questionnaire; VAS = Visual Analogue Scale; ILD= Interstitial lung diseases; NSAIDS= Non-Steroidal Anti-Inflammatory Drugs; RBCs= Red blood cells; WBCs= White blood cells; PLTs= Platelets; ALT=Alanine transaminase; AST=Aspartate aminotransferase; ESR= erythrocyte sedimentation rate; CRP= C - reactive protein; Anti- CCP= Anti cyclic citrullinated peptide.

Table 2: Disease activity scoring systems in RA patients

Variables	RA patients (N= 200), Mean ±SD, N (%),Median (Range)
DAS28_ESR	4.37 ± 0.95
Remission (≤2.6)	10 (5%)
Low disease activity (> 2.6 and ≤ 3.2)	19 (9.5%)
Moderate disease activity (> 3.2 and ≤ 5.1)	121 (60.5%)
High disease activity (> 5.1)	50 (25%)
DAS28_CRP	3.81 ± 0.96
Remission (≤2.6)	16 (5.5%)
Low disease activity (> 2.6 and ≤ 3.2)	29 (9.5%)
Moderate disease activity (> 3.2 and ≤ 5.1)	125 (62.5%)
High disease activity (> 5.1)	30 (15%)
SDAI	73.45 ± 14.77
Remission (≤3.3)	0 (0%)
Low disease activity (> 3.3 and ≤ 11)	15 (7.5%)
Moderate disease activity (>11 and ≤ 26)	66 (33%)
High disease activity (> 26)	119 (59.5%)
CDAI	63.66 ± 20.43
Remission (≤2.8)	0 (0%)
Low disease activity (> 2.8 and ≤ 10)	22 (11%)
Moderate disease activity (> 10 and ≤ 22)	74 (37%)
High disease activity (> 22)	104 (52%)
PAS	4.94 ± 1.49
Remission (0- 0.25)	0 (0%)
Low disease activity (0.26 – 3.7)	66 (33%)
Moderate disease activity (3.71 - < 8)	99 (49.5%)
High disease activity (8- 10)	35 (17.5%)
PAS II	5.17 (2.06 – 8.37)
Remission (0- 0.25)	0 (0%)
Low disease activity (0.26 – 3.7)	72 (36%)
Moderate disease activity (3.71 - < 8)	102 (51%)
High disease activity (8- 10)	26 (13%)
RAPID 3	6.13 ± 1.89
Remission (0- 1)	0 (0%)
Low disease activity (> 1 – 2)	16 (8%)
Moderate disease activity (> 2 - 4)	46 (23%)
High disease activity (> 4 - 10)	138 (69%)

RA: Rheumatoid Arthritis; DAS28-ESR = Disease Activity Score with 28-joint counts using ESR; DAS28-CRP = Disease Activity Score with 28-joint counts using CRP; SDAI = Simplified Disease Activity Index; CDAI = Clinical Disease Activity Index; PAS = Patient Activity Scale; PAS II= Patient Activity Scale II; RAPID3 = Routine Assessment of Patient Index Data with 3 measures.

Table 3: Correlation between RA disease activity scores with clinical and laboratory data of RA patients

Variables		DAS28_ESR	DAS28_CRP	SDAI	CDAI	PAS	PAS II	RAPID 3
Age	**r**	0.134	0.099	0.091	0.122	- 0.036	0.008	- 0.007
	p	0.059	0.162	0.202	0.086	0.616	0.915	0.921
Disease duration	**r**	-0.023	-0.112	0.007	0.004	0.050	0.112	0.278
	p	0.751	0.113	0.918	0.957	0.482	0.116	**0.026***
Duration of morning stiffness	**r**	0.443	0.454	0.395	0.402	0.135	0.094	0.312
	p	**0.013***	**0.008***	**0.044***	**0.023***	0.249	0.183	**0.018***
Number of tender joints	**r**	0.538**	0.521**	0.411**	0.456**	0.259	0.174	0.264
	p	**< 0.001***	**< 0.001***	**0.003***	**< 0.001***	**0.025***	0.106	**0.030***
Number of swollen joints	**r**	0.533	0.486	0.454	0.468	0.229	0.243	0.336
	p	**< 0.001***	**< 0.001***	**0.008***	**0.004***	**0.046***	**0.034***	**0.010***
CRP	**r**	0.219	0.802	0.473	0.328	0.164	0.179	0.225
	p	0.064	**< 0.001***	**< 0.001***	**0.040***	0.159	0.135	0.113
ESR	**r**	0.886	0.235	0.206	0.218	0.245	0.252	0.277
	p	**< 0.001***	**0.036***	0.086	0.074	**0.046***	**0.044***	**0.023***
Hemoglobin level	**r**	0.100	0.203	0.051	0.109	0.012	0.078	0.166
	p	0.583	0.448	0.681	0.552	0.163	0.611	0.370
WBCs	**r**	-0.145	0.224	0.064	0.152	0.471	0.209	0.083
	p	0.459	0.492	0.321	0.337	0.246	0.234	0.724
RBCs	**r**	0.175	0.047	0.246	0.232	0.449	0.290	0.246
	P	0.651	0.830	0.464	0.369	0.384	0.128	0.146
Platelets	**R**	0.343	0.173	0.196	0.052	0.177	0.156	0.232
	P	0.127	0.451	0.499	0.734	0.510	0.521	0.158
mHAQ	**R**	0.241	0.271	0.233	0.224	0.491	0.445	0.472
	P	0.103	0.095	0.129	0.138	**< 0.001***	**< 0.001***	**< 0.001***

RA= Rheumatoid Arthritis; CRP = C-reactive protein; ESR = erythrocyte sedimentation rate; WBCs= White blood cells; RBCs=Red blood cells; mHAQ = modified Health Assessment Questionnaire; DAS28-ESR = Disease Activity Score with 28-joint counts using ESR; DAS28-CRP = Disease Activity Score with 28-joint counts using CRP; SDAI = Simplified Disease Activity Index; CDAI = Clinical Disease Activity Index; PAS = Patient Activity Scale; PAS II= Patient Activity Scale II; RAPID3 = Routine Assessment of Patient Index Data with 3 measures; *: significant (p< 0.05); r: Spearman'scoefficien

Table 4: Relation between disease activity score categories and sex, RF positivity, anti-CCP positivity, and radiographic erosions in RA patient

Activity		F:M	RF positivity (N=180)	Anti-CCP positivity (N=74)	Erosions (N=13)
	Remission (N=10)	9 :1	8 (80%)	3 (30%)	1 (10%)
	Low (N=19)	8.6:1	16 (84.2%)	8 (42.1%)	2(10.5%)
DAS28-ESR	**Moderate (N=121)**	9.7:0.3	110 (90.9%)	47 (38.8%)	4 (3.3%)
	High (N=50)	9.4:0.6	46 (92%)	16 (32%)	6 (12%)
	P value	0.241	0.381	0.126	0.072
	Remission (N=16)	8.8:1.3	13(81.2%)	6 (37.5%)	1 (6.2%)
	Low (N=29)	8.6:1.4	24 (82.8%)	12 (41.4%)	3 (10.3%)
DAS28-CRP	**Moderate (N=125)**	9.5:0.6	110 (92%)	45 (36%)	5 (4%)
	High (N=30)	9.3:9.7	28 (93.3%)	11 (36.7%)	4 (13.3%)
	P value	0.356	0.278	0.138	0.160

Activity		F:M	RF positivity (N=180)	Anti-CCP positivity (N=74)	Erosions (N=13)
	Remission (N=0)	0	0	0	0
	Low (N=15)	4:1	13 (86.7%)	4 (26.7%)	2 (13.3%)
SDAI	**Moderate (N=66)**	9.6:0.5	62 (93.9%)	26 (39.4%)	5 (7.6%)
	High (N=119)	9.3:0.7	105 (88.2%)	44 (37%)	6 (5%)
	P value	0.130	0.463	0.086	0.107
	Remission (N=0)	0	0	0	0
	Low (N=22)	8.6:1.4	19 (86.4%)	5 (22.7%)	4 (18%)
CDAI	**Moderate (N=74)**	9.3:0.7	67 (90.5%)	27 (36.5%)	3 (4.1%)
	High (N=104)	9.3:0.7	94 (90.4%)	42 (40.4%)	6 (5.8%)
	P value	0.138	0.372	0.055	0.086
	Remission (N=0)	0	0	0	0
	Low (N=66)	9.4:5	60 (90.9%)	24 (36.4%)	5 (7.6%)
PAS	**Moderate (N=99)**	9:1	91 (91.9%)	39 (39.4%)	5 (5%)
	High (N=35)	9.4:0.6	29 (82.9%)	11 (31.4%)	3 (8.6%)
	P value	0.106	0.062	0.182	0.158
	Remission (N=0)	0	0	0	0
	Low (N=72)	9.4:0.6	67(93.1%)	26 (36.2%)	4 (5.6%)
PAS II	**Moderate (N=102)**	9:1	91 (89.2%)	39 (38.2%)	5 (4.9%)
	High (N=26)	9.6:0.4	22 (84.6%)	9 (34.6%)	4 (15.4%)
	P value	0.146	0.098	0.345	0.066
	Remission (N=0)	0	0	0	0
	Low (N=16)	9.4:0.6	12 (75%)	6 (37.5%)	3 (5.6%)
RAPID 3	**Moderate (N=46)**	8.9: 1	39 (84.8%)	17 (37%)	4 (8.7%)
	High (N=138)	9.5 :0.5	129 (93%)	51 (37%)	6 (4.3%)
	P value	0.170	**0.042***	0.892	0.122

Data are expressed as number (%); RF: Rheumatoid factor; Anti-CCP: Anti- Cyclic Citrulinated Peptide; RA= Rheumatoid Arthritis; DAS28-ESR= Disease Activity Score with 28-joint counts using ESR; DAS28-CRP= Disease Activity Score with 28-joint counts using CRP; SDAI = Simplified Disease Activity Index; CDAI = Clinical Disease Activity Index; PAS = Patient Activity Scale; PAS II= Patient Activity Scale II; RAPID3 = Routine Assessment of Patient Index Data with 3 measures; *: significant ($p< 0.05$)

Table 5: Agreement analysis between different disease activity scores in RA patients

Variables		Kappa Statistic (K)	P value
	DAS28-CRP	k= 0.829	**P < 0.001***
	SDAI	k= 0.378	**P = 0.001***
	CDAI	k= 0.400	**P = 0.001***
DAS28-ESR with:	**PAS**	k= 0.266	**P = 0.036***
	PASII	k= 0.252	**P = 0.040***
	RAPID3	k= 0.230	**P = 0.048***
	SDAI	k= 0.328	**P = 0.002***
	CDAI	k= 0.348	**P = 0.001***
DAS28-CRP with:	**PAS**	k= 0.245	**P = 0.042***
	PASII	k= 0.239	**P = 0.049***

Variables		Kappa Statistic (K)	P value
	RAPID3	k= 0.216	P = 0.066
	CDAI	k= 0.904	**P < 0.001***
SDAI with:	**PAS**	k= 0.190	P = 0.128
	PASII	k= 0.184	P = 0.240
	RAPID3	k= 0.316	**P = 0.010***
	PAS	k=0.214	P = 0.108
CDAI with:	**PASII**	k=0.206	P = 0.115
	RAPID3	k=0.300	**P = 0.013***
PAS with:	**PASII**	k=0.910	**P = 0.001***
	RAPID3	k=0.174	P = 0.158
PASII with:	**RAPID3**	k=0.170	P = 0.166

RA=Rheumatoid Arthritis; DAS28-ESR = Disease Activity Score with 28-joint counts using ESR; DAS28-CRP = Disease Activity Score with 28-joint counts using CRP; SDAI = Simplified Disease Activity Index; CDAI = Clinical Disease Activity Index; PAS = Patient Activity Scale; PAS II= Patient Activity Scale II; RAPID3 = Routine Assessment of Patient Index Data with 3 measures; K: kappa agreement;*: significant (p< 0.05).

DISCUSSION

According to EULAR, a treat-to-target approach is necessary to manage RA in order to achieve remission or low disease activity [19]. Various RA disease activity measures have been identified in the literature, exhibiting variability in their performance and feasibility for everyday use [17]. The 2019 ACR guideline identified the top scores for assessing disease activity as CDAI, SDAI, DAS28-ESR\CRP, RAPID3, PAS, and PASII [20].

In the present work, the disease activity indices (CDAI, SDAI and DAS28-ESR/CRP) did not show significant

correlation with mHAQ and CBC variables. These results indicate that these indices were not necessarily reflecting functional ability of RA patients as demonstrated by the study of Nagafusa et al. [21], who discovered that whereas DAS28-CRP only connected with physical and Disabilities of the Arm, Shoulders, and Hand (DASH), SDAI and CDAI did not correspond with any measure of physical function.

Similarly, Muhammed et al. [22] revealed that the relationship between DAS-28 and hematological parameters as determined by RBC, hemoglobin, and platelets was not significant.

The current findings showed a substantial correlation between the swollen joints count (SJC), ESR, and mHAQ, with PAS, PASII, and RAPID3. The tender joints count (TJC) was substantially linked with both PAS and RAPID3. A significant relationship was also identified between RAPID3 score and the duration of morning stiffness as well as the overall duration of the disease. These results indicate that these indices could be utilized to evaluate disease activity and may also serve as indicators of the functional status of RA patients. In harmony, Singh et al. [23] reported a robust correlation between RAPID3 and various parameters from the RA core dataset, such as pain levels, physical function, ESR, SJC and TJC.

Current data delineated that, age, sex distribution, positivity for RF and anti-CCP, radiographic erosion, and varying degrees of disease activity as determined by SDAI, CDAI, DAS28-ESR, DAS28-CRP, PAS and PASII scores were all similar among the patients without significant differences. Similar outcomes were noted for RAPID3, except for RF, where the group exhibiting high disease activity showed a markedly higher frequency of positivity.

Likewise, Eissa et al. [24] showed insignificant difference between the disease activity measures (DAS28-CRP, CDAI, SDAI) concerning sex, RF positivity and radiographic erosion. Similarly, previous studies reported insignificant correlation between DAS28-ESR and DAS28-CRP with Anti-CCP [25, 26].

All of the RA disease activity scores examined in this study exhibited strong relationships with one another, while there were negligible associations between RAPID3 and DAS28-ESR and DAS28-CRP. These findings aligned with other research conducted across a wide range of demographics that found a strong positive connection between DAS28-CRP, SDAI, CDAI, and DAS28-ESR [27, 28]. Furthermore, Dhaon et al. [29] found a significant relation between CDAI and SDAI.

Salaffi et al. [30] matched with results of the present study as there were significant associations between the following indices (SDAI, CDAI, and RAPID3) and also between SDAI and CDAI with DAS28-ESR, but disagreed with the present study as they discovered a significant relationship between RAPID3 and DAS28-ESR.

In the present study, DAS28-CRP and DAS28-ESR had good agreement in-between each other but showed fair agreement between each of them with SDAI, CDAI, PAS and PASII. Also, there was good agreement between SDAI and CDAI but fair agreement between each of them with RAPID3 and there was non-significant agreement between each of them with PAS and PASII. Also, our results showed good agreement between PAS and PASII. According to RAPID3 there was fair agreement with DAS28-ESR, SDAI and CDAI, but no significant agreement was found between RAPID3 with DAS28-CRP, PAS and PASII.

The current findings have been supported by other studies which reported good agreement between DAS28-ESR and DAS28-CRP [27, 31].

Medeiros et al. [23] found similar outcomes when comparing the agreement level of DAS28-ESR with CDAI and SDAI. Additionally, there was nearly perfect agreement between the SDAI and CDAI, indicating that this strong agreement supports the idea that the inclusion of CRP in the CDAI calculation does not significantly alter the evaluation of disease activity level in comparison to the SDAI.

Malibiradar et al. [33] discovered a high degree of concordance between the SDAI and CDAI that matched with this work. Nonetheless, there was strong agreement between DAS28-ESR and SDAI as well as CDAI, which was at odds with our findings. This research supported the findings of Kumar et al. [34], who discovered a "slight-to-fair" agreement between DAS28-ESR and CDAI, but less substantial agreement between DAS28-ESR and RAPID3.In line, a large number of other researchers discovered fair agreement between DAS28-ESR and CDAI; however, they discovered that, in contrast to our findings, agreement with DAS-ESR was moderate for SDAI and fair for DAS-CRP [24, 35, 36]. Ghosh et al. (2011), on the other hand, discovered a strong agreement between RAPID3 and DAS28-ESR [37]. Findings were not in line with an Austrian study, showing an agreement between RAPID3 and DAS28-ESR and CDAI [38].

Dhaon et al. [29] discovered, in contrast to our investigation, that the agreement with DAS-28-CRP was good for SDAI and moderate for CDAI.

In contrast, Aletaha and Smolen [27] discovered a strong concordance between DAS28-ESR and SDAI and CDAI. Almansouri et al. [39] showed moderate agreement between RAPID3 and DAS28-ESR but low agreement between RAPID3 and DAS28-CRP, which is in disagreement. Moreover, Horta-Baas et al. [40] found that the agreement between RAPID3 with CDAI, SDAI, and DAS28-ESR was only modest, while the agreement with PASII was good for SDAI and CDAI but moderate for DAS28-ESR.

The DAS-28 index was regarded as the benchmark until the introduction of newer, simplified methodologies in the past decade. The early DAS-28 calculation employed ESR and, to a lesser extent, CRP. CRP is a helpful substitute for DAS28-ESR because it is less impacted by confounding factors and more sensitive to brief changes in disease activity. However, rheumatologists working in overcrowded clinics will find it impossible to calculate DAS-28 because of its complicated nature, which needs the use of an online calculator. To assess disease activity, CDAI is a composite measure that excludes acute-phase reactants. The parts of the simple algebraic addition to ascertain this are the TJC, SJC, physician global evaluation (PhGA), and PtGA. SDAI offers a rapid and efficient way to assess RA in clinical practice since it incorporates CRP in the same components as CDAI. A significant advantage of CDAI is that it eliminates the need for laboratory tests, allowing for its application in various settings

and at any time for evaluating disease activity in RA patients [29].

The PAS and PASII have similar variables including: (PtGA, pain assessment on the visual analogue scale (VAS) and HAQ for the PAS, or HAQ II for the PAS-II); this similarity may account for the study's complete agreement between the two measures. One advantage that the PASII has over the PAS is that it uses a shorter HAQII, which is easier for patients to complete [16].

In busy outpatient care settings, Abdulaziz et al. [4], using RAPID3 as an alternative to other disease activity scores is more practical, time-efficient, and contact-free. RAPID3 expands the assessment of a patient's complaints, including those not detected by DAS, SDAI, and CDAI scores, like foot pain. In rural settings, the lack of laboratory assessments like CRP and ESR allows rheumatologists with fewer financial resources to perform more feasible evaluations.

Among the study's limitations was single-center research; it cannot be applied to all RA patients in Egypt. Lack of follow-up. Lastly, not taking into consideration medication received and comorbidities.

In conclusion, this study clarified that the composite disease indices (DAS28-ESR/CRP, SDAI, and CDAI) and the PROMs (PAS, PASII, and RAPID3), which have substantial associations with clinical and laboratory parameters of disease activity are highly efficient. It is advisable to use CDAI and PROMs in routine clinical practice, particularly where laboratory data are unavailable.

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