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Relevant associations between alexithymia and health-literacy in persons with psoriasis

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Objective: To explore possible associations between alexithymia and health literacy (HL) in persons with psoriasis.

Methods: We conducted a cross-sectional study, including 825 persons with moderate to severe psoriasis, using the Toronto Alexithymia Scale (TAS-20), and the Health Literacy Questionnaire (HLQ). Descriptive statistics compare HL means between alexithymic and not alexithymic participants. Associations between alexithymia and HL are analyzed using a linear multiple regression model.

Results: 26 % of the participants were characterized as alexithymic, and 26.8% had borderline alexithymia. Higher alexithymia scores were associated with lower education, biological medicines, and more comorbidities, together with lower self-efficacy. The health literacy (HL) domains with the strongest associations with alexithymia were those focusing on managing and getting support for health, as well as the ability to find health information.

Conclusion: A more elevated alexithymia score is associated with lower health literacy. Further studies of these associations may contribute to a more comprehensive perspective of psoriasis. To know a patient's alexithymia level and HL needs may guide health care personnel's understanding of possible associations between health status, clinical presentation, behaviour, and response to treatment.

(181 words)

1.0 Introduction

Psoriasis is a chronic inflammatory disease characterized by skin symptoms and physical [1-4] and psychological [5,6] comorbidities. The condition can debut at all ages, and its chronic and unpredictable nature has consequences for psychological well-being [7,8]. The knowledge about psoriasis pathogenesis and effective pharmacological treatment options have advanced significantly, but still, many patients lack efficient treatment regimes [9,10] and low adherence to treatment is a common problem [11]. Psycho-dermatology is a relatively new field within dermatology and examines the role that stress and other psychological issues play in conditions affecting the skin [12]. A recent systematic review [13] on stress in psoriasis found that, on average, 46% of the patients believed their disease was reactive to stress. Alexithymia is defined as a personality trait characterized by a reduced ability to recognize and verbalize internal emotions, where thoughts tend to be fixated on the external environment [14]. The cognitive style of alexithymia is marked by concrete, down-to-earth, externally focused thoughts, rather than introspection, fantasy, or daydreaming [15]. Hence, persons with alexithymia usually show little insight into their feelings, symptoms, and motivation, and may experience confusion, give vague answers, and report physical states when asked about their feelings [16,17]. Additionally, they also have difficulties feeling and expressing empathic responses making it challenging to establish and maintain interpersonal relationships [18]. Consequently, alexithymia may be considered as one of several risk factors for a variety of medical and psychological disorders, as it may increase the proneness to their development in addition to genetic determinants and emotional stress [17]. Information on the prevalence of alexithymia with psoriasis and the association between alexithymia and the burden of psoriasis is limited, but several studies have found a substantially elevated prevalence among persons with psoriasis (15 to 32%) compared to healthy controls (10-13%) [14,19,20]. A recent study found that patients with alexithymia showed a higher burden of

psoriasis, including significant impairment of quality of life, higher levels of anxiety and higher risk of depression and anxiety compared with patients without alexithymia [19]. Higher alexithymia scores have been associated with lower self-management (SM) in persons with psoriasis participating in Climate Helio Therapy (CHT) [21]. Furthermore, studies from other contexts have revealed a negative relationship between alexithymia and self-efficacy [22,23]. Promisingly, a recent systematic review suggests that it is possible to modify alexithymia through treatment [24]. Moreover, mindfulness-based interventions have proven to be effective with associated clinical benefits [25].

Health literacy (HL) is a prerequisite to good self-management and defined as an ability to access, understand and use information in ways that promote and maintain good health [26]. Lower HL is often associated with lower education [27], increased emergency use of the hospital system [28], decreased ability to self-care [29], and decreased communication with health care professionals [30]. Within chronic care, the importance of adequate HL seems evident, with the patients' needs for more frequent access to the health care system, the necessity to navigate the different parts of the healthcare systems, to communicate with professionals and actively self-manage their health condition(s). Furthermore, as our healthcare system gets more complex and as a larger part of the responsibility for SM is moving into patients' hands, the ability to understand and process complex information is becoming increasingly important [31]. Consequently, interventions to support and help patients with chronic conditions such as psoriasis in relation to patient education, self-management support (SMS), and access to the healthcare system need to be tailored to their HL level in order to be effective [32,33].

Alexithymia and limited HL have separately been emphasised as barriers to self-management [21,34,35]. However, possible associations between the two phenomena have to the best of our knowledge not yet been investigated within psoriasis. One study with healthy Norwegians that had a regular check-up at their dentist showed that low oral HL was associated with alexithymia [36]. Alexithymia and impaired HL may separately impact the psychosocial responses of persons towards their psoriasis. Both phenomena may also influence responsiveness to change in clinical encounters or impact the outcomes of SM interventions.

Consequently, both may be barriers to successful patient-practitioner communication. Hence, we hypothesize that that low HL is associated with alexithymia. Exploring possible relationships between patients` HL and alexithymia may, therefore, be of crucial importance for good clinical care in psoriasis. The following research question is asked;

- In psoriasis context, to what extent are health literacy associated with alexithymia (total score and sub-scores) controlled for selected demographic variables (sex, age, and educational level), clinical variables (disease severity and quantity of comorbidities) and self-management capacity?

2. Methods

2.1 Participants and the CHT program

From March to August 2017, we invited 1275 participants by postal mail, which all in the period 2011- 2016 had participated in the Norwegian Climate Helio Therapy program (CHT) in Gran Canaria (i.e., they have moderate to severe psoriasis). The Norwegian Health Authorities cover the costs for a 3-week multidisciplinary (dermatologist, nurses, and sports educator) program, including tailored sunlight UVB radiation [37], physical exercise, group discussions, and education on psoriasis. Potential study participants received the information,

consent form and the survey questionnaire. A return/reminder letter was sent six weeks following the first mail out of the survey. A total of 825 patients completed and returned the questionnaire package (65% response rate), while 90.5% of these (N= 746) provided a full completion of both the HLQ and the TAS 20.

2.2 Measures

Alexithymia: The Toronto Alexithymia Scale (TAS 20) was used to measure alexithymia. TAS 20 is a 20 item self-report scale with a three-factor structure congruent with the alexithymia construct, “difficulty in identifying feelings (DIF),” “difficulty in describing feelings (DDF)” and externally oriented thinking (EOT).” The internal consistency, reliability, and validity of the scale are suitable for numerous versions in different languages [38,39] and have demonstrated excellent reliability in a previous study within the same context [21]. Items are rated using a 5-point Likert scale whereby 1 = strongly disagree and 5 = strongly agree. Five items are negatively keyed (items 4, 5, 10, 18, and 19). The total alexithymia score is the sum of responses to all 20 items, while the score for each subscale factor is the sum of the responses to that subscale. The TAS-20 uses cutoff scoring: equal to or less than 51 = non-alexithymia, equal to or greater than 61 = alexithymia (11). Scores of 52 to 60 = possible alexithymia. Cronbach’s alpha was 0.86 with all items, and for the three subscales, $\alpha_{DIF} = 0.87$, $\alpha_{DDF} = 0.74$, and for $\alpha_{EOT} = 0.52$.

Health literacy: The Health Literacy Questionnaire (HLQ) [40] includes 44 items over nine independent scales, each representing a different element of the overall HL construct. On each scale, there are four to six items. The opening five scales comprise items that ask the respondents to indicate their level of agreement (possible score 1-4), and the remaining scales

(6–9) embody scales of self-reported capability (possible score 1-5). The full HLQ offers nine individual scores based on an average of the items within each of the nine scales, with higher scores indicating higher HL. The questionnaire has no total score, as that could potentially mask individual needs in specific HL domains (Cronbach`s alpha: 0.71 to 0.87).

Self-management capacity: SM was measured by two scales from the Health Education and Impact Questionnaire (HeiQ) [41]: “Skill and technique acquisition” and “Self-Monitoring and insight.” The scales have 4 and 6 items, rated on a four-point Likert scale (1 = strongly disagree to 4 = strongly agree). The items in each scale are summed, and the sum is divided by the actual number of items in each scale; thus, the scale scores range between 1 and 4. A higher score indicates better SM related to the specific scale.

Self-efficacy was measured by **The General Self-efficacy scale (GSES)** that assesses the beliefs that one can perform novel or difficult tasks in life or cope with hardship [42]. The scale has ten items with a response range from 1 (not at all true) to 4 (exactly true).

Correspondingly, sum scores range from 10 to 40, where a higher score means higher self-efficacy (Cronbach alpha: 0.85).

Clinical variables: Disease severity was measured by the Self-Administrated Psoriasis Area and Severity Index (SAPASI) [43], a structured instrument that allows subjects to assess the severity of psoriasis. SAPASI scores range from 0 to 72 where a higher score indicates a more severe illness (Cronbach alpha: 0.74). Medical comorbidity is measured using an adapted and simplified version of the Self-Administered Comorbidity Questionnaire (SCQ-18) [44], where higher scores indicate a more severe comorbidity profile.

Sociodemographic variables represented age, gender, and education.

2.3 Data analysis

Descriptive statistics report the characteristics of the study population. The Expectation maximization (EM) algorithm was used to impute missing HLQ item scores [45]. For all HLQ scales, assumptions of normal distribution were met.

In the statistical analyses, the TAS 20 total score was used both as a continuous and categorized variable [38]. For statistical comparisons, two groups were created, with the cut off value of 61 to dichotomize persons with psoriasis in alexithymic and non-alexithymic individuals. Consequently, the borderline participants were analysed in the non-alexithymic group.

Pearson's correlations were used to investigate bivariate associations between TAS-20 scores and the HLQ scores and other relevant variables.

Bivariate correlations (Pearson's coefficient) and hierarchical multiple regression analysis were used to investigate possible associations with the TAS 20 sum score and the three subcategories as dependent variables). A four-step regression model was performed for entering the independent variables (Table 1). Residuals had an approximately normal distribution, and tests for linearity were not statistically significant, indicating that all associations were nearly linear. Multicollinearity was not a problem (VIF value < 3.75).

Statistical analyses were performed using SPSS® version 25 (SPSS Inc., Chicago, IL, USA), p-values <0.05 were considered statistically significant.

(Table 1: The four steps for entering independent variables in the regression model approximately here)

2.4 Ethics

The study was approved by the Regional Committee for Medical Research Ethics for Southern Norway (ID 2016/1745) and conducted following the Helsinki declaration. Administrative leaders of Section for Climate treatment at Oslo University Hospital and the Centre for Privacy and Information Security at Oslo University Hospital also approved the study.

3.0 Findings

The prevalence of alexithymia in our population was 26.0%, and 26.8% was found to have borderline alexithymia (Table 2). Scores ranged from 24 to 90 across the sample, and the mean total score on the TAS-20 was 51.7 (± 13.0). The mean TAS – 20 score for the alexithymic persons was 67.7 (± 5.6) and 46.1 (± 9.8) for the non-alexithymic group (- 21.6 (CI: -23.07-20.14), $p < 0.001$). The demographics, clinical variables, and self- management measures are presented in Table 3, divided into alexithymia status.

Neither the TAS 20 total score nor the DIF score (results not shown) showed significant gender differences. However, in the DDF (0.81, (CI: 0.142, 1.48, $p < 0.001$) and in the EOT score (1.55 (CI: 0.91, 2.18), $p < 0.001$), men scored significantly higher. The persons with alexithymia reported less years of education ($\chi^2 = 31.40$, $p < 0.001$) and a higher percentage were not working ($\chi^2 = 4.28$, $p = 0.038$).

(Table 2: Number (%) of participants scoring related to alexithymia status, approximately here)

Concerning the clinical variables, significantly more of the persons with alexithymia used biological medicines, indicating a more severe disease ($\chi^2 = 5.3$, $p = 0.06$). However, there were no significant differences in disease severity measured by the SAPASI score between the two

groups. Conversely, alexithymic participants reported more joint pain ($\chi^2 = 5.7$, $p = 0.019$); actually 75% of the persons with alexithymia reported joint pain. Participants with alexithymia also reported more comorbidities ($Z = -3.8$, $p < 0.001$) compared with the non-alexithymic group. Regarding self-management measures, the non-alexithymic persons scored significantly better on both HeiQ scales (Table 3) and also reported better self-efficacy (3.0 (CI: 2.3, 3.7), $p < 0.001$).

(Table 3. Table 3: Socio-demographic characteristics and descriptive statistics related to the alexithymia scores - approximately here)

Table 4 presents the results from Pearson's correlations and the four multiple linear regression models. Results showed that in the model with TAS 20 as the dependent variable, education (standardized beta coefficient (st.β) -0.17) and self-efficacy (st.β -0.25) both had a statistically significant negative association to the TAS 20 sum score. Also, psoriasis knowledge (st.β -0.15) had a highly significant negative association, indicating that having alexithymia is related to lower education, lower self-efficacy and less knowledge about psoriasis. Comorbidity had a statistically significant positive association (st.β 0.12), suggesting that having more comorbidities are associated with a higher alexithymia level. In regard to the associations between HL and alexithymia, lower score on "Actively managing health (domain 3)", "Have social support for health (d4)" and "Ability to find good health information (d8)", were all associated with a higher TAS 20 sum score (st.β -0.10 to -0.19). The same was a higher score in domain 5 "Appraise health information" (st.β 0.13). The variance explained by this model was 33.6% (adjusted R Square).

In the model with “Difficulty describing feeling” (DDF) as the dependent variable, sex showed a statistically significant negative association (St.β -.11), indicating that being a man was associated with a higher DDF score. Also here, the model presented significant negative associations between level of education and level of self-efficacy and the DDF factor. Lower score on “Actively managing health (d 3), “Have social support for health” (d4) and “Ability to actively engage with health care providers” (d6) (st.β -.13 to -.17), together with a higher score on domain 5 “Appraise health information (st.β .14, p= 0.003) were significantly associated with difficulties describing feelings, with the model explaining 26.9% of the variance.

The model with the “Difficulty identifying feelings” (DIF) factor as a dependent variable, also showed a statistically significant negative association between education, psoriasis knowledge and self-efficacy (st.β -.12 to -.22) and the DIF score. Also, the same positive association with comorbidities was evident in this model (st.β .14). Regarding associations between HL and DIF, only the 5th HL domain “Appraise health information” showed a significant positive association with the (DIF) factor score (st.β .19). The variance of this model explained 27.4%.

Also, in the model with the “Externally oriented thinking” (EOT) factor as the dependent variable, sex had a statistically significant negative association with this alexithymia trait, indicating that men scored higher than women. Education, psoriasis knowledge and self-efficacy had the same negative associations to this factor as to the other alexithymia scales. A lower score on “Actively managing health (d 3)” (st.β -.19), and “Ability to find good health information” (st.β -.26, p) had significant associations with a higher score on externally oriented thinking (EOT). The variance explained by this model was 23.4 %.

(Table 4 Regression analysis -approximately here)

4.0 Discussion and Conclusion

4.1 Discussion

In our psoriasis sample, we found a high prevalence of alexithymia that is consistent with previous psoriasis research [14,19,20], and significantly higher than the approximately 10% present in the general population [46]. Also, a large portion of the patients with psoriasis scored as possible alexithymic.

This is the first study trying to gain insight into the relationship between comprehensive HL and alexithymia, and our results support the hypothesis that lower scores of HL are associated with alexithymia. This is also found in a previous study regarding oral HL [36], although with a less wide-ranging HL measure.

This possibly essential link between alexithymia and health literacy in psoriasis context makes it crucial to further develop a holistic approach in communication with patients and in SMS. To know a patient's alexithymia level and HL needs may guide HCPs' understanding of the associations between health status, clinical presentation, behaviour, and response to treatment.

Several studies show that alexithymia may be associated with difficulties in perceiving symptoms, included underestimating physical and emotional indicators of exacerbation, together with a delay in seeking health care [47,48]. In episodes of near-fatal asthma, for example, a surprising delay in seeking medical assistance has been shown for people with alexithymia (78). The trait is also predictive of symptom persistence after treatment in patients with functional gastrointestinal disorders [49] and cholelithiasis [50].

Concerning controlling variables, we also found that having lower education is associated with a higher score on the TAS 20 total score and the Difficulty Identifying Feelings and Difficulty Describing Feelings scores. These results are consistent with previous findings showing that alexithymia is associated with socio-demographics [51]. Concerning gender, according to previous studies, we would expect a higher prevalence of alexithymia as a personality trait in males than females [38,51,52]. However, in our study, the alexithymic characteristics of women were found to be similar to men. The literature seems somewhat diverged, as a study in psoriasis found a significant relationship between alexithymia and female gender [20]. However, both in our study and in a COPD study [53], the EOS scale was significantly higher in male participants than in females, suggesting that externally oriented thinking predispose males to alexithymia.

Also, men scored higher in the Difficulty Describing Feelings factor; this is also found in a Finnish study [54]. Maybe this can indicate that men with psoriasis are more prone to being emotionally stoic and repress their vulnerable emotions and may need more encouragement to express their feelings verbally than females with psoriasis. This difference may also be caused by cultural norms and socialization of men, argued by Levant as “normative male alexithymia” [55].

It is also interesting that the TAS-20 scores showed no significant associations with the PASI, meaning that the severity of psoriasis could not be considered a good predictor for alexithymic symptoms in these participants. Consistent with our data, some studies have shown that the PASI score as a representing factor of skin involvement has a limited role in predicting the effect on mental status such as alexithymia [20,56]. We also found that self-efficacy was negatively and strongly correlated with alexithymia; this is in line with previous research on college students [23]. Chung et al. (2013) also reported that self-efficacy was

significantly and negatively correlated with alexithymia in patients experiencing epileptic seizures [22].

The bivariate correlations showed highly significant negative relationships between the TAS 20 sum score, the sub-factors, and the HL domains, indicating that a low HL score associates with a higher alexithymia score. Results from our regression models establish that lower scores on the HLQ domains were associated with a higher score on TAS 20 total score and its subfactors. However, we also observed a significant positive correlation between the HL scale “Appraisal of health information” and the TAS 20 sum score and the two sub-factors “Difficulty Identifying Feelings” (DIF) and “Difficulty Describing Feelings” (DDF). This suggests that higher-order competencies such as “critical health literacy” are more positively related to alexithymia and the difficulties with describing and identifying feelings opposed to functional and communicative or interactive competences. Critical appraisal of information is about cognitive skills in managing and interpreting information as well as about assessing the personal relevance of the information [57]. In the context of this study, it seems like people scoring higher on alexithymia also are capable to interpret information and weigh this information against their preferences.

We focused on a broad concept of HL [32] instead of only the functional part of the concept. The linear regression results generally showed that lower health literacy was associated with higher alexithymia scores. However, not all domains of HL were associated with the TAS 20 total score, and different HL domains are associated with the three TAS -20 factors. Furthermore, some HLQ domains showed no associations to alexithymia. This may support the notion that the functional, communicative, and critical components of HL may be seen as complementary [58].

Low scores on having social support for health (domain 4), actively managing health (domain 3) and ability to actively engage with HCPs (domain 6) were associated with high scores on the Difficulty Describing Feelings factor. These three HL domains are concerned with the relationship to HCPs, and low scores indicate being passive in their approach to healthcare. Hence, this seems congruent with the alexithymia persons striving to describe their feelings and appear confused by questions inquiring about specifics of feelings [59]. They have, therefore, been described as “uninterested” in therapy [60]. In a study in Italian hypertensive patients, the participants with alexithymia showed wide fluctuations in their emotions, going from lack of contact with emotions to the emergence of emotions in an intense and unregulated way, for example, suddenly being likely to explode in anger. This is maybe becoming even more evident for persons with alexithymia and psoriasis, as the knowledge of psycho-dermatology is increasing among health care personnel [61]. This new knowledge could lead to changes in the communication approach as HCPs acknowledge psoriasis being an interaction between the mind and the skin, thereby asking even more personal questions, making the interaction more threatening. Possibly, by helping people with psoriasis and alexithymia to understand their condition and being able to put their feelings into words, for example by using empathetic support strategies such as motivational interviewing or mindfulness [25], the therapeutic approaches are more likely to be successful.

However, interacting with health care personnel on physical symptoms might be less of a problem for alexithymic patients as this may function well for their externally oriented thinking [15]. For example, has previous research shown that surgical treatment is seen as positive by alexithymic persons because it is invasive, leaves a visible sign, and thereby is perceived as effective [62]. Hence, a comprehensive and “aggressive” psoriasis treatment may be perceived in the same way. The fact that the “alexithymia group” also used significant

more biological treatment may support this view (Table 3). Another study found that Alexithymia positively correlated with somatization [14]. Lumley et al. [47] have speculated whether the compulsive nature and external focus of alexithymia patients prompt greater adherence to structured exercise interventions and behavioural recommendations.

4.2 Strengths and limitations

This is to the best of our knowledge; the largest study reported about associations between alexithymia and HL. The sample size, the response rate, and the use of valid instruments indicate an important methodological strength, yielding safe generalized results.

Some limitations should be mentioned. The participants are to a great deal middle-aged, even if their ages range from 21-83, and there may, therefore, be limitations to whether the study findings are transferable to a larger life span setting. Also, data were collected by self-report questionnaires even though alexithymic patients may have trouble inadequately assessing their emotional deficit [47], and patients with low HL may have difficulties filling out the forms [35]. Moreover, it is possible that we overestimate the level of HL due to the self-report nature of the data collection- as people with very low HL may not participate in such a survey. This is extra troublesome as the patients with alexithymia score lower than the full sample in all HLQ domains (results not shown) [63], even if this psoriasis cohort in total scores lower than studies including other chronic conditions [28,64]. Second, the cross-sectional design of our study precluded any causal interpretation of the relationship between HL and alexithymia. Furthermore, another methodological issue is the relatively low Cronbach alpha (0.52) of the EOT scale, showing low internal consistency. However, this is not a study-specific problem as the reliability of the EOT scale has been questioned in several studies, especially where the language is not English [39,65]. Low Cronbach alpha is

interpreted both as a cultural context problem as well as a problem in the translation of the EOT construct [66].

4.3 Conclusion

Our findings suggest that studying the associations between psychological factors such as alexithymia and HL may contribute to a more comprehensive perspective of psoriasis. To know a patient's alexithymia level and HL strengths and limitations may guide our understanding of health status, clinical presentation, behavior, and responses to treatment.

4.4 Practice Implications

These results suggest that alexithymia, together with HL, needs to be considered in self-management support and shared decision-making efforts in the context of psoriasis.

Furthermore, health care personnel may need to plan the therapeutic process differently depending on the person's alexithymia status. This seems especially relevant for patients with psoriasis as alexithymia has been reported to mask accompanying psychological distress causing the patients to seek health care related to somatization [67]. Hence in patients with deficits in affect regulation, as alexithymia, health care personnel should avoid affect provocations and convey a supportive and empathetic communication style [16]. Future studies should give special attention to patients with psoriasis, alexithymia, and health literacy limitations when discussing treatment modalities and also when assessing the effect of educational and SM interventions.

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Table 1: The four steps for entering independent variables in the regression model

Step 1	Age, gender & education as independent variables
Step 2	Step 1 + SAPASI and number of diseases
Step 3	Step 1 & 2 + Psoriasis knowledge (PKQ), self-management (heiQ domains) and self-efficacy
Step 4	Step 1-3 + The nine domains of health literacy (HLQ)

Table 2: Number (%) of participants scoring related to alexithymia status.

No alexithymia (TAS 20 score 0-51) N (%)	Possibly alexithymia (TAS 20 score 52- 60) N (%)	Alexithymia (TAS 20 score 61-100) N (%)	Total N (%)
352 (47.2 %)	200 (26.8%)	194 (26.0 %)	746 (100%)

Table 3: Socio-demographic characteristics and descriptive statistics related to the alexithymia scores

Demographic, clinical and descriptive statistics	Full sample Mean (SD)/ N(%) (N= 745)	No alexithymia TAS 20: 0-60 Mean (SD)/ N (%) (N= 547)	Alexithymia TAS 20: 61- 100, Mean (SD) / N(%) (N= 193)	χ^2 , p value; between group difference (95 % confidence interval), p-value; Z-value, p- value
Male (%)	385(51.7%)	285 (74.5%)	97 (25.4%)	
Female (%)	360 (48.3%)	261 (72.7%)	98 (27.3%)	$\chi^2 = 0.35$, $p = 0.56$
Age (Mean years) (SD)	52.8 (12.4) (range 21- 83)	52.95 (12.3)	52.55 (12.4)	0.40, (CI: 1.62,2.42), $p = 0.70$
Level of Education (N= 741)				
Prim/secondary school ≤ 10 years,	449 (60.6%)	300 (66.8%)	149 (33.2%)	
High school /Vocational ≤ 13 years / College/ University ≤ 3 years	292 (39.4%)	249 (85.3%)	43 (14.7%)	$\chi^2 = 31.40$, $p < 0.001$
Work status: Working	414 (50.6%)	295 (53.7%)	87 (45.1%)	$\chi^2 = 4.28$, $p = 0.038$
Not working	404 (49.4%)	254 (46.3%)	106 (54.9%)	
Disease severity SAPASI (0-72; Higher score = more serious disease)	7.51 (4.9)	7.20 (4.8)	7.98 (5.1)	-0.78 (CI: 1.59, 0.023), $p = 0.057$
Biological medicines (N=811) YES	115 (14.2%)	73 (13.5%)	35 (18.1%)	$\chi^2 = 5.3$, $p = 0.06$
Number of comorbidities	4.4 (2.5)	4.23 (2.4)	5.06 (2.6)	Z = -3.76, $p < 0.001$
Joint pain (NO/YES) (N= 740)	233 (31.5%) / 507 (68.5%)	186 (33.9%) / 363 (66.1%)	47 (24.6%) / 144 (75.4%)	$\chi^2 = 5.7$, $p = 0.019$
HeiQ: Self- Monitoring and insight (n= 712)	3.15 (0.43)	3.17 (0.42)	3.08 (0.43)	.10 (CI:0.024, 0.17), $p = 0.009$
HeiQ: Skill and technique acquisition (N= 730)	2.80 (0.55)	2.85 (0.53)	2.68 (0.57)	.17 (CI: 0.08, 0.26), $p < 0.001$
Self-efficacy (GSES) (10- 40; higher score = higher self- efficacy)	30.19 (4.59)	30.96 (4.16)	27.96 (5.01)	3.0 (CI: 2.27, 3.73), $p < 0.001$
TAS 20 sum score (score 20 -100) Higher score = more alexithymia	51.7 (13.0)	46.06 (9.81)	67.7 (5.62)	-21.6 (CI: -23.07, -20.14), $p < 0.001$
Difficulty Identifying Feelings (DIF)	17.88 (6.82)	15.12 (5.26)	26.0 (4.18)	-10.6 (CI:-11.40, -9.76), $p < 0.001$
Difficulty Describing Feelings (DDF)	12.91 (4.65)	11.27 (4.07)	17.56 (2.61)	-6.3 (CI: -6.91, -5.68), $p < 0.001$
Externally Oriented Thinking (EOT)	20.96 (4.45)	19.76 (4.21)	24.40 (3.12)	-4.65 (CI: -5.30, - 3.99), $p < 0.001$

Self-Administrated Psoriasis and Severity Index (SAPASI), General Self efficacy Scale (GSE), DIF: Difficulty in identifying feelings”, DDF: Difficulty in describing feelings, EOT: Externally oriented thinking. The values are means (\pm SD) unless otherwise indicated. SD: standard deviation. Difference between groups: (a) independent samples t-tests of means, (b) Pearson’s Chi-square (χ^2) tests of proportions and (c) Mann–Whitney U-tests of medians. N differs among individual analyses because of missing values. Educational level: 1 -4 (higher score= higher level of education), Quantity of comorbidities: higher score = more comorbidity, SAPASI (0-30: Higher score = more severe disease), Self-Efficacy (GSE) (higher score – better self-efficacy).

Table 4. Associations between TAS 20 sum scores and its` sub-scores and knowledge, self-management, and health literacy factors after controlling for demographic and clinical factors by multiple regression analysis (Enter) (n=825) (r, standardized beta weights, adjusted R², and significance level).

	Difficulty Identifying Feelings (DIF)					Externally Oriented Thinking (EOT)				
	<i>r</i>	<i>Step 1</i> (β ₁)	<i>Step 2</i> (β ₂)	<i>Step 3</i> (β ₃)	<i>Step 4</i> (β ₄)	<i>r</i>	<i>Step 1</i> (β ₁)	<i>Step 2</i> (β ₂)	<i>Step 3</i> (β ₃)	<i>Step 4</i> (β ₄)
Age (years)	.00	-.003	-.04	-.04	-.03	.01	-.01	-.03	-.03	-.04
Sex (0=men, 1=women)	.07	.10*	.06	.06	.06	-.17***	-.14***	-.15***	-.15***	-.13***
Educational level (higher score= higher education)	-.29***	-.30***	-.27***	-.18***	-.15***	-.32***	-.31***	.30***	-.21***	-.17
SAPASI (Higher score = more severe disease)	.08**		.06	.05	.04	.09**		.05	.04	.03
Comorbidities (higher score = more comorbidity)	.26***		-.23***	.17***	.14***	.08*	.08*		.05	.05
Psoriasis Knowledge (PKQ) (Higher score = higher PSO knowledge)	-.23***			.13**	-.12**	-.27***			-.15***	-.12**
Self-monitoring & Insight (heiQ)	-.17***			-.04	-.02	-.14***			-.07	-.01
Skill & Technique acquisition (heiQ)	-.25***			-.05	-.01	-.12**			.05	.08
Self-efficacy sum score (Higher score = higher self-efficacy)	-.37***			-.23***	-.22***	-.26***			-.19***	-.15***
(HLQ1) Feeling understood and supported by HCP	-.17***				.04	-.15***				-.01
(HLQ2) Having sufficient information to manage my health	-.24***				.04	-.18***				.09
(HLQ3) Actively managing health	-.16***				-.05	-.28***				-.19***
(HLQ4) Have social support for health	-.23***				-.06	-.16***				-.04
(HLQ5) Appraise health information	-.07*				.19***	-.25***				-.05
(HLQ6) Ability to actively engage with healthcare providers	-.32***				-.12	-.17***				-.01
(HLQ7) Ability to navigate the health care system	-.33***				-.05	-.17***				.10
(HLQ8) Ability to find good health information	-.32***				-.06	-.31***				-.26***
(HLQ9) Ability to understand health information well enough to know what to do	-.32***				-.08	-.23***				.31
Adjusted R²		.090	.141	.226	.274		.121	.127	.182	.234
R change			.053***	.090***	.058***			.008*	.060***	.062***

Step1: Standardized beta weights using age, sex, educational attainment as independent variables.

Step 2: Standardized beta weights using step one + additional diseases and SAPASI as independent variables.

Step 3: Standardized beta weights using steps one & two + Psoriasis Knowledge, self-management domains (heiQ - Health Education Impact Questionnaire), and self-efficacy as independent variables.

Step4: Standardized beta weights using Step 1-3 + the nine HLQ domains as independent variables.

*Significant at the .05 level, ** Significant at the .01 level, ***Significant at the .001 level

	Difficulty Identifying Feelings (DIF)					Externally Oriented Thinking (EOT)				
	<i>r</i>	<i>Step 1</i> (β_1)	<i>Step 2</i> (β_2)	<i>Step 3</i> (β_3)	<i>Step 4</i> (β_4)	<i>r</i>	<i>Step 1</i> (β_1)	<i>Step 2</i> (β_2)	<i>Step 3</i> (β_3)	<i>Step 4</i> (β_4)
Age (years)	.00	-.003	-.04	-.04	-.03	.01	-.01	-.03	-.03	-.04
Sex (0=men, 1=women)	.07	.10*	.06	.06	.06	-.17***	-.14***	-.15***	-.15***	-.13***
Educational level (higher score= higher education)	-.29***	-.30***	-.27***	-.18***	-.15***	-.32***	-.31***	.30***	-.21***	-.17
SAPASI (Higher score = more severe disease)	.08**		.06	.05	.04	.09**		.05	.04	.03
Comorbidities (higher score = more comorbidity)	.26***		-.23***	.17***	.14***	.08*	.08*	.05	.05	.05
Psoriasis Knowledge (PKQ) (Higher score = higher PSO knowledge)	-.23***			.13**	-.12**	-.27***			-.15***	-.12**
Self-monitoring & Insight (heiQ)	-.17***			-.04	-.02	-.14***			-.07	-.01
Skill & Technique acquisition (heiQ)	-.25***			-.05	-.01	-.12**			.05	.08
Self-efficacy sum score (Higher score = higher self-efficacy)	-.37***			-.23***	-.22***	-.26***			-.19***	-.15***
(HLQ1) Feeling understood and supported by HCP	-.17***				.04	-.15***				-.01
(HLQ2) Having sufficient information to manage my health	-.24***				.04	-.18***				.09
(HLQ3) Actively managing health	-.16***				-.05	-.28***				-.19***
(HLQ4) Have social support for health	-.23***				-.06	-.16***				-.04
(HLQ5) Appraise health information	-.07*				.19***	-.25***				-.05
(HLQ6) Ability to actively engage with healthcare providers	-.32***				-.12	-.17***				-.01
(HLQ7) Ability to navigate the health care system	-.33***				-.05	-.17***				.10
(HLQ8) Ability to find good health information	-.32***				-.06	-.31***				-.26***
(HLQ9) Ability to understand health information well enough to know what to do	-.32***				-.08	-.23***				.31
Adjusted R²		.090	.141	.226	.274		.121	.127	.182	.234
R change			.053***	.090***	.058***			.008*	.060***	.062***

Step1: Standardized beta weights using age, sex, educational attainment as independent variables.

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