

Improvement of Depressive and Fatigue Symptoms under Dupilumab Therapy in Atopic Dermatitis Patients: Results from the TREATgermany Registry

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Atopic dermatitis is commonly associated with depressive symptoms and fatigue, which significantly impact quality of life. While clinical trials suggest beneficial effects of dupilumab on mental health, real-world evidence remains limited. This longitudinal cohort study analysed data from adult patients treated with dupilumab in the TREATgermany registry. Subgroups were defined by baseline Center for Epidemiologic Studies Depression Scale (CES-D) scores ≥ 16 (clinically significant depressive symptoms) and Fatigue Severity Scale (FSS) scores > 4 (significant fatigue). Clinical severity (Eczema Area and Severity Index [EASI], objective Scoring Atopic Dermatitis [oSCORAD]), quality of life (DLQI), psychological symptoms, treatment needs and benefits (PNQ, PBI) and drug survival were assessed over 12 months. Among 633 patients, those with elevated baseline CES-D ($n=309$) or FSS ($n=281$) scores reported greater disease burden measured by DLQI, while EASI and oSCORAD did not differ between subgroups. Both CES-D and FSS scores decreased markedly within the first 3 months. Sleep and social functioning needs were more frequently reported in high-burden subgroups and more often fulfilled after 12 months. Drug survival was comparable across subgroups. Dupilumab treatment was associated with significant improvements in depressive symptoms, fatigue and skin severity. Patients with higher baseline mental health burden showed comparable improvements in patient-relevant domains, supporting the broad relevance of dupilumab in real-world atopic dermatitis care.

SIGNIFICANCE

Atopic dermatitis is a chronic inflammatory skin disease that affects not only the skin but also mental well-being, with many patients experiencing depressive symptoms and fatigue. This real-world study analysed data from 633 adults in the German TREATgermany registry treated with dupilumab, an antibody therapy. Within 3 months, depressive symptoms and fatigue showed substantial improvement, which persisted over 12 months. Patients with a high mental health burden at the start benefited just as much as those with less burden. The findings indicate that dupilumab is associated with improvements not only in skin symptoms but also the psychological well-being of patients with atopic dermatitis.

Key words: atopic dermatitis; depression; fatigue; eczema; dupilumab; biologics.

Submitted Apr 16, 2026. Accepted after revision Jul 2, 2026

Published Aug 6, 2026.

DOI: 10.2340/actadv.v106.adv-2026-0616

Acta Derm Venereol 2026; 106: adv-2026-0616.

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Atopic dermatitis (AD) is a chronic, relapsing inflammatory skin disease characterised by intense pruritus, xerosis and eczematous lesions. It affects approximately 20% of children and adolescents and 4–5% of adults in industrialized countries (1, 2). Beyond

the cutaneous symptoms, patients with moderate-to-severe AD often experience a considerable disease burden due to a high prevalence of psychiatric comorbidities, including depression, anxiety disorders and attention deficit/hyperactivity disorder (ADHD) (3–6). These mental health impairments contribute to substantial reductions in health-related quality of life and can complicate disease management.

Several mechanisms are implicated in the increased psychiatric morbidity among AD patients. These include chronic sleep disruption, emotional distress linked to visible skin lesions, experiences of social rejection or discrimination and substance abuse (7–10). Furthermore, AD-related chronic systemic inflammation and neuroimmune dysregulation may contribute to the pathophysiology of depression and fatigue (11). This gives rise to a potential bidirectional relationship between psychological stress and AD severity.

Dupilumab, a monoclonal antibody targeting the IL-4 receptor α chain and thereby inhibiting IL-4 and IL-13 signalling, has demonstrated significant efficacy and safety in randomised controlled trials and registries in moderate-to-severe AD (12–14). In addition to reducing objective disease severity and pruritus, dupilumab has been shown to improve health-related quality of life and alleviate symptoms of depression and anxiety, as assessed by DLQI and HADS scores (15, 16). Moreover, recent observational data suggest that dupilumab therapy may lower the incidence of newly diagnosed psychiatric disorders in AD patients (17). Despite this growing evidence, most data originate from clinical trial settings with limited generalisability. Real-world evidence on changes in depressive symptoms and fatigue during dupilumab treatment, particularly when assessed longitudinally with validated scales, is scarce. Moreover, the potential association between baseline depressive symptoms or fatigue and subsequent treatment outcomes has not yet been explored.

The present study aimed to evaluate the course of depressive and fatigue-related symptoms in adults with moderate-to-severe AD undergoing dupilumab therapy in routine clinical care, using data from the prospective TREATgermany registry. Specifically, we assessed changes in the Center for Epidemiologic Studies Depression Scale (CES-D) and Fatigue Severity Scale (FSS) over 12 months, analysed associations between psychiatric symptom burden and clinical outcomes and investigated potential correlations with treatment persistence.

METHODS

Since 2016, patients with moderate-to-severe atopic dermatitis (AD) have been prospectively enrolled in the adult part of academia-led TREATgermany registry, a noninterventional, multicentre cohort study designed to

collect longitudinal real-world data on the diagnosis, treatment and disease burden of AD in routine clinical care. Details on the study design have been described earlier (18, 19). This analysis is reported in accordance with the STROBE guidelines for observational cohort studies.

As part of standardised follow-up visits, patients complete validated questionnaires on health-related quality of life and mental health. Fatigue was assessed using the mean Fatigue Severity Scale (FSS; mean score range 1–7). A mean score >4 was used to define clinically relevant fatigue, in line with the validation by Valko et al. and consistent with its widespread use as a threshold for clinically significant fatigue across chronic disease populations (20). Depressive symptoms were evaluated using the Center for Epidemiologic Studies Depression Scale (CES-D), range 0–60, with a cut-off score ≥ 16 indicating clinically relevant depressive symptoms (21, 22). For the present analysis, we included all TREATgermany patients with a documented dupilumab treatment initiation between registry entry and December 2023. Patients were included if they had initiated dupilumab therapy from 2 weeks prior to a visit to a maximum of 4 weeks postvisit and had available FSS and/or CES-D data. Only those patients who initiated dupilumab therapy after its market approval and had a clearly defined baseline visit without evidence of switching from or to another systemic treatment were included. Therapy switching was defined as (i) another systemic agent had been discontinued with a documented stop date within 28 days before the dupilumab start date; (ii) systemic therapy was ongoing or newly initiated at baseline, suggesting sequential or overlapping treatment.

For the present analysis 2 cohorts of patients were compared: those with elevated baseline fatigue (FSS >4) or depressive symptoms (CES-D ≥ 16) and those with low baseline FSS or CES-D. Longitudinal analyses focused on changes in CES-D, FSS, and Dermatology Life Quality Index (DLQI) scores at 3 (13 $\pm$ 2 weeks), 6 (26 $\pm$ 4 weeks) and 12 (52 $\pm$ 6 weeks) months after dupilumab initiation.

Drug survival was analysed in a broader cohort comprising all patients who initiated dupilumab during the inclusion period without therapy switching ($N=750$), irrespective of subsequent availability of CES-D/FSS follow-up data, since drug-survival assessment does not require longitudinal psychometric data. Kaplan–Meier curves were stratified by baseline CES-D (≥ 16 vs <16 ; $N=737$) and FSS (>4 vs ≤ 4 ; $N=736$).

Statistics

Descriptive statistical analyses were performed using Stata 15 and R software, version 4.5.1 (23). Group comparisons of continuous variables were conducted using the Wilcoxon rank-sum test or the Student *t*-test,

depending on data distribution. Multiple comparisons were adjusted using Bonferroni correction. A 2-sided $p < 0.05$ was considered statistically significant (* $p < .05$; ** $p < .01$; *** $p < .001$).

Pairwise correlations between changes in clinical and patient-reported outcomes were primarily assessed using Pearson correlation coefficients and visualised as correlation matrices for the 3-, 6- and 12-month visits. Given the skewed distribution of several delta scores, Spearman rank correlation coefficients were additionally calculated as a sensitivity analysis to assess the robustness of the observed correlation patterns against non-normality and potential nonlinear

monotonic associations. Spearman correlation matrices are provided in Fig. S1.

RESULTS

Between June 2016 and December 2023, a total of 2,012 adult patients with AD were enrolled in the TREATgermany registry (Fig. 1). Among the 826 patients initiated on dupilumab, 76 were excluded due to a switch from another therapy. An additional 117 patients were excluded due to either missing follow-up visits ($n = 91$) or discontinuation of dupilumab prior to the first follow-up visit ($n = 26$). The final analysis

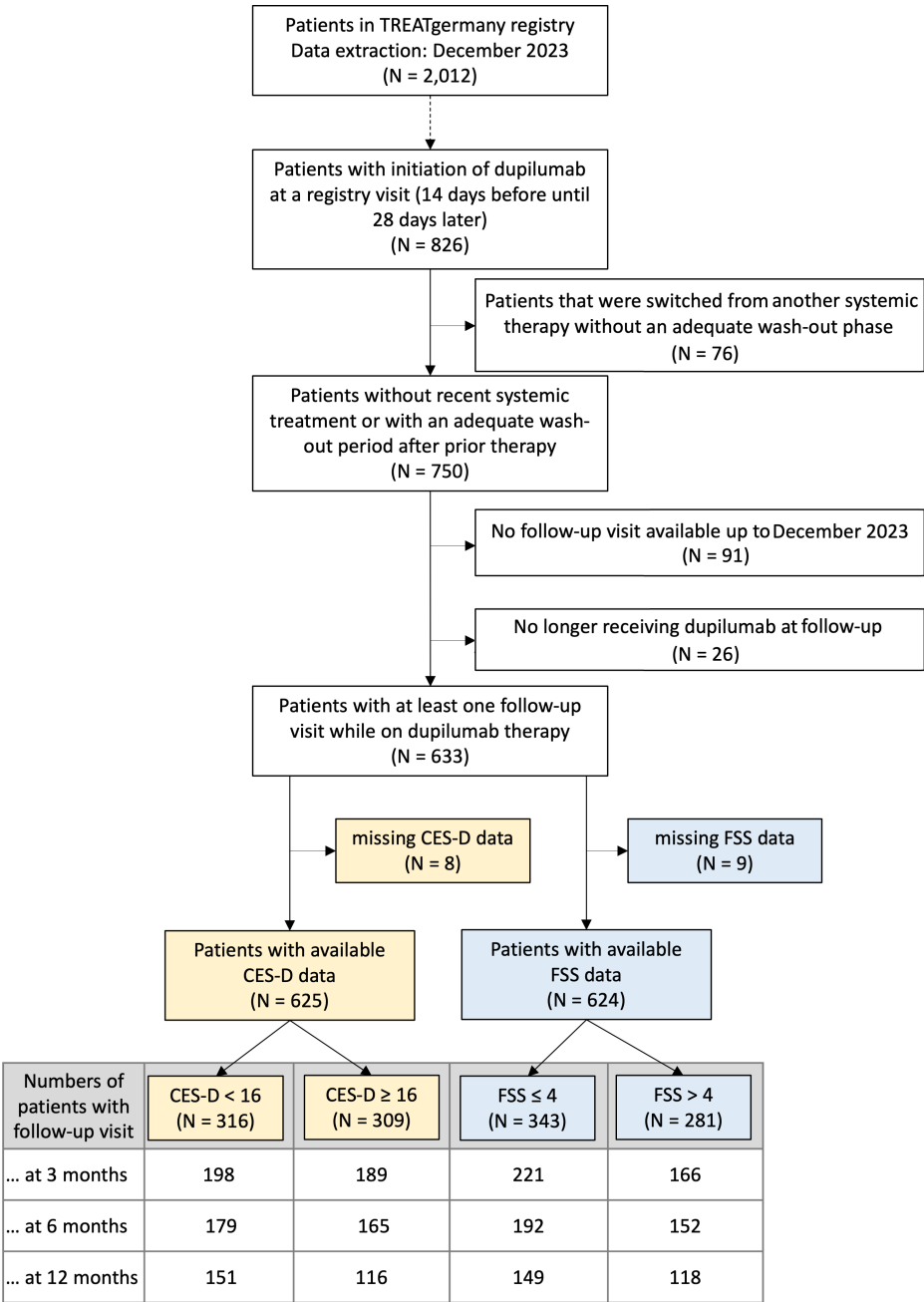


Fig. 1. Flow diagram of patient selection.

cohort comprised 633 patients. Baseline CES-D data were available for 625 patients and FSS data for 624. Patients with elevated CES-D (≥ 16) or FSS (>4) scores differed from those with lower scores in terms of sex and educational status but were similar regarding age, smoking behaviour and AD onset. Demographics are summarised in **Table I**.

Mean CES-D and FSS scores decreased continuously over the course of 12 months following dupilumab initiation (**Fig. 2**). At baseline, the mean CES-D score across all patients was 17.3 ± 10.3 , indicating that a substantial proportion of patients presented with clinically relevant depressive symptoms. By month 3, the mean CES-D score had significantly decreased to 12.3 ± 9.5 , with further reductions observed at months 6 (11.9 ± 9.4) and 12 (10.9 ± 9.3). A similar pattern was observed for fatigue: the mean FSS score decreased from 3.9 ± 1.6 at baseline to 3.2 ± 1.5 at month 3, 3.0 ± 1.5 at month 6, and 2.9 ± 1.5 at month 12 (**Fig. 2**, Tables SI and SII). Notably, the most pronounced improvement for both CES-D and FSS was observed within the first 3 months of therapy.

To assess patient expectations and treatment-related outcomes, the Patient Needs Questionnaire (PNQ) and Patient Benefit Questionnaire (PBQ) were completed at baseline and at the follow-up visits, respectively, and analysed in subgroups stratified by baseline CES-D and FSS scores (Tables SIII and SIV). Among patients

with elevated depressive symptoms or fatigue, the need “to be able to sleep better” was substantially more often rated as important compared to patients without increased depressive and fatigue scores, respectively. Further marked differences were observed in all items of social and psychosocial domains: patients in the high CES-D and FSS groups more frequently prioritised needs related to the disease’s impact on partnership, sexuality and social life. After 12 months of dupilumab therapy, these patients reported higher perceived benefit in these areas compared to those without elevated CES-D/ FSS-baseline scores.

As expected, baseline CES-D and FSS scores were significantly higher in the respective high-burden subgroups (CES-D ≥ 16 and FSS >4), reflecting the predefined stratification (**Fig. 3A** and **B**, Tables SI and SII). Although the numerical difference between subgroups decreased over time, the differences remained statistically significant at 3, 6 and 12 months. To assess whether the baseline psychological burden influenced the improvement in quality of life under dupilumab treatment, DLQI scores were evaluated over 12 months in subgroups stratified by baseline CES-D and FSS values (**Fig. 3C** and **D**). At baseline, patients with clinically relevant depressive symptoms (CES-D ≥ 16) showed a significantly higher impairment of quality of life (DLQI: 17.5 ± 6.8 vs 10.1 ± 5.7 , $p < 0.001$) (**Fig. 3C**). Patients with relevant fatigue at baseline

Table I. Baseline characteristics of AD patients within the TREATgermany registry at dupilumab initiation. Shown are the baseline characteristics (age, gender, family status, school certificate, employment, smoking status and AD onset) at the initiation of dupilumab (month 0). The values are categorised in FSS ≤ 4 , FSS >4 as well as in CESD <16 and CESD ≥ 16

	FSS ≤ 4 (n=343)	FSS >4 (n=281)	CESD <16 (n=316)	CESD ≥ 16 (n=309)	Total (n=633)
Age [at start visit]	39.7 $\pm$ 14.8	39.4 $\pm$ 14.7	40.4 $\pm$ 14.8	38.7 $\pm$ 14.7	39.6 $\pm$ 14.7
Gender					
Diverse	1 [0.3%]	0 [0.0%]	0 [0.0%]	1 [0.3%]	1 [0.2%]
Male	208 [60.6%]	140 [49.8%]	199 [63.0%]	149 [48.2%]	354 [55.9%]
Female	134 [39.1%]	141 [50.2%]	117 [37.0%]	159 [51.5%]	278 [43.9%]
Family status					
Partnership [unmarried]	95 [28.2%]	82 [29.4%]	86 [27.6%]	91 [29.5%]	177 [28.6%]
Married	113 [33.5%]	105 [37.8%]	120 [38.6%]	98 [32.2%]	218 [35.3%]
Divorced	11 [3.3%]	11 [4.0%]	8 [2.6%]	14 [4.6%]	22 [3.5%]
Widowed	6 [1.8%]	3 [1.1%]	3 [1.0%]	6 [2.0%]	9 [1.5%]
Single	112 [33.2%]	77 [27.7%]	94 [30.2%]	95 [31.3%]	192 [31.1%]
School certificate					
Without	1 [0.3%]	1 [0.4%]	1 [0.3%]	1 [0.3%]	2 [0.3%]
Secondary school certificate	31 [9.1%]	28 [10.0%]	27 [8.6%]	32 [10.4%]	59 [9.4%]
Secondary school diploma	127 [37.4%]	90 [32.0%]	116 [36.8%]	101 [32.9%]	220 [35.2%]
A-level	94 [27.6%]	99 [35.2%]	90 [28.6%]	103 [33.6%]	193 [30.9%]
University degree	87 [25.6%]	63 [22.4%]	81 [25.7%]	70 [22.8%]	151 [24.2%]
Employment					
No	66 [19.4%]	68 [24.2%]	51 [16.2%]	83 [27.0%]	136 [21.8%]
Yes	274 [80.6%]	213 [75.8%]	264 [83.8%]	224 [73.0%]	489 [78.2%]
Smoking status					
Smoker	72 [21.2%]	74 [26.3%]	69 [21.9%]	78 [25.4%]	149 [23.9%]
Ex-smoker (<10 years)	50 [14.7%]	37 [13.2%]	43 [13.6%]	44 [14.3%]	87 [13.9%]
Ex-smoker (≥ 10 years)	36 [10.6%]	31 [11.0%]	38 [12.1%]	29 [9.5%]	67 [10.7%]
Non-smoker	182 [53.5%]	139 [49.5%]	165 [52.4%]	156 [50.8%]	322 [51.5%]
AD onset					
Since infancy	190 [55.9%]	169 [60.1%]	185 [58.7%]	174 [56.7%]	361 [57.8%]
Since before starting school	64 [18.8%]	40 [14.2%]	56 [17.8%]	48 [15.6%]	104 [16.7%]
Since school/youth	45 [13.2%]	29 [10.3%]	37 [11.8%]	38 [12.4%]	75 [12.0%]
Since adulthood	39 [11.5%]	42 [15.0%]	35 [11.1%]	46 [15.0%]	81 [13.0%]
Unknown	2 [0.6%]	1 [0.4%]	2 [0.6%]	1 [0.3%]	3 [0.5%]

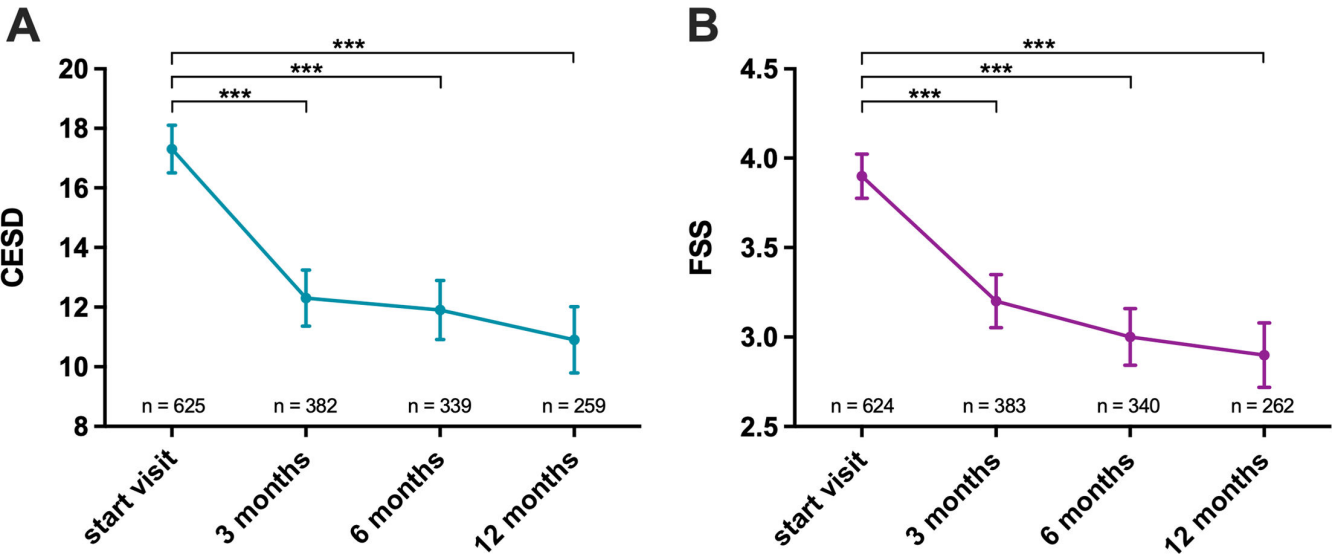


Fig. 2. Depressive symptom and fatigue score of AD patients in the TREATgermany registry receiving dupilumab therapy. Mean and 95 % confidence interval depicted for total (A) Center for Epidemiologic Studies Depression Scale (CES-D) and (B) Fatigue Severity Scale (FSS). Dupilumab start visit and follow-up visits at 3, 6 and 12 months of therapy were considered. Y-axis limits correspond to the observed score range.

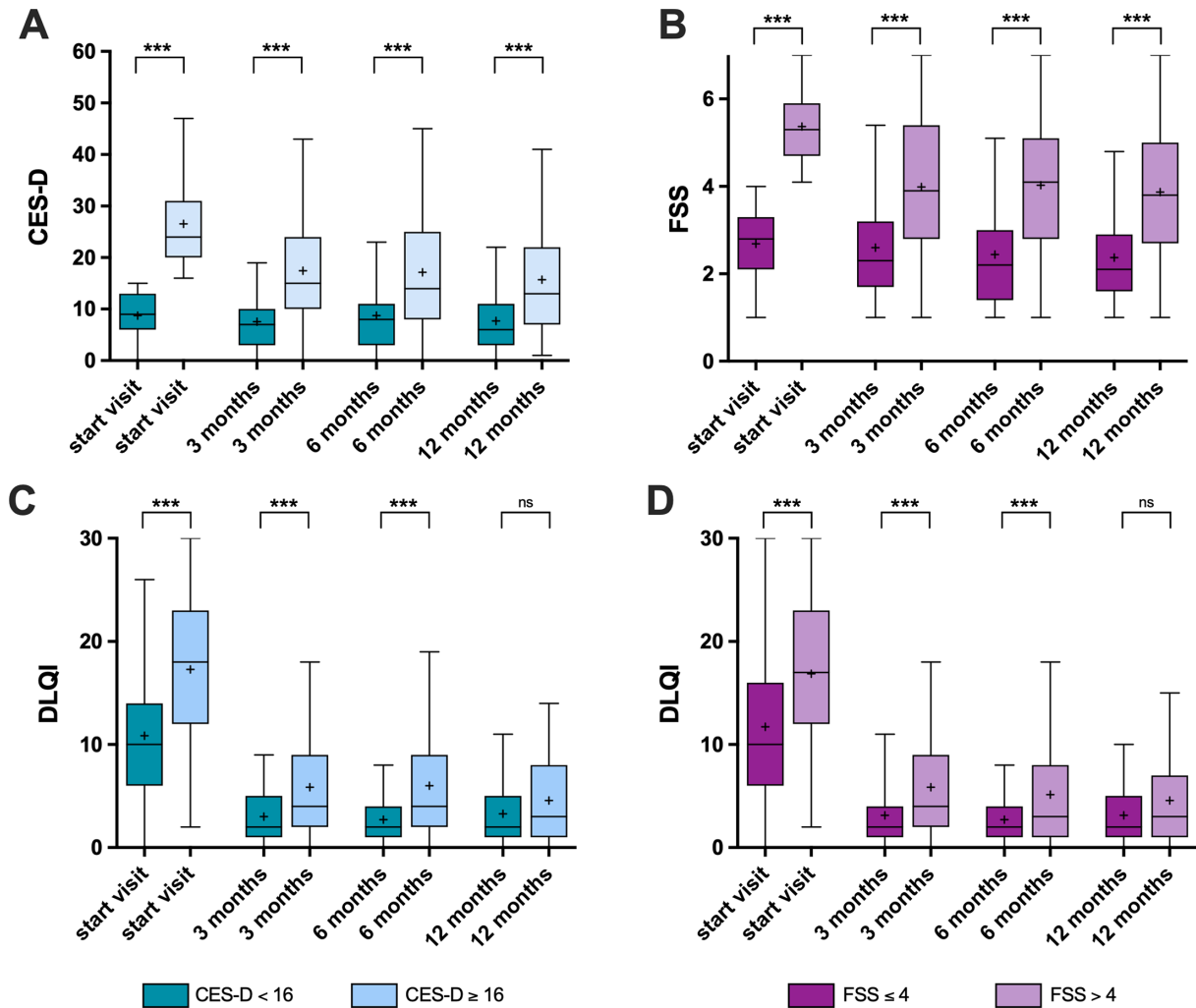


Fig. 3. CES-D, FSS and DLQI scores over time stratified by baseline psychological symptom burden. Patients were differentiated between with and without clinically relevant depressive symptoms (CES-D ≥ 16 vs. < 16) (A: CES-D and C: DLQI) and with and without relevant fatigue (FSS > 4 vs. ≤ 4) (B: FSS, D: DLQI).

(FSS>4) also reported higher baseline DLQI values compared to those with FSS≤4 (17.2 ± 7.0 vs 10.9 ± 6.3 , $p < 0.001$) (Fig. 3D). All subgroups showed continuous improvement under dupilumab, with the most marked changes again occurring in the first 3 months. At 12 months, DLQI scores had markedly improved in both fatigue and depression subgroups and were comparable between them.

The course of objective disease severity, assessed by EASI and oSCORAD, showed marked reductions in both scores during dupilumab treatment (Fig. 4). Mean EASI and oSCORAD values declined substantially within the first 3 months and remained stable thereafter. Stratification by baseline depressive symptoms (CES-D ≥ 16 vs < 16) and fatigue levels (FSS > 4 vs ≤ 4) revealed no relevant differences in EASI or oSCORAD scores at any timepoint during follow-up. Patients with and without elevated CES-D or FSS values showed comparable improvements in clinical severity.

To further investigate the relationship between psychological improvement and changes in disease

activity, correlation analyses were conducted for the 3-, 6- and 12-month visits (Fig. 5A–C). Improvements in depressive symptoms (Δ CES-D) and fatigue (Δ FSS) showed only weak correlations with objective, physician-assessed disease severity scores (Δ EASI and Δ oSCORAD), whereas stronger associations were observed with the patient-reported outcome Δ POEM. Sensitivity analyses using Spearman rank correlation coefficients yielded highly similar correlation patterns across all follow-up visits (Fig. S1).

To assess long-term treatment adherence in relation to psychological symptom burden, 1-year drug survival was analysed using Kaplan–Meier estimates, stratified by baseline CES-D and FSS scores (Fig. 6). Overall, drug survival after 12 months of dupilumab therapy remained high across all subgroups. In patients with CES-D ≥ 16 at baseline, 12-month drug survival was comparable to that of patients with CES-D < 16 (Fig. 6A). Similarly, no relevant differences were observed between patients with FSS > 4 and those with FSS ≤ 4 (Fig. 6B). Comparison of baseline

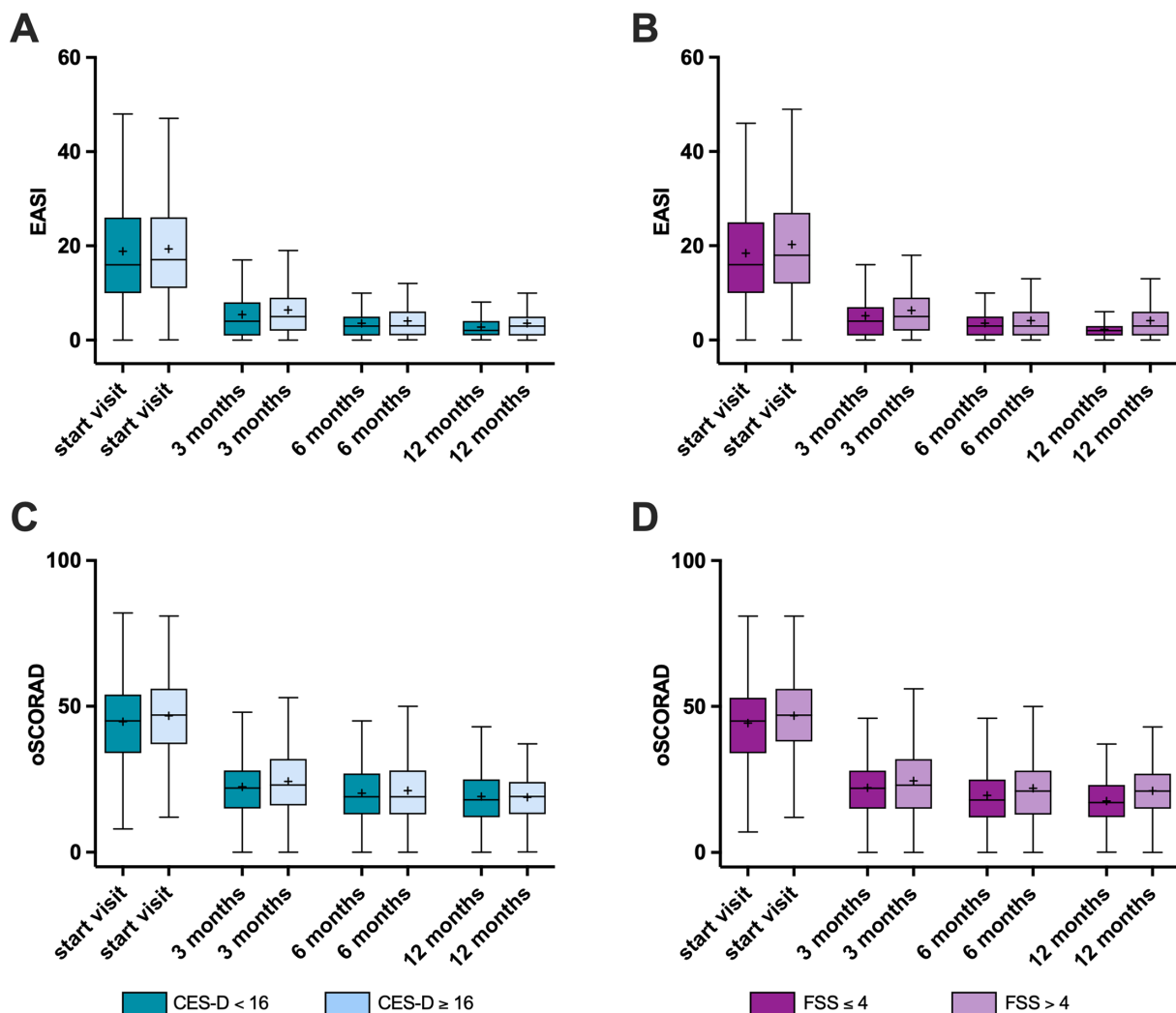


Fig. 4. EASI and oSCORAD scores during 12 months of dupilumab therapy, stratified by baseline psychological symptom burden. A/C: Disease severity measured by EASI and oSCORAD in CES-D subgroups. B/D: Disease severity measured by EASI and oSCORAD in FSS subgroups.

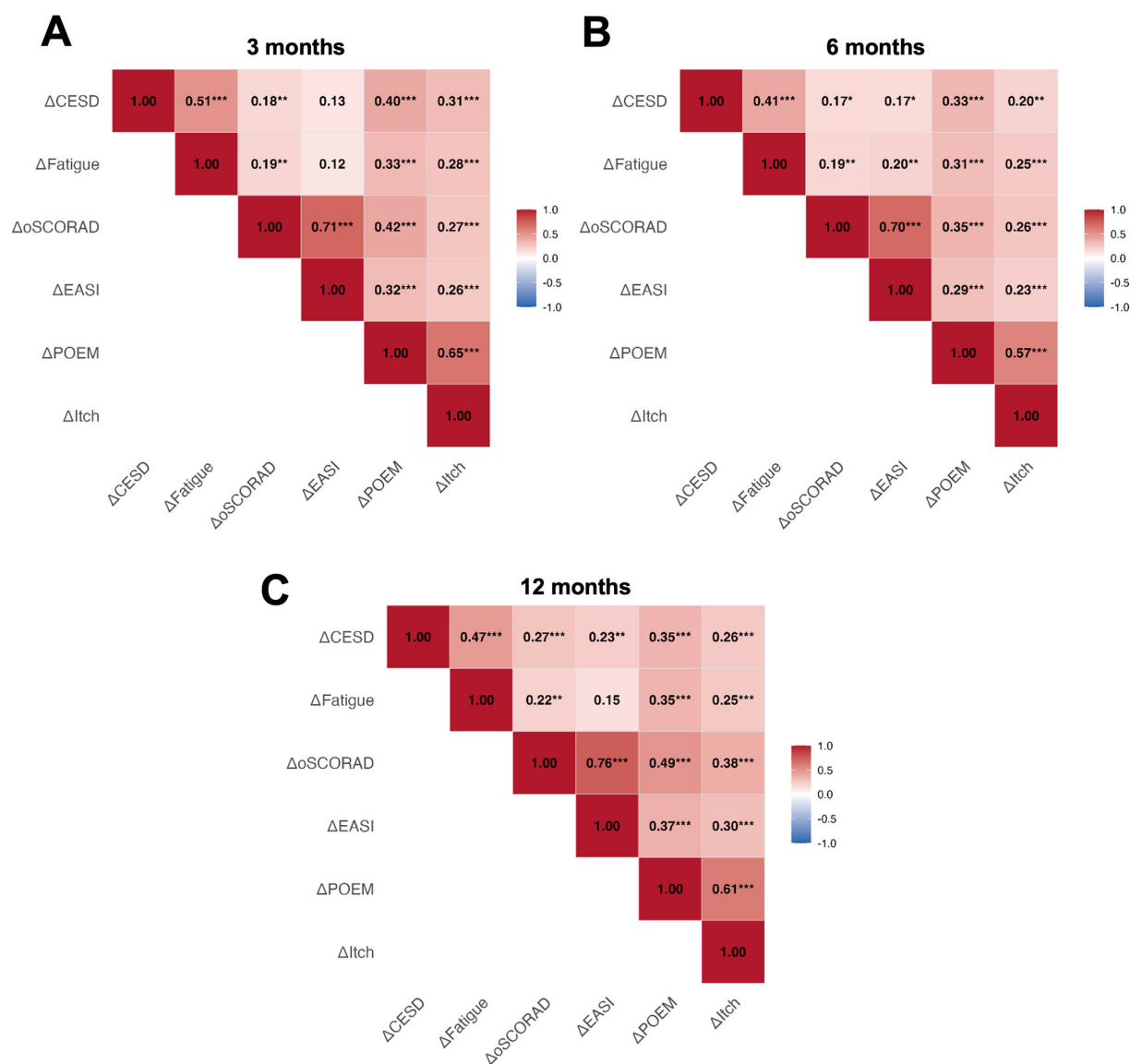


Fig. 5. Correlation matrices of changes in clinical and patient-reported outcomes over time. A: After 3 months, B: after 6 months and C: after 12 months. Each panel shows pairwise Pearson correlation coefficients (R) between changes in depressive symptoms (Δ CES-D), fatigue (Δ Fatigue), clinical severity scores (Δ oSCORAD, Δ EASI), patient-reported disease activity (Δ POEM) and itch intensity (Δ Itch). Asterisks indicate significance after Bonferroni correction ($p < 0.05 = *$, $p < 0.01 = **$, $p < 0.001 = ***$).

characteristics between patients with available 12-month follow-up data and those without revealed no significant differences in CES-D, FSS, EASI, oSCORAD, DLQI, age or sex (Table S5).

DISCUSSION

Using data from the TREATgermany registry, this study provides longitudinal real-world evidence on the course of depressive symptoms and fatigue under dupilumab treatment in adults with moderate-to-severe AD, prospectively assessed with the validated CES-D and FSS instruments and stratified by baseline psychological symptom burden. In patients initiating dupilumab, we observed substantial improvements in

both CES-D and FSS scores over a 12-month follow-up, with the most pronounced changes already evident at the 3-month visit. Importantly, these improvements occurred in parallel with the reduction in objective disease severity (oSCORAD, EASI), suggesting a potential link between successful skin disease control and improvements in mental health and fatigue. No minimal important difference (MID) has been validated for either instrument in AD; the 0.45-point FSS threshold proposed in multiple sclerosis (24) cannot be transferred uncritically, and no established MID exists for the CES-D. Several converging observations nonetheless suggest clinical meaningfulness: 60.7% of patients with baseline CES-D ≥ 16 and 57.4% of those with baseline FSS > 4 fell below the respective clinical

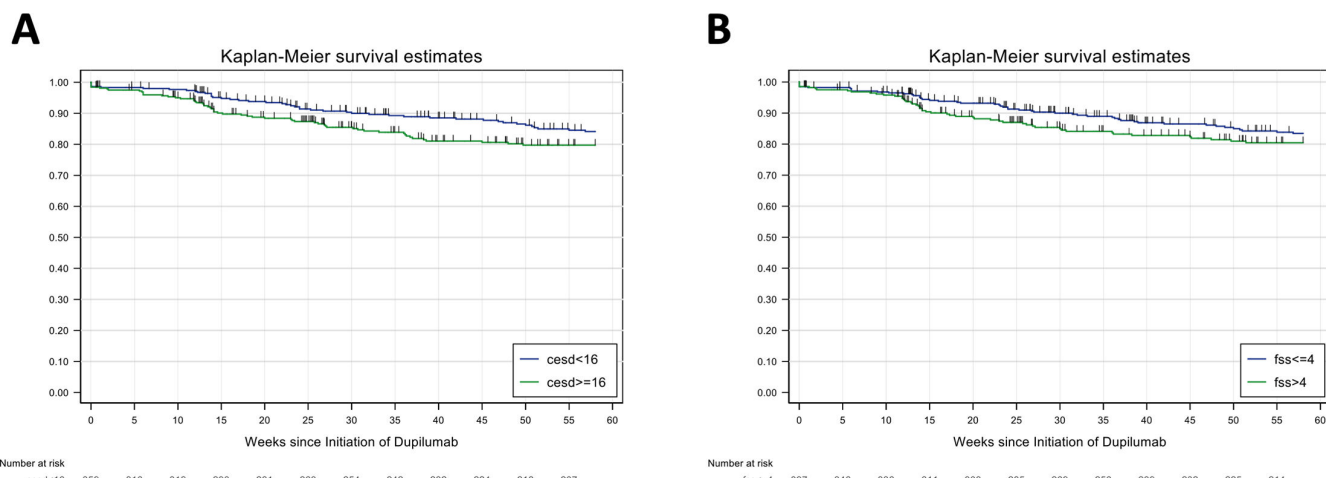


Fig. 6. Drug survival of dupilumab over 12 months, stratified by psychological symptom burden at baseline. Patients who initiated dupilumab without therapy switching are included ($N=750$); this cohort is broader than the main analysis cohort ($N=633$; Fig. 1), as drug-survival assessment does not require subsequent CES-D/FSS follow-up data. A: Kaplan-Meier curve comparing drug survival between patients with CES-D ≥ 16 and <16 ($N=737$). B: Kaplan-Meier curve comparing drug survival between patients with FSS >4 and ≤ 4 ($N=736$).

cut-offs by month 12, the observed mean changes ($\Delta\text{CES-D} = -6.4$; $\Delta\text{FSS} = -1.0$) approximated or exceeded the half-baseline-SD heuristic for meaningful change (25), and the effect magnitude aligns with placebo-controlled trial data (16, 26).

Patients with elevated CES-D and FSS scores at baseline indicating clinically relevant depressive symptoms or fatigue exhibited substantially higher subjective disease burden, patient needs related to sleep and psychosocial functioning. However, treatment with dupilumab was associated with convergence in psychological outcomes between subgroups. After 12 months of therapy, the initially significant differences between high and low CES-D and FSS groups were no longer observed regarding DLQI. These findings highlight the relevance of targeted AD therapy not only for skin inflammation but also for mental health parameters under real-life conditions.

The observed improvements in depressive symptoms and fatigue are in line with prior clinical trial evidence suggesting a beneficial impact of dupilumab on mental health domains (12, 26). A post hoc analysis of pivotal trials (SOLO 1, SOLO 2, and CHRONOS) indicated that dupilumab treatment led to reductions in depressive symptoms and anxiety scores, as assessed by the Hospital Anxiety and Depression Scale (HADS) (16). Our data extend these findings by confirming sustained real-world effects and by employing validated instruments such as the CES-D and the FSS.

Despite higher baseline burden, drug survival in patients with elevated CES-D or FSS scores did not differ from those without such symptoms. This finding is consistent with comparable tolerability and acceptance of dupilumab across subgroups, irrespective of baseline depressive or fatigue burden.

Changes in CES-D and FSS correlated less strongly with changes in physician-assessed disease

severity ($\Delta\text{oSCORAD}$, ΔEASI) than with changes in the patient-reported POEM. While this pattern is compatible with a closer link between mental well-being and patients' own perception of disease burden, it could equally arise from shared method variance among self-reported instruments, and the cross-sectional structure of change-score correlations does not permit inferences about directionality. Patient-reported outcomes therefore merit inclusion alongside physician-assessed measures in capturing patient-relevant treatment effects, although the relative weight of these measurement domains cannot be established from our data. A positive association between pruritus intensity and depressive symptom severity was observed at baseline ($r=0.34$), whereas the correlation between changes in itch and changes in CES-D during treatment was comparatively weak. Whether this reflects an itch-independent component of psychological improvement, shared method variance among patient-reported outcomes, or other unmeasured factors cannot be resolved from our data, and mechanistic inferences regarding the relative contributions of itch reduction, systemic inflammation, sleep or psychosocial functioning are beyond the scope of the present analysis. These results underline the multifactorial burden of AD, which extends beyond skin symptoms to include psychological strain and functional impairments. They also emphasise the utility of a comprehensive, multidimensional assessment in both clinical trials and routine care to evaluate treatment success.

Limitations

Several limitations should be acknowledged. First, as an academic registry without a control group of patients not receiving systemic therapy, our

design does not permit causal attribution of the observed improvements to dupilumab, and regression to the mean (RTM) remains a plausible competing explanation given that patients initiate therapy at peak disease burden. However, in a post hoc comparison with registry patients with baseline CES-D $\geq$ 16 who did not initiate systemic therapy, the untreated comparator plateaued from week 13 and remained above the clinical threshold of 16 at 52 weeks, whereas the dupilumab subgroup achieved a larger total reduction and fell below it (data not shown). Although subject to channelling bias and not a randomised control, this comparison provides an empirical upper bound on nonspecific change and supports an additional treatment-related component, consistent with placebo-controlled trial evidence (16). Nevertheless, part of the observed improvement may reflect RTM or other time-dependent factors, and the absolute treatment-attributable effect should be interpreted with caution. Second, attrition to the 12-month visit was substantial in absolute terms but largely noninformative: of 633 patients, 108 (17.1%) had insufficient observation time before the data cut-off, 146 (23.1%) remained on dupilumab without a visit in the predefined window, 73 (11.5%) were lost to follow-up and only 38 (6.0%) discontinued dupilumab within the first year (Table S6). Drug survival was high and similar across subgroups (Fig. 6), and baseline characteristics of completers and noncompleters were comparable (Table S5), arguing against substantial bias from informative dropout. Despite these limitations, the use of validated instruments and prospective longitudinal data from a large multicentre national registry support the external validity of our findings.

Conclusion

Our data provide real-world evidence that dupilumab treatment is associated with significant improvements in depressive symptoms and fatigue in patients with moderate to severe AD. This supports the broad therapeutic value of dupilumab and highlights the need to include psychological endpoints in future assessments of AD management strategies.

ACKNOWLEDGEMENTS

The authors gratefully acknowledge the substantial contributions made to this work by the participating patients, physicians and clinical staff, the documentation team and the TREATgermany Study Group as listed on treatgermany.org.

Funding sources: TREATgermany is an academic, investigator-initiated clinical disease registry that is financially supported by AbbVie Deutschland GmbH & Co. KG, Almirall Hermal GmbH, Galderma S.A., LEO Pharma GmbH, Lilly Deutschland GmbH, and Sanofi.

Data availability statement: Data will be made available on reasonable request by the TREATgermany head office.

Ethics committee: The TREATgermany registry has been approved by the responsible ethics committees (No. EK TUD 118032016) and is listed at the clinicaltrials.gov database (NCT03057860). The patients in this manuscript have given written informed consent to publication of their case details.

Conflict of interest: ST has received honouraria for lectures or scientific advice from AbbVie, ALK, Almirall, Galderma, Janssen/JNJ, LEO Pharma, Lilly, Novartis, and Regeneron/Sanofi. AH has received institutional research grants from Beiersdorf, Amgen GmbH, TFS GmbH, has lectured at educational events sponsored by AbbVie, ALK, LEO Pharma, Novartis, Pierre Fabre, Lilly, Sanofi, Beiersdorf and Almirall, has participated in advisory boards for AbbVie, Almirall, LEO Pharma, Klinge Pharma, Novartis and Sanofi and has received travel grants from Janssen, Pfizer and AbbVie. MA has served as a consultant, lecturer, researcher, and/or has received research grants from AbbVie, Almirall, Beiersdorf, Eli Lilly, Galderma, LEO and Sanofi-Genzyme. SA has received lecture and/or consultancy fees from Novartis, LEO Pharma, Amgen, Lilly, Sanofi, Beiersdorf, Janssen, UCB and AbbVie. JS reports institutional grants for investigator-initiated research from the German Federal Joint Committee, German Ministry of Health, German Ministry of Research, European Union, German Federal State of Saxony, Novartis, Sanofi, ALK, and Pfizer. He participated in advisory board meetings as a paid consultant for Sanofi, Lilly, and ALK. SW has received institutional research grants from LEO Pharma, Pfizer Inc. and Sanofi; and has performed consulting work and lectures for AbbVie, Almirall, Apogee, Astria, Boehringer, Eli Lilly, Galderma, GSK, LEO Pharma, Pfizer Inc., Sanofi, and Regeneron. TW has received honouraria for lectures or scientific advice on atopic dermatitis from AbbVie, Almirall, Galderma, Janssen/JNJ, LEO Pharma, Leti, Lilly, Novartis, Pfizer and Regeneron/Sanofi. AH has received honouraria for lectures or scientific advice on atopic dermatitis from AbbVie, Almirall, Galderma, Janssen/JNJ, LEO Pharma, Leti, Lilly, Novartis, Pfizer and Regeneron/Sanofi. BS has received honouraria for lectures or scientific advice on atopic dermatitis from AbbVie, Almirall, Amgen, Aptiv Solutions, Biogen, BMS, Dermapharm, Galderma, Incyte, Janssen, Leo Pharma, Lilly Pharma, Novartis, Pfizer and Regeneron/Sanofi. All other coauthors declared no conflict of interest.

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