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ORIGINAL RESEARCH ARTICLE

Guselkumab-Treated Patients with Plaque Psoriasis Who Achieved Complete Skin Clearance for ≥ 156 Consecutive Weeks: A Post-Hoc Analysis From the VOYAGE 1 Clinical Trial

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Abstract

Background Treatment of moderate-to-severe plaque psoriasis with biologics, such as guselkumab, has demonstrated greater efficacy over traditional non-biologic treatments. However, given patient diversity, greater understanding of the relationship between patient characteristics, positive clinical outcomes, and long-term response to biologics is crucial for optimizing treatment choices.

Materials and Methods This post-hoc analysis of the 5-year VOYAGE 1 clinical trial compares baseline characteristics of patients maintaining a Psoriasis Area and Severity Index (PASI) score of 0 at all visits for ≥ 156 consecutive weeks (PASI = 0 group) with those that never achieve PASI = 0 (comparator group), using descriptive statistics and a multiple logistic regression model. Guselkumab plasma trough concentrations in both response groups were assessed from Weeks 4–156.

Results Of patients who started guselkumab treatment at Week 0 or at Week 16 after switching from placebo, 22.7% (112/494) maintained PASI = 0 for ≥ 156 consecutive weeks. Numerical differences in baseline characteristics, including age, obesity, diabetes, PASI score, disease duration, smoking status, and psoriatic arthritis comorbidity, were identified between the PASI = 0 group and comparator group. Plasma guselkumab levels were consistently higher in the PASI = 0 group. Multiple logistic regression analysis revealed absence of diabetes, lower Dermatology Life Quality Index score at baseline, and higher Week 4 guselkumab plasma concentration as significantly ($p < 0.05$) associated with the PASI = 0 group.

Conclusion A substantial (22.7%) number of guselkumab-treated patients in the VOYAGE 1 clinical trial maintained complete skin clearance for a consecutive period of ≥ 156 weeks. Factors associated with this outcome may suggest clinical benefits of holistic treatment approaches.

Trial Registration NCT02207231.

1 Introduction

Plaque psoriasis is the most common form of psoriasis [1] and the concept of this highly prevalent disease [2, 3] involving accumulating disease memory and increasing impact of chronification is now well established [4]. However, further understanding of the relationship between the baseline demographics and clinical characteristics of patients with moderate-to-severe plaque psoriasis and their response to biologic treatment may help predict outcomes in clinical practice. The importance of effective and lasting treatment to patients has been highlighted in a recently published consensus on what constitutes 'freedom from disease' [5].

Key Points

This post-hoc analysis of the VOYAGE 1 clinical trial revealed that 22.7% of guselkumab-treated patients with plaque psoriasis were able to maintain complete skin clearance for 3 or more years.

Factors associated with the achievement of sustained long-term skin clearance were the absence of previously diagnosed diabetes, lower impact of psoriasis on quality of life at baseline, and higher Week 4 guselkumab plasma concentration.

This analysis provides insights into factors that might predict a better long-term treatment response.

Extended author information available on the last page of the article

Consequently, it would be important to identify specific characteristics that could predispose patients to a sustained positive response to treatment, especially in the context of the long-term management of the disease. In addition, this would provide clinicians with valuable information with which to develop personalized treatment plans that align with patients' needs.

Over the last few decades, biologic therapies have improved the treatment of moderate-to-severe plaque psoriasis by demonstrating greater efficacy over traditional non-biologic treatments [6–9]. In order to evaluate the efficacy and safety of guselkumab, an anti-interleukin (IL)-23 antibody, 837 patients with moderate-to-severe plaque psoriasis, with a Psoriasis Area and Severity Index (PASI) score of ≥ 12 at screening and at baseline, were recruited and randomized at baseline to receive either placebo, guselkumab, or adalimumab in the VOYAGE 1 phase III clinical trial (Fig. 1) [8, 10]. The results demonstrated high PASI response for guselkumab-treated patients throughout the 5-year clinical trial period, as well as greater efficacy of guselkumab compared with placebo at 16 weeks and compared with adalimumab at Weeks 16, 24, and 48 [8, 11]. Guselkumab has also been shown to have superior efficacy to adalimumab in the VOYAGE 2 clinical trial up to week 48 while maintaining this response over 5 years [11], and superior efficacy to secukinumab in the ECLIPSE clinical trial up to Week 48 [12]. Furthermore, patients derived benefits by switching to guselkumab from ustekinumab in the NAVIGATE clinical trial [13]. One head-to-head clinical trial showed faster skin clearance for ixekizumab compared with guselkumab, with patients in the ixekizumab arm having a slightly larger improvement in PASI from baseline as early as Week 1 [14], although results were only reported up to Week 12, hence long-term comparative data from a clinical trial setting is missing. Numerous real-world studies have also confirmed the efficacy and safety profile of guselkumab, confirming the promising results of clinical trials [15–20].

To better understand the relationship between patient characteristics and long-term clinical response, a post-hoc analysis of the 5-year VOYAGE 1 clinical trial data was conducted among all the patients who started guselkumab at Week 0 or at Week 16 (after switching from placebo), to assess the maintenance of their response to therapy. Specifically, we investigated baseline characteristics and serum guselkumab levels in guselkumab-treated patients who achieved complete skin clearance (PASI = 0) for ≥ 156 consecutive weeks (i.e., without relapse). The aim of this research was to identify factors associated with a positive response to treatment, which may inform personalized treatment regimens and enhance treatment approaches when using guselkumab.

2 Methods

This exploratory post-hoc analysis was performed using the full 5-year dataset of the VOYAGE 1 clinical trial (ClinicalTrials.gov identifier NCT02207231) [11]. Data from patients treated with guselkumab from both Week 0 (guselkumab arm) and Week 16 (placebo crossover arm) who maintained PASI = 0 at all visits for ≥ 156 consecutive weeks of treatment (PASI = 0 group) were compared with data from patients who never achieved PASI = 0 at any visit (comparator group) (Fig. 1). For purposes of assigning participants into these two response groups, missing PASI values were considered to not be 0. Study visits were scheduled at Week 0, Week 2, Week 4, then every 4 weeks up to Week 52, and then every 8 weeks through to the final visit at Week 252. Of note, as this study ended at Week 252, the initial PASI = 0 response needed to occur within the first 96 weeks or first 80 weeks of guselkumab treatment for those starting at Week 0 or Week 16, respectively, in order to fulfil the requirement of at least 156 consecutive weeks of complete skin clearance.

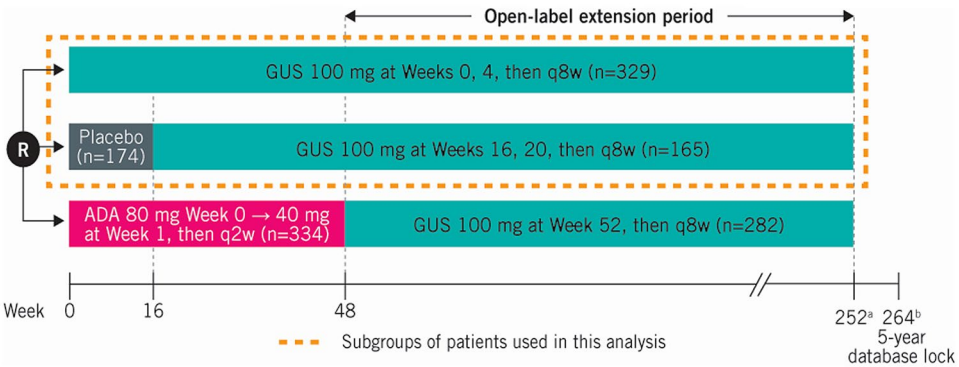

Fig. 1 VOYAGE 1 clinical trial design, including open-label extension through Year 5. [a]The last dose of guselkumab was administered at Week 252; efficacy was evaluated through Week 252. [b]Safety was evaluated through Week 264. *ADA* adalimumab, *GUS* guselkumab, *q2w* every 2 weeks, *q8w* every 8 weeks, *R* randomization

Guselkumab 100 mg was administered by subcutaneous injection at Weeks 0, 4, 12, and every 8 weeks through Week 252 (this corresponds with Weeks 16, 20, and 28 and every 8 weeks through Week 252 of the study for those in the placebo crossover arm).

Descriptive statistics were used to describe baseline characteristics of the two response groups, and a multiple logistic regression model was used to identify factors associated with long-term skin clearance. Based on previous reports [7, 8, 21], relevant baseline patient and disease characteristics incorporated in this post-hoc analysis included age, sex, body weight, body mass index (BMI) group (BMI ≥ 30/BMI < 30), diagnosis of diabetes (collected from the Medical History at screening), current smoking status, psoriasis duration, PASI score, Dermatology Life Quality Index (DLQI) score, presence of psoriatic arthritis (PsA), Investigator Global Assessment score, body surface area (BSA) of psoriasis involvement, prior biologic treatment, and prior treatment with systemic therapy.

In addition, Week 4 guselkumab plasma concentration (Week 4 of the study for those in the guselkumab arm of the study and Week 20 of the study for those in the placebo crossover arm) was also included in the regression model. Guselkumab plasma trough concentrations in both response groups were assessed prior to treatment between Weeks 4 and 156 after the start of guselkumab treatment. Plasma levels at Weeks 4, 8, 16, and 24 were measured 4 weeks after guselkumab treatment; plasma levels at Week 12 and every 8 weeks until Week 156 were measured 8 weeks after guselkumab treatment.

The odds ratios obtained from multiple logistic regression analysis indicate the level of association between each given factor and maintaining a PASI score of 0, with the Wald test to ascertain confidence intervals; p values of ≤ 0.05 indicated a statistically significant association, and p values of ≤ 0.1 identified potential parameters of interest. PASI scores over time, and time to achieving PASI = 0, were also reported. Data from patients assigned to either response group were analyzed as observed, without further imputation.

3 Results

The main results from VOYAGE 1, including comparisons between the placebo crossover arm (before and after crossover) and the guselkumab arm have been reported previously [8]. Of the patients treated with guselkumab from Week 0 (guselkumab arm) and Week 16 (placebo crossover arm), a total of 22.7% (112/494) maintained PASI = 0 at all visits for ≥156 consecutive weeks (Fig. 2a). At Visit 0 of guselkumab treatment, the PASI = 0 group had a mean PASI score of 19.5 and the comparator group a mean baseline PASI score of 22.1. In both the PASI = 0 group and the comparator group, there was a steep decline in PASI values up to Week 12; they plateaued at Week 16 and were generally maintained through to Week 252. In contrast to the PASI = 0 group, the comparator group maintained a mean PASI score of ~ 3 (median ~ 2.5) from Week 16 through to Week 252 (Fig. 2a). By Week 16, 50% of patients in the PASI = 0 group had achieved complete skin clearance (Fig. 2b).

The PASI = 0 group contained a numerically higher proportion of patients in the lowest age category (< 45 years: 53.6% vs 46.8%), a lower proportion of patients with obesity (BMI ≥ 30 kg/m^2: 32.1% vs 48.1%), a lower percentage diagnosed with diabetes (3.6% vs 15.2%), and a lower percentage of current smokers (30.4% vs 36.7%) versus the comparator group. The PASI = 0 group also had a numerically greater prevalence of psoriatic arthritis (PsA) at baseline (23.2% vs 16.5%), lower disease severity (mean PASI score: 20.6 vs 23.4), and shorter duration of psoriasis (mean years: 16.5 vs 18.9) versus the comparator group (Table 1).

The multiple logistic regression analysis revealed no previous diagnosis of diabetes ($p = 0.047$), lower DLQI score (indicating a lower impact of psoriasis on quality of life) at baseline ($p = 0.030$), and higher Week 4 guselkumab plasma concentration ($p = 0.016$) as significantly associated with achieving PASI = 0 at all visits for ≥ 156 consecutive weeks. Obesity and psoriasis duration represent potential additional parameters of interest ($p < 0.1$) for future studies (Fig. 3).

Mean peak and trough guselkumab plasma concentrations were numerically higher in the PASI = 0 group compared with the comparator group at all assessments. After Week 28, trough guselkumab levels of the comparator group ranged from 0.83 to 1.15 µg/mL, while they ranged from 1.04 to 1.40 µg/mL in the PASI = 0 group. Trough concentrations in both groups were relatively stable from Week 28 up to Week 156 of guselkumab treatment (Fig. 4).

4 Discussion

This post-hoc analysis evaluated patients who achieved and maintained complete skin clearance with guselkumab treatment at all study visits in the VOYAGE 1 clinical trial for ≥ 156 consecutive weeks compared with those who never achieved complete skin clearance over the same period. These cohorts were chosen with the aim of identifying factors associated with achieving and maintaining complete skin clearance that may be used to predict treatment outcomes for guselkumab. Our analysis revealed that nearly 25% of patients with moderate-to-severe plaque psoriasis treated with guselkumab maintained complete skin clearance (PASI = 0) for 3 or more consecutive years, with half

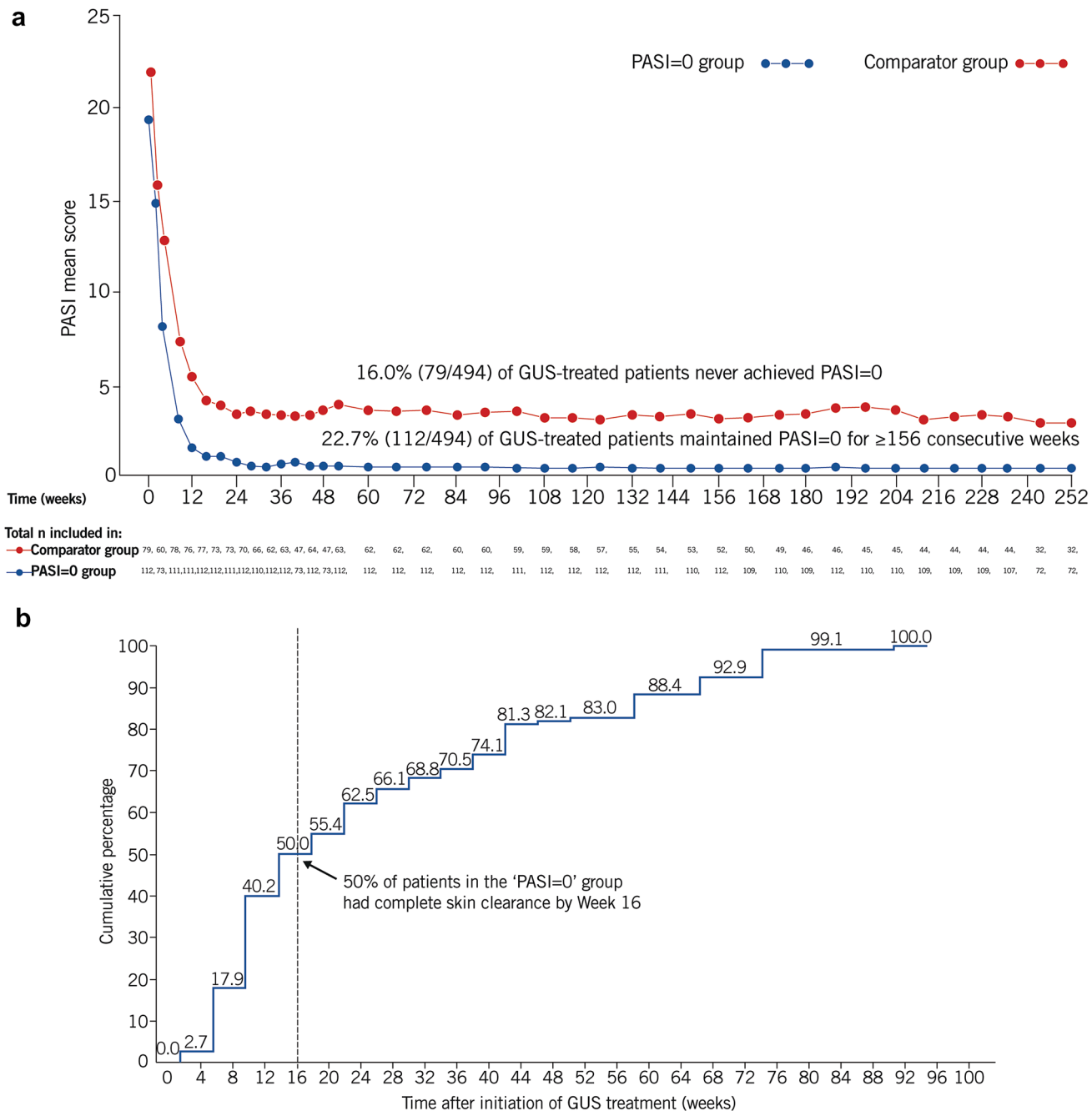

Fig. 2 PASI score **a** comparison between the PASI = 0 group and comparator group over time and **b** cumulative percentage of patients achieving complete skin clearance in the PASI = 0 group (n = 112). Dotted line indicates that half of the patients who achieved PASI = 0 did so within 16 weeks. *GUS* guselkumab, *PASI* Psoriasis Area and Severity Index

of them beginning this period of PASI maintenance at or before Week 16.

To provide the best opportunity for identifying factors associated with maintaining complete skin clearance, we compared the extremes with the comparator group consisting of trial participants who never achieved PASI = 0. Nevertheless, in this group of patients there was still a reduction in mean PASI score from ~ 22 at baseline to between 2 and 4 from Week 16 through to Week 252. According to guidelines provided by the National Institute for Health and Care Excellence (NICE) in the UK, an adequate response is defined as either achieving PASI 75 at 16 weeks from when treatment was initiated or achieving PASI 50 and a 5-point reduction in DLQI at Week 16 from when treatment started [22]. In addition, there is a general consensus that the therapeutic goal for psoriasis should

Table 1 Baseline demographics and clinical characteristics of the PASI = 0 and comparator groups

	PASI = 0 (n = 112)	Comparator[a] (n = 79)	Odds ratio (95% Wald confidence limits), p-value
Age, years	43.2 (40.9–45.5)	44.5 (41.8–47.2)	1.001 (0.968–1.035), $p = 0.941$
Age category, %			
< 45 years	53.6 (43.9–63.1)	46.8 (35.5–58.4)	–
≥ 45 to < 65 years	42.0 (32.7–51.7)	49.4 (37.9–60.9)	–
≥ 65 years	4.5 (1.5–10.1)	3.8 (0.8–10.7)	–
Male, %	74.1 (65.0–81.9)	70.9 (59.6–80.6)	1.344 (0.564–3.204), $p = 0.505$
Weight, kg	86.7 (82.4–91.1)	89.0 (84.1–93.9)	1.021 (0.995–1.048) $p = 0.120$
BMI, kg/m^2	28.5 (27.3–29.7)	30.2 (28.7–31.7)	0.391 (0.131–1.162) $p = 0.091$
BMI category, %			
< 25 kg/m^2	28.6 (20.4–37.9)	24.1 (15.1–35.0)	–
≥ 25 to < 30 kg/m^2	39.3 (30.2–49.0)	27.9 (18.4–39.1)	–
≥ 30 kg/m^2	32.1 (23.6–41.6)	48.1 (36.7–59.6)	–
PASI score	20.6 (19.3–21.9)	23.4 (20.8–26.0)	1.018 (0.942–1.100) $p = 0.651$
BSA involvement, %	26.0 (23.5–28.5)	31.6 (26.7–36.5)	0.988 (0.952–1.024) $p = 0.506$
Disease duration, years	16.5 (14.5–18.6)	18.9 (16.4–21.4)	0.971 (0.937–1.005) $p = 0.091$
Age at diagnosis, years	26.8 (24.2–29.4)	25.7 (23.0–28.4)	–
Prior biologic therapies, n	0.2 (0.1–0.4)	0.3 (0.1–0.4)	1.196 (0.497–2.878) $p = 0.690$
Systemic biologic-naïve patients, %	26.8 (18.9–36.0)	27.9 (18.4–39.1)	0.700 (0.302–1.621) $p = 0.405$
PsA prevalence, %	23.2 (15.8–32.1)	16.5 (9.1–26.5)	2.144 (0.818–5.619) $p = 0.121$
Diabetic, %	3.6 (1.0–8.9)	15.2 (8.1–25.0)	0.225 (0.052–0.977) $p = 0.047$
Current smoker, %	30.4 (22.0–39.8)	36.7 (26.1–48.3)	0.678 (0.334–1.347) $p = 0.281$
Current alcohol consumption, %	58.0 (48.3–67.3)	58.2 (46.6–69.2)	–

Data are mean or % (95% CI)

BMI body mass index, *BSA* body surface area, *CI* confidence interval, *PASI* Psoriasis Area and Severity Index, *PsA* psoriatic arthritis

[a]Patients who never achieved PASI = 0 at any visit

be achieving an absolute PASI score of ≤ 3 or a PASI90 response [23]. Based on this guidance, the > 85% reduction in PASI score, and PASI scores plateauing at around 3 for the comparator group, suggests that these patients had an overall adequate response to guselkumab at Week 16. This, in turn, highlights the challenge of finding significant differences between the PASI = 0 and comparator group. Notably, some factors were associated with long-term skin clearance in the univariable analysis but not the multivariable analysis, including age and BMI (treated as a categorical variable, BMI ≥ 30 or BMI < 30), despite a higher proportion of patients under 45 years of age and a lower proportion of BMI ≥ 30 patients in the PASI = 0 group. The reason for this difference is unclear but may reflect insufficient power and the generally small sample size in the multivariable analysis.

Previously, body weight has been shown to impact the clinical response of biologic treatment [24, 25], with several studies reporting its association with greater drug clearance and volume of distribution, resulting in lower overall systemic exposure [26]. Some studies have further supported this by showing a negative impact of higher body weight on the likelihood of a clinical response [24, 25, 27]; however, other work investigating biologic treatments reported weight having no significant impact on clinical response [26–28]. Here, we showed weight (treated as a continuous variable, in increments of 1 kg) did not demonstrate a trend in the descriptive analysis between the groups and also suggested no significant association with PASI response as shown by the multiple logistic regression analysis; when investigating the odds ratio of Week 4 guselkumab plasma concentrations, weight and BMI were included as independent variables and therefore cannot explain the observed effect of guselkumab plasma levels. The lack of effect of weight on treatment outcomes in guselkumab-treated patients is in line with previous subgroup analyses of the VOYAGE trials [29, 30], and suggests that patients with higher body weight do not benefit from increased dosage.

A previous report investigating the effects of diabetes on guselkumab plasma concentration demonstrated 12% higher apparent clearance of guselkumab in patients with this metabolic disorder, indicating marginally reduced guselkumab

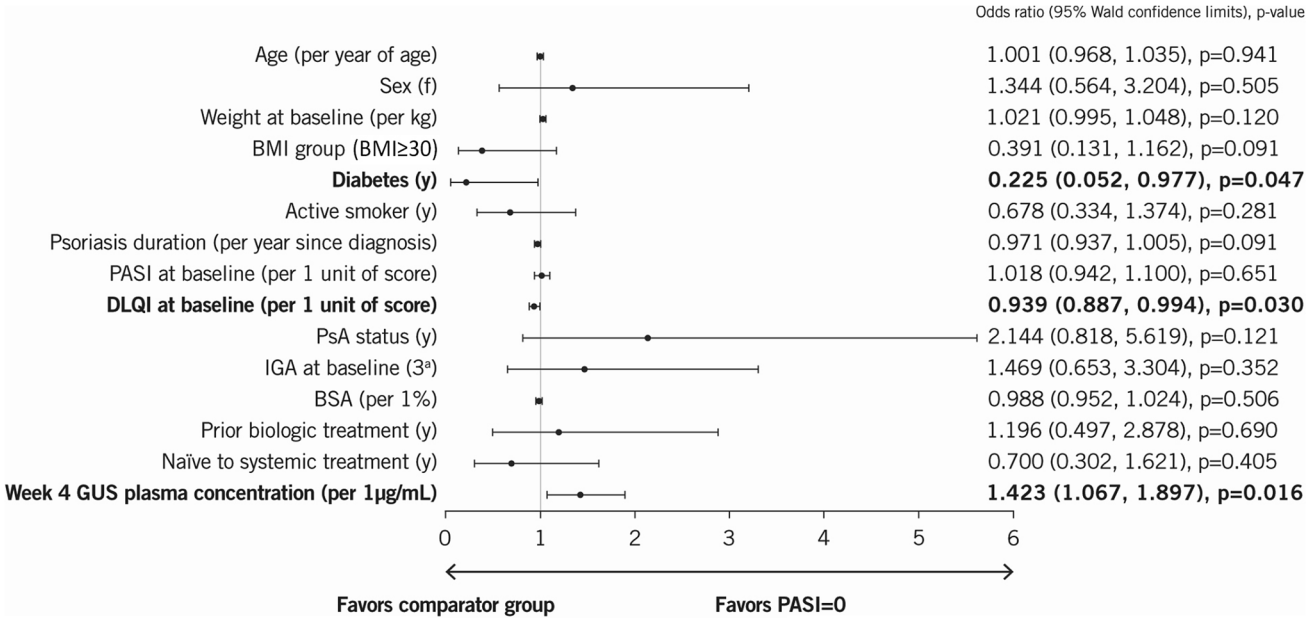

Fig. 3 Multiple logistic regression of factors influencing treatment response**.** Error bars represent 95% Wald confidence limits**.** This analysis represents ORs, where OR = 1 indicates exposure does not affect odds of maintaining PASI = 0, OR > 1 indicates factors associated with higher odds of maintaining PASI = 0, and OR < 1 refers to exposure associated with lower odds of maintaining PASI = 0. [a]Categorical scores for IGA at baseline were either 3 or 4. *BMI* body mass index, *BSA* body surface area, *DLQI* Dermatology Life Quality Index, *GUS* guselkumab, *IGA* Investigator Global Assessment, *OR* odds ratio, *PASI* Psoriasis Area and Severity Index, *PsA* psoriatic arthritis

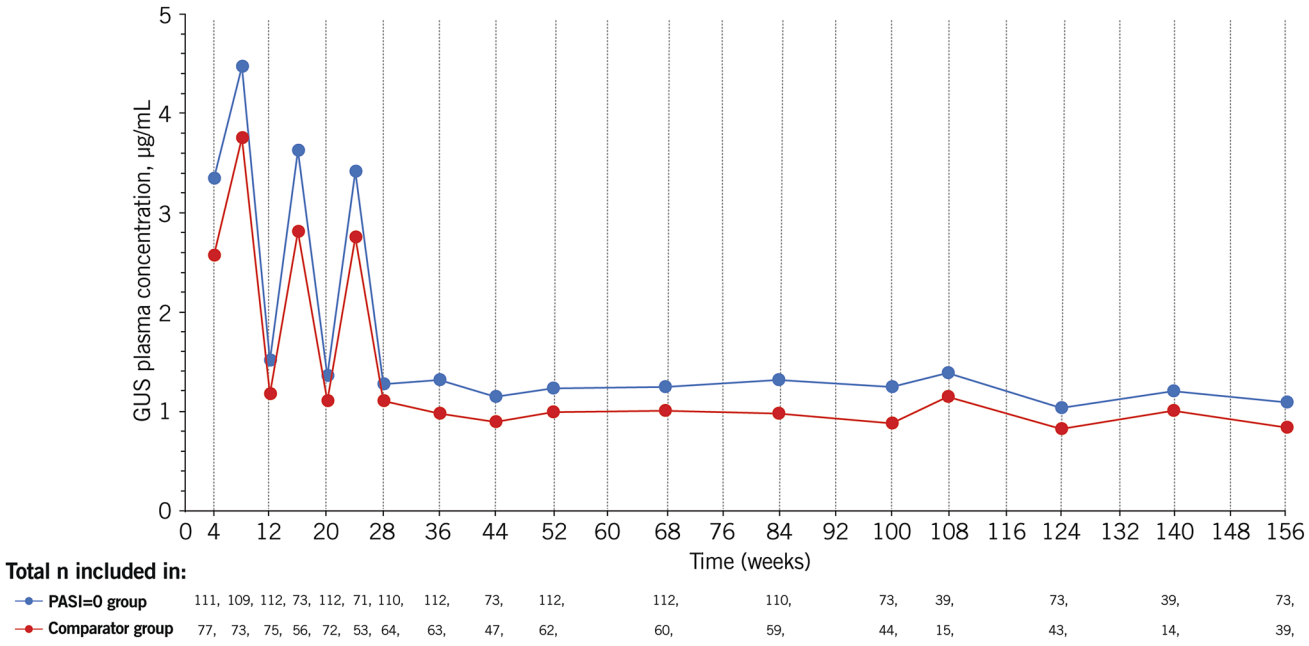

Fig. 4 Comparison of mean guselkumab serum concentration between the PASI = 0 group and comparator group over time**.** Guselkumab plasma trough concentrations were assessed prior to treatment and between Weeks 4 and 156 from the start of guselkumab treatment. Plasma levels at Weeks 4, 8, 16, and 24 were measured 4 weeks after guselkumab treatment; plasma levels at Week 12 and every 8 weeks until Week 156 were measured 8 weeks after guselkumab treatment. Guselkumab or placebo administrations during the first 156 weeks are indicated by *dashed lines* in the figure. From Week 28 onwards, only trough levels were assessed. Data from visits where $n \leq 3$ have been excluded. *GUS* guselkumab, *PASI* Psoriasis Area and Severity Index

exposure in diabetic patients [31]. Among those receiving guselkumab for treating psoriatic arthritis, diabetes and body weight have also been identified as factors contributing to pharmacokinetic variability of treatment [32]. Similar reports with other biologics, such as ustekinumab, demonstrate increased clearance in patients with diabetes, and real-world evidence has demonstrated a lower response to risankizumab in patients with a BMI ≥ 30 [33], suggesting that this association may be more broadly associated with biologic therapy [34]. The association between obesity and diagnosed diabetes could have a compounded effect with the elevated clearance and volume of distribution seen in patients with greater body weight [35]. However, in the logistic regression model, the effect of diabetes was still present after weight and BMI were taken into account, and the absence of a diabetes diagnosis was still associated with long-term skin clearance when guselkumab plasma levels were controlled for; taken together, these findings suggest an additional mechanism to those seen in individuals with greater body weight. Nonetheless, this analysis further highlights, in contrast to our findings for weight and BMI, the possibility that absent history of diabetes could be considered predictive for long-term stable response; notably, guidelines recommend screening for diabetes in clinical practice [36]. Further, increased drug clearance in diabetic patients may introduce clinically relevant effects when investigating strict endpoints, such as PASI = 0 and DLQI 0/1.

While higher plasma concentration of guselkumab at Week 4 was found to be significantly associated with long-term maintenance of PASI = 0, the difference in guselkumab concentration between the two response groups does not appear to be due to differences in the stability of plasma concentrations, as demonstrated by the consistency of the trough levels for both groups throughout the treatment period. Studies on the effect of different therapeutic antibodies in the target tissues are ongoing [37] and could provide further insights related to this.

Lower DLQI score (indicating lower impact of psoriasis on quality of life) at baseline was identified as significantly associated with long-term complete skin clearance in the multiple logistic regression model. While changes in PASI and DLQI scores are known to be correlated [38, 39], patient-reported outcomes, such as DLQI, capture additional nuances to standard physician measurements [38]. The potential reasons for and relevance of the association between lower DLQI score at baseline and achieving and maintaining long-term PASI = 0, is unknown at this stage. The importance of providing a holistic approach to addressing important aspects of psoriasis treatment, such as quality of life, has been highlighted in multiple consensus studies. A US-based consensus exercise in 2017 concluded that a reasonable response after 3 months of treatment would be a reduction in BSA of 3% or improvement of ≥ 75% from baseline, and that the use of a single criterion was most preferred when assessing the achievement of treatment goals. However, in the pre-Delphi workshops of this consensus exercise, patients expressed that BSA does not capture several important aspects of the disease, including location, symptoms, and quality of life [40]. A more recent consensus exercise, which also included patients, defined freedom from disease in psoriasis as a multifaceted concept with five key domains: management of clinical symptoms, healthcare team support, psychosocial elements, treatment, and quality of life and well-being [5]. Therefore, obtaining long-term skin clearance may contribute towards patients achieving 'freedom from disease', however additional aspects, such as quality of life endpoints, are also important and require addressing; further studies are needed to better understand the association between baseline DLQI score and long-term skin clearance.

Duration of psoriasis was identified as a factor of interest from the multiple logistic regression model, supporting previous findings demonstrating that more time living with the disease significantly impacted the likelihood of achieving PASI 90–100 response compared with achieving PASI < 50 [41]. It has also been shown that patients with longer disease duration are more likely to have had a greater variety of previous therapies for psoriasis [42]. Further studies, such as the GUIDE clinical trial, which compares outcomes for patients with short disease duration (< 2 years) versus long disease duration, may be able to provide additional insight into this [43].

A numerically greater percentage of individuals who achieved and maintained complete skin clearance had never smoked. In agreement with this, smoking has also been shown, using a fixed-effects model, to negatively impact the efficacy of biologic drugs [44]. However, in the model used in this post-hoc analysis, this factor was not identified as predictive for long-term skin clearance. We also observed a numerically higher percentage of patients with psoriatic arthritis in the PASI = 0 group, despite previous research demonstrating biologics to have similar efficacy on patients regardless of psoriatic arthritis status [45]. This may represent an interesting area for future investigations, though this result was not confirmed in the regression model and may, therefore, simply be a consequence of the small sample size.

A limitation of this post-hoc analysis is that a relatively small number of patients were included due to the criteria for defining each of the response groups based on the extremes of consistently or never achieving PASI = 0. Furthermore, it is important to consider that a PASI100 response is not always indicative that a patient is no longer impacted by their disease. While this may be the case for the majority, residual disease impact can still sometimes be observed by other measures, such as

DLQI [46]. The number of patients included was also limited due to the inability to combine data from the VOYAGE 1 and 2 clinical trials for guselkumab, as the latter had a withdrawal phase, and its inclusion would therefore potentially introduce bias to the results. In addition, there are several limitations that apply to post-hoc analyses generally, which should also be considered when interpretating the results; specifically, subgroups were not randomized and a control group is absent.

Nonetheless, the findings observed in this post-hoc analysis are in line with recent real-world research demonstrating that guselkumab has high efficacy in spite of comorbidities [18, 20]. The emphasis on the value of real-world evidence in recent years stems from the fact that these observational studies include patients typically excluded by the rigid inclusion and exclusion criteria of clinical trials, such as patients with multiple comorbidities or concomitant infections. Our findings expand upon this research showing how certain comorbidities and baseline characteristics can affect treatment outcomes. Further research into how certain characteristics can influence psoriasis treatment outcomes should be conducted in a real-world context to further evaluate these relationships.

5 Conclusion

This is the first analysis evaluating patients who achieved complete skin clearance for ≥ 156 consecutive weeks versus those who never achieved this over the same period. Our analysis showed that a substantial number of patients treated with guselkumab maintained complete skin clearance for at least 156 consecutive weeks. The absence of previously diagnosed diabetes, lower DLQI score at baseline (indicating lower impact of psoriasis on quality of life), and higher Week 4 guselkumab plasma concentration were identified as factors associated with patients achieving long-term skin clearance. This analysis provides insights into factors that could play a role in achieving a long-term treatment response, and for which screening should be conducted as part of the general management of psoriasis, in order to give patients the best chance at achieving long-term positive outcomes.

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Declarations

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Competing interests LP reports consulting fees from AbbVie, Almirall, Amgen, Biogen, Boehringer Ingelheim, Bristol Myers Squibb, Janssen, JS BIOCAD, Leo-Pharma, Lilly, Novartis, Pfizer, Sandoz, Samsung-Bioepis, and UCB; payment or honoraria from Janssen, Lilly, Novartis, and UCB; support for attending meetings and/or travel from Janssen and UCB; grants received from Abbvie, Almirall, Amgen, Boehringer Ingelheim, Janssen, Leo-Pharma, Lilly, Novartis, and UCB; and a non-financial relationship with the International Psoriasis Council. AC reports consulting fees from AbbVie and UCB; payment or honoraria from AbbVie, Almirall, Amgen, Galderma, Janssen, Lilly, Novartis, and UCB; support for attending meetings and/or travel from AbbVie; and participation on a Data Safety Monitoring Board and/or Advisory Board for AbbVie, Almirall, Amgen, Boehringer Ingelheim, Janssen, Leo-Pharma, Lilly, Novartis, and UCB. EMGJdJ reports receiving research grants from AbbVie, BMS, Janssen Pharmaceutica, Leo Pharma, Lilly, Novartis, and UCB; and has acted as a consultant, paid speaker, and/or participated in research sponsored by companies that manufacture drugs used for the treatment of psoriasis or eczema, including AbbVie, Almirall, Amgen, Boehringer-Ingelheim, Celgene, Galapagos, Janssen Pharmaceutica, Leo Pharma, Lilly, Novartis, Sanofi, and UCB. TT reports consulting fees from AbbVie, Almirall, Amgen, Arena Pharmaceuticals, Biocad, Boehringer Ingelheim, Bristol-Myers Squibb, Celgene, Eli Lilly, Janssen, Leo Pharma, MSD, Novartis, Pfizer, Samsung-Bioepis, Sandoz, and Sanofi; payment or honoraria from AbbVie, Almirall, Boehringer Ingelheim, Bristol-Myers Squibb, Eli Lilly, Janssen, Leo Pharma, MSD, Novartis, Pfizer, Sandoz, and Sanofi; support for attending meetings and/or travel from AbbVie, Almirall, Janssen, Leo Pharma, MSD, Novartis, Pfizer, and Sanofi; and participation on a Data Safety Monitoring Board and/or Advisory Board for Samsung-Bioepis. RBW reports consulting fees from AbbVie, Almirall, Amgen, Arena, Astellas, Avillion, Biogen, Boehringer Ingelheim, Bristol Myers Squibb, Celgene, DiCE, GSK, Janssen, Leo, Lilly, Novartis, Pfizer, Sanofi, Sun Pharma, UCB, and UNION; payment or honoraria from AbbVie, Almirall, Boehringer Ingelheim, Bristol Myers Squibb, Celgene, Janssen, Leo, Lilly, Novartis, Pfizer, Sanofi, Sun Pharma, and UCB; and grants received from AbbVie, Almirall, Janssen, Leo, Lilly, Novartis, Pfizer, and UCB. RW holds stock at Johnson & Johnson and was a full-time employee of Janssen at the time of the study. SW is a full-time employee of and owns stock at Janssen. PG is a full-time employee at Janssen. TG is a full-time employee at Janssen. MJ holds stocks at Johnson & Johnson and is a full-time employee at Janssen. JB is a full-time employee at Janssen. CC reports consulting fees from AbbVie, Amgen, Boehringer Ingelheim, Bristol-Myers Squibb, Celgene, Eli Lilly, Galderma, Incyte, Janssen, LEO Pharma, MSD, Novartis, Pfizer, Samsung, Sanofi, and UCB; payment or honoraria from AbbVie, Amgen, Boehringer Ingelheim, Bristol-Myers Squibb, Celgene, Eli Lilly, Galderma, Incyte, Janssen, LEO Pharma, Novartis, Pfizer, Sanofi, and UCB; participation on a Data Safety Monitoring Board and/or Advisory Board for AbbVie, Amgen, Boehringer Ingelheim, Bristol-Myers Squibb, Celgene, Eli Lilly, Galderma, Janssen, LEO Pharma, MSD, Novartis, Pfizer, and UCB; grants received from AbbVie, Amgen, Boehringer Ingelheim, Celgene, Eli Lilly, Galderma, Janssen, LEO Pharma, Novartis, and Pfizer; and leadership and/or fiduciary roles for the European Society for Dermatological Research and the Swiss Society for Dermatology and Venereology.

Ethics approval This study was conducted in accordance with the ethical principles that have their origin in the Declaration of Helsinki and that are consistent with Good Clinical Practices and applicable regulatory requirements. Given that this is a post-hoc analysis of the VOYAGE 1 clinical trial, ethical approval was not needed.

Consent to participate Patients provided their written consent to participate in the study after having been informed about the nature and

purpose of the study, participation/termination conditions, and risks and benefits of treatment.

Consent to publish Not applicable.

Data availability statement The data sharing policy of Janssen Pharmaceutical Companies of Johnson & Johnson is available at https://www.janssen.com/clinical-trials/transparency. As noted on this site, requests for access to the study data can be submitted through the Yale Open Data Access (YODA) Project site at http://yoda.yale.edu.

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