Exploration of Musculoskeletal Diseases

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Open Access Review

Biologics and biosimilars in musculoskeletal diseases: addressing regulatory inconsistencies and clinical uncertainty

Lauren N. McGrath[1*], David Moodie[2], Steven R. Feldman[1,3,4]

[1]Center for Dermatology Research, Department of Dermatology, Wake Forest University School of Medicine, Winston-Salem, NC 27104, United States

[2]University of Central Florida College of Medicine, Orlando, FL 32827, United States

[3]Department of Pathology, Wake Forest University School of Medicine, Winston-Salem, NC 27104, United States

[4]Department of Social Sciences & Health Policy, Wake Forest University School of Medicine, Winston-Salem, NC 27104, United States

***Correspondence:** Lauren N. McGrath, Center for Dermatology Research, Department of Dermatology, Wake Forest University School of Medicine, 4618 Country Club Road, Winston-Salem, NC 27104, United States. lauren.mcgrath@students.jefferson.edu

Academic Editor: Valderilio Feijó Azevedo, Federal University of Paraná, Brazil

Received: February 15, 2025 **Accepted:** July 2, 2025 **Published:** July 21, 2025

Cite this article: McGrath LN, Moodie D, Feldman SR. Biologics and biosimilars in musculoskeletal diseases: addressing regulatory inconsistencies and clinical uncertainty. Explor Musculoskeletal Dis. 2025;3:100798. https://doi.org/10.37349/emd.2025.100798

Abstract

Biologics are complex protein-based medications derived from living organisms, used primarily to treat immune-related diseases. Unlike small-molecule drugs synthesized from chemicals, biologics are produced using advanced biotechnology, making their replication difficult. Biosimilars are nearly identical alternatives to biologics, and they offer a cost-effective option that produces equivalent safety or efficacy outcomes as their reference biologics. Biosimilars are not classified as generic drugs and have a unique regulatory pathway. While biosimilars must demonstrate structural, functional, and clinical similarity to reference biologics, regulatory requirements vary across the US Food and Drug Administration (FDA), the European Medicines Agency (EMA), and the World Health Organization (WHO). The FDA used to mandate clinical studies for interchangeability status, while the EMA and WHO had more flexible approval pathways that enable broader biosimilar adoption. However, the FDA's approach is evolving, and they may grant interchangeability with scientific justification without separate switching studies. Regulatory inconsistencies extend beyond biosimilars, as batch-to-batch variability in brand-name biologics does not face the same scrutiny as biosimilar approvals. Addressing these regulatory disparities and greater alignment among the FDA, EMA, and WHO may enhance biosimilar adoption. Acceptance of biosimilars may expand treatment accessibility, reduce healthcare costs, and maintain standards of safety and efficacy in managing musculoskeletal diseases.

Keywords

Biosimilars, biologic medications, biopharmaceuticals, reference products, interchangeability

Introduction

Biologics or biologic therapies have transformed the treatment of musculoskeletal disease (MSD), including psoriatic arthritis (PsA), rheumatoid arthritis (RA), and ankylosing spondylitis (AS). These medications are derived from the cells of living organisms using biotechnology and processes such as gene cloning and expression in recombinant DNA technology [1]. They are designed to target specific components of the immune system to control inflammation and disease progression. While efficacious, these medications are costly, and competition was introduced through the development of less-expensive biosimilar alternatives. Biosimilars have, by definition, similar efficacy and safety to their reference biologic counterparts.

Detecting change in patients' disease progression, symptoms, and debility in MSDs such as PsA, RA, and AS can be difficult due to the reliance on patients' subjective symptom reporting in clinical assessments. In contrast, the closely related dermatologic condition, psoriasis, provides an objective and visible outcome—skin lesions—that does not depend on patient-reported symptoms. Psoriasis severity can be quantitatively assessed using validated measures such as the Psoriasis Area and Severity Index (PASI) or body surface area (BSA), providing an objective metric for treatment response. Psoriasis is a valuable model for evaluating the similarity between biosimilars and biologics for PsA, as it is typically treated with biologic monotherapy. This approach minimizes confounding factors such as concomitant methotrexate or steroid use, that commonly used in MSD therapy, that could mask differences in immunogenicity.

There are regulatory inconsistencies despite growing evidence supporting biosimilar use in MSDs. Initially, the US Food and Drug Administration (FDA) mandated additional phase III clinical trials for interchangeability. This is no longer the case for every biosimilar candidate, as the FDA is now accepting scientific justification not necessarily from switching studies. Conversely, the European Medicines Agency (EMA) allows broader substitution based on analytical and pharmacokinetics and pharmacodynamics (PK-PD) data. The World Health Organization (WHO) has proposed that PK-PD studies may be sufficient for biosimilarity assessment; this would streamline approvals and eliminate the need for large-scale clinical trials. This review examines the global regulatory landscape and real-world adoption of biosimilars in MSD treatment.

Biosimilars versus biologics: What is the difference?

Biologic medications are complex proteins derived from the cells of living organisms using advanced biotechnology and elaborate processes such as gene cloning and expression in recombinant DNA technology [1]. Unlike small-molecule drugs, which are chemically synthesized and structurally uniform, biologics are large, intricate proteins such as monoclonal antibodies or receptor modulators. Additionally, unlike these small-molecule drugs, biologics are designed to target specific components of the immune system. Due to factors such as their large molecular size, complex structure, and variability in manufacturing and environmental conditions, biologics inherently exhibit inter-batch variability, which makes it challenging for manufacturers to produce identical copies, even with the same production process [2]. Biosimilars are near-identical structural and functional alternatives to approved biologics, similar to the concept of generic drugs [3]. Today's batches of biologics are not identical to the original version approved years ago. For example, the original infliximab medication was approved in 1988; production of this drug for the past 37 years has resulted in shifts in the drug that have not affected its efficacy. The FDA is not conducting phase III trials on the 2025 version of infliximab to compare it to the original 1988 infliximab. Therefore, we have no more up-to-date clinical data for the current reference product than we do for its biosimilar counterpart.

Biosimilars are near-identical structural and functional alternatives to approved biologics, similar to the concept of generic drugs [3]. The current complex process of creating and replicating biologic drugs always leads to some degree of variation between batches, which may lead to some concerns about the efficacy and safety of successive batches. Through the FDA's process of extrapolation, biosimilars can mostly be used for every indication for which their brand-name counterpart is used, once approved, without additional phase III clinical trials [3, 4]. The only caveat to this statement is that some biosimilars have "skinny labels", which include approval only for specific indications.

FDA biosimilar approval process

Before FDA regulatory approval, biosimilars must first demonstrate they meet strict quality factors and have no clinically meaningful differences in safety, purity, or potency compared to the reference biologic. The FDA's process begins with structural characterization. Biosimilars must exhibit near-identical structural and functional similarity, including the same post-translational modifications, same amino acid sequences, and end-product stability compared to the original reference biologic (Table 1) [3, 5]. Once this is established, biosimilars must demonstrate in vivo and in vitro similarity regarding PD, toxicity, and immunogenicity. While in vivo animal studies are still required, the FDA has announced that they plan on phasing out or reducing animal testing; they are now encouraging investigational new drug applications to utilize NAMs (New Approach Methodologies) data instead, which consist of AI-based models and cell lines [6]. Although meeting these preclinical criteria implies that biosimilars would perform the same as their counterparts, the FDA still requires additional clinical data in their approval process (Table 2) [7].

Table 1. Factors compared between biologics and biosimilars in the FDA approval process [3, 5]

Factors compared between biologics and biosimilars
1. Sequence of amino acids
2. Potency
3. Post-translational modifications
4. Analysis of impurities
5. Binding affinity to target
6. End-product stability
7. Molecular weight
8. Delivery device
9. Antibody-dependent cell-mediated phagocytosis
10. Antibody-dependent cell-mediated cytotoxicity
11. Receptor specificity
12. Receptor binding
13. Receptor signaling

FDA: Food and Drug Administration

Table 2. FDA regulatory process for biologics versus biosimilars approval [3]

Process	Biologic	Biosimilar
Quality factors	Characterization of product (target selection, molecular design, etc.)	Characterization of product (target selection, molecular design, etc.); comparison to the original biologic
Preclinical	In vivo and in vitro study demonstrating pharmacodynamics, toxicity, and immunogenicity profile	In vivo and in vitro study demonstrating similarity of pharmacodynamics, toxicity, and immunogenicity profile compared to the original biologic
Clinical	Phase I clinical trials	Phase I clinical trials
	Phase II clinical trials	Phase II clinical trials are not required
	Phase III clinical trials with a large sample size, for all indications	Initially, the FDA did require a switching arm against the reference product. In interchangeability trials, multiple switches were required, too. Phase III clinical trials are no longer an absolute requirement for approval

FDA: Food and Drug Administration

In phase I clinical trials, biosimilars must demonstrate comparable safety, PK-PD to the original reference biologic. Biosimilars are not required to undergo phase II clinical trials, which typically consist of randomized, controlled studies evaluating primary disease outcomes, symptomatic improvement, and disease biomarker changes. Biosimilars were previously required to undergo phase III clinical trials where they had to prove similar efficacy, safety, and immunogenicity in a single indication rather than every approved condition of the reference biologic. This allowed biosimilar manufacturers to avoid expensive clinical testing, which allows for reduced market prices [3]. However, the FDA now states that biosimilar

manufacturers may omit phase III trials if sufficient evidence of similarity is demonstrated through structural, functional, PK, and immunogenicity analyses [8].

While the FDA permits extrapolation of biosimilar indications based on totality of evidence, some physicians feel hesitant due to the lack of phase III clinical trial data for other indications. Among surveyed physicians, 54–94% of physicians were confident in prescribing biosimilars, but 65–67% expressed concerns, most related to safety, efficacy, and immunogenicity [9]. However, perceptions of biosimilar safety may vary depending on a physician's experience and their field of expertise. Physicians who frequently prescribe biosimilars may feel more confident in extrapolation, while those less familiar may be more cautious. Although every batch of a reference biologic has some degree of variability, concerns are more often directed toward biosimilars, despite the fact that biosimilars are typically supported by more extensive comparative testing than the current batches of originator products.

Interchangeability of biosimilars

The FDA defines an interchangeable medication as one that can be substituted for its reference product at a pharmacy without permission from the prescribing physician [10]. The FDA generally requires biosimilars to undergo treatment-switching studies before they can be classified as interchangeable. Some products, such as insulin glargine and ranibizumab, have received interchangeability status without switching studies. More recently, certain adalimumab biosimilars have also been granted interchangeability or provisional designations without completing formal switching trials. Treatment-switching studies, sometimes referred to as clinical-switching studies, are randomized controlled trials that involve switching patients from the control group (i.e., original biologic) to the experimental group (i.e., biosimilar) to observe any changes in patient outcomes. As of June 2025, eight biosimilars of adalimumab have been approved by the FDA for interchangeable status (Table 3) [11, 12]. In a 12-month observational study, patients with axial spondyloarthritis originally on adalimumab who were transitioned to a biosimilar experienced a similar low disease activity and no change in CRP (C-reactive protein) levels; the one-year drug retention rate for these patients on the adalimumab biosimilar was 94.6% [13]. While there is batch-to-batch variation in innovator products, no switching studies are required for switches between batches of an innovator product.

Table 3. Biosimilars approved by the FDA for MSDs [11, 12]

Biosimilar name (active ingredient)	Reference biologic	Original approval date	Indications	Interchangeability
Abrilada (adalimumab-afzb)	Humira (adalimumab)	September 2016	RA, JIA, PsA, AS, CD, UC, PsO	Yes
Amjevita (adalimumab-atto)	Humira (adalimumab)	September 2016	RA, JIA, PsA, AS, CD, UC, PsO	Yes
Avsola (infliximab-axxq)	Remicade (infliximab)	December 2019	RA, PsA, AS, CD, UC, PsO	No
Avtozma (tocilizumab-anoh)	Actemra (tocilizumab)	January 2025	RA, GCA, PJIA, SJIA, COVID-19	Yes
Cyltezo (adalimumab-adbm)	Humira (adalimumab)	August 2017	RA, JIA, PsA, AS, CD, UC, PsO	Yes
Erelzi (etanercept-szzs)	Enbrel (etanercept)	August 2016	RA, JIA, PsA, AS, PsO	No
Eticovo (etanercept-ykro)	Enbrel (etanercept)	April 2019	RA, JIA, PsA, AS, PsO	Yes (only 25 mg/0.5 mL, 50 mg/mL)
Hadlima (adalimumab-bwwd)	Humira (adalimumab)	July 2019	RA, JIA, PsA, AS, CD, UC, PsO	Yes
Hulio (adalimumab-fkjp)	Humira (adalimumab)	July 2020	RA, JIA, PsA, AS, CD, UC, PsO	Yes
Hyrimoz (adalimumab-adaz)	Humira (adalimumab)	October 2018	RA, JIA, PsA, AS, CD, UC, PsO	Yes
Idacio (adalimumab-aacf)	Humira (adalimumab)	December 2022	RA, JIA, PsA, AS, CD, UC, PsO, HS, UV	No

Table 3. Biosimilars approved by the FDA for MSDs [11, 12] (*continued*)

Biosimilar name (active ingredient)	Reference biologic	Original approval date	Indications	Interchangeability
Imuldosa (ustekinumab-srlf)	Stelara (ustekinumab)	October 2024	PsO, PsA, CD, UC	No
Inflectra (infliximab-dyyb)	Remicade (infliximab)	April 2016	RA, PsA, AS, CD, UC, PsO	No
Ixifi (infliximab-qbtx)	Remicade (infliximab)	December 2017	RA, PsA, AS, CD, UC, PsO	No
Otulfi (ustekinumab-aauz)	Stelara (ustekinumab)	September 2024	PsO, PsA, UC, CD	Yes
Pyzchiva (ustekinumab-sbdc)	Stelara (ustekinumab)	October 2023	PsA, CD, UC, PsO	Yes
Renflexis (infliximab-abda)	Remicade (infliximab)	April 2017	RA, PsA, AS, CD, UC, PsO	No
Riabni (rituximab-arrx)	Rituxan (rituximab)	December 2020	RA, NHL, CLL, GPA, MPA, PV	No
Ruxience (rituximab-pvvr)	Rituxan (rituximab)	July 2019	RA, NHL, CLL, GPA, MPA, PV	No
Selarsdi (ustekinumab-aekn)	Stelara (ustekinumab)	April 2024	PsA, CD, UC, PsO	Yes
Simlandi (adalimumab-ryvk)	Humira (adalimumab)	February 2024	RA, JIA, PsA, AS, CD, UC, PsO	Yes
Starjemza (ustekinumab-hmny)	Stelara (ustekinumab)	May 2025	PsO, PsA, UC, CD	Yes
Steqeyma (ustekinumab-stba)	Stelara (ustekinumab)	December 2024	PsO, PsA, CD, UC	Yes
Tofidence (tocilizumab-bavi)	Actemra (tocilizumab)	September 2023	RA, GCA, PJIA, SJIA, COVID-19	No
Truxima (rituximab-abbs)	Rituxan (rituximab)	November 2018	RA, NHL, CLL, GPA, MPA	No
Tyenne (tocilizumab-aazg)	Actemra (tocilizumab)	March 2024	RA, GCA, PJIA, SJIA, CRS, COVID-19	No
Wezlana (ustekinumab-auub)	Stelara (ustekinumab)	October 2023	PsO, PsA, CD, UC	Yes
Yesintek (ustekinumab-kfce)	Stelara (ustekinumab)	November 2024	PsO, PsA, UC, CD	Yes
Yuflyma (adalimumab-aaty)	Humira (adalimumab)	May 2023	RA, JIA, PsA, AS, CD, UV, PsO, HS	Yes
Yusimry (adalimumab-aqvh)	Humira (adalimumab)	December 2021	RA, JIA, PsA, AS, CD, UC, PsO	No

AS: ankylosing spondylitis; CD: Crohn's disease; CLL: chronic lymphocytic leukemia; CRS: cytokine release syndrome; FDA: Food and Drug Administration; GCA: giant cell arteritis; GPA: granulomatosis with polyangiitis; HS: hidradenitis suppurativa; JIA: juvenile idiopathic arthritis; MPA: microscopic polyangiitis; MSD: musculoskeletal disease; NHL: non-Hodgkin's lymphoma; PJIA: polyarticular juvenile idiopathic arthritis; PsA: psoriatic arthritis; PsO: plaque psoriasis; PV: pemphigus vulgaris; RA: rheumatoid arthritis; SJIA: systemic juvenile idiopathic arthritis; UC: ulcerative colitis; UV: urticarial vasculitis

EMA and EU biosimilar approval process

The EMA regulates the approval of biosimilars in the European Union (EU). Similar to the FDA's approval process, the EU begins with structural and functional analyses of the biosimilars, where they must demonstrate near-identical molecular characteristics to their reference biologics, including amino acid sequence, post-translational modifications, and receptor binding [14]. Then, higher-order structure and biological activity assessments that look at characteristics such as secondary and tertiary protein structure confirm that the biosimilar's function is comparable to the reference biologic. Biosimilars are then required to undergo preclinical testing. This includes in vitro and in vivo studies to evaluate receptor binding, PK-PD, and immunogenicity risk [14]. If no clinically meaningful differences are identified in these evaluations, large-scale phase III trials are not required, which contrasts with the FDA's approval process [14, 15].

In the EU, clinical efficacy studies are conducted only when needed; they also focus on the most sensitive patient population and indication rather than all indications of the reference biologic. This means that if biosimilarity is demonstrated in a particular condition, the biosimilar can be approved for all other indications of the reference biologic without additional, expensive trials [14, 15]. This process facilitates broader biosimilar approvals in the EU; in comparison, the FDA requires clinical data for each approved indication.

Unlike the FDA, the EMA does not have a formal designation for interchangeability. Once a biosimilar is approved by the EMA, it is considered suitable for substitution with the reference product based on the totality of evidence supporting biosimilarity. Decisions regarding whether substitution can occur at the pharmacy level are made at the national level (Table 4) [16]. Some EU countries, such as Estonia and Poland, allow automatic biosimilar substitution at the pharmacy level, while others, including Germany and Spain, require physicians to directly prescribe biosimilars rather than assume they will be substituted at the pharmacy level (Table 4) [17]. Deferring these policies to each nation in a decentralized approach contrasts with the interchangeability requirements of the FDA, which limit automatic substitution in the US market.

Table 4. Biosimilar substitution policies across EU countries [17]

Country	Automatic substitution allowed?	Policy details
Czechia	Yes	Automatic substitution at pharmacy level
Estonia	Yes	Automatic substitution at pharmacy level
France	Conditional	Allowed for treatment-naive or same-group patients unless prohibited by physician
Latvia	Yes	Automatic substitution at pharmacy level
Poland	Yes	Automatic substitution at pharmacy level
Denmark	No	Physician-driven substitution encouraged
Germany	No	Physician-driven substitution encouraged
Netherlands	No	Physician-driven substitution encouraged
Italy	No	Physician-driven substitution encouraged
Spain	No	Physician must explicitly prescribe biosimilar
Sweden	No	Physician-driven substitution encouraged

EU: European Union

These regulatory differences impact the approval and availability of biosimilars for MSDs. The EMA has approved a minimally broader range of biosimilars for musculoskeletal conditions compared to the FDA (33 biosimilars versus 31), including multiple versions of adalimumab, infliximab, and etanercept (Table 5) [18]. The EMA has a faster biosimilar approval process from the FDA, yet there has been no higher incidence of biosimilar-related adverse effects, and no biosimilars have been removed from the EU market due to safety concerns after EMA approval [19], nor in the US.

Table 5. EMA approved biosimilars for the treatment of MSDs [18]

Biosimilar name	Reference biologic*	Brand name	Indications
Abrilada	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Amgevita	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Amsparity	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Ardalicip	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Avsola	Infliximab	Remicade	RA, PsA, AS, CD, UC, PsO
Benepali	Etanercept	Enbrel	RA, PsA, AS, PsO
Ciptunec	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Cyltezo	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Erelzi	Etanercept	Enbrel	RA, PsA, AS, PsO

Table 5. EMA approved biosimilars for the treatment of MSDs [18] (*continued*)

Biosimilar name	Reference biologic*	Brand name	Indications
Eticovo	Etanercept	Enbrel	RA, PsA, AS, PsO
Flixabi	Infliximab	Remicade	RA, PsA, AS, CD, UC, PsO
Halimatoz	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Hadlima	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Hulio	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Hukyndra	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Hyrimoz	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Idacio	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Imraldi	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Inflectra	Infliximab	Remicade	RA, PsA, AS, CD, UC, PsO
Ixifi	Infliximab	Remicade	RA, PsA, AS, CD, UC, PsO
Kromeya	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Libmyris	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Mabura	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Nepexto	Etanercept	Enbrel	RA, PsA, AS, PsO
Pyzchiva	Ustekinumab	Stelara	PsA, CD, UC, PsO
Remsima	Infliximab	Remicade	RA, PsA, AS, CD, UC, PsO
Renflexis	Infliximab	Remicade	RA, PsA, AS, CD, UC, PsO
Simlandi	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Solymbic	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Steqeyma	Ustekinumab	Stelara	PsA, CD, UC, PsO
Tofidence	Tocilizumab	RoActemra	RA, SJIA, PJIA, COVID-19
Trudexa	Adalimumab	Humira	RA, PsA, AS, CD, UC, PsO
Tyenne	Tocilizumab	RoActemra	RA, SJIA, PJIA, COVID-19

* The EMA does not use US-style suffixes to differentiate biosimilars from their reference biologic. AS: ankylosing spondylitis; CD: Crohn's disease; EMA: European Medicines Agency; MSDs: musculoskeletal diseases; PJIA: polyarticular juvenile idiopathic arthritis; PsA: psoriatic arthritis; PsO: plaque psoriasis; RA: rheumatoid arthritis; SJIA: systemic juvenile idiopathic arthritis; UC: ulcerative colitis

WHO biosimilar approval process

The WHO developed global guidelines for the evaluation and approval of biosimilars, with the goal of ensuring consistent regulatory standards across many different countries. The WHO's pathway to biosimilar approval is in a stepwise approach, much like the FDA and EU's, with goals to reduce unnecessary clinical testing while ensuring biosimilarity [20]. The approval process involves structural and functional comparability between the biosimilar and its reference biologic, and then requires non-clinical studies that assess the PK-PD and immunogenicity risks [20]. This contrasts with the FDA, which often requires phase III trials in at least one sensitive indication. Rather, the WHO suggests that comparative PK-PD studies in healthy volunteers or patient populations could be sufficient. The WHO also supports the extrapolation of indications [20].

The WHO's stance on biosimilar approval is intended to support lower-income and middle-income countries (LMICs) where conducting large-scale clinical trials can be cost-prohibitive. The WHO's guidelines can accelerate biosimilar approval timelines and reduce regulatory burdens by relying on analytical comparability and PK-PD studies. The WHO also collaborates with many national regulatory authorities to unify these biosimilar standards across different regions [21]. However, unlike the FDA and EMA, which have distinct policies on biosimilar substitution, the WHO does not mandate specific criteria for interchangeability [20]. Instead, it leaves substitution policies up to individual national regulatory agencies [20]. The WHO's opinion is that long-term pharmacovigilance and real-world evidence assessing the safety and efficacy of biosimilars is necessary post-approval [20, 21].

Conclusions

The introduction and use of biologics represent advancements in modern medicine, particularly in the treatment of inflammatory and immune-mediated MSDs. While biosimilars provide a cost-effective alternative to brand-name biologics, their widespread acceptance is hindered by concerns regarding efficacy, safety, and the complexity of the approval process. There are regulatory differences across the US, EU, and WHO guidelines that influence the pace and extent of biosimilar adoption. The FDA has uniquely defined and regulated interchangeability, including specific criteria that may involve additional clinical data for interchangeable designation, though these regulations are evolving. In contrast, the EMA and the WHO do not have a concept of interchangeability. Despite differences in policy, biosimilars perform comparably to their reference biologics, with no increased safety concerns or adverse effects. Biosimilarity of drugs used for MSD is often demonstrated in psoriasis, a condition even more sensitive for detecting differences in therapeutic agents than is PsA, providing robust evidence for their use for musculoskeletal conditions, including rheumatoid and PsA. However, additional regulatory requirements, not required of different non-identical batches of reference products, including treatment-switching studies and state-level substitution laws, continue to pose barriers to broader adoption. Aligning regulatory policy may facilitate faster approvals without compromising safety. If regulatory policies and healthcare providers' trust improve, biosimilars may play a transformative role in enhancing treatment access and patient outcomes in MSDs worldwide.

Abbreviations

AS: ankylosing spondylitis

EMA: European Medicines Agency

EU: European Union

FDA: Food and Drug Administration

MSD: musculoskeletal disease

PK-PD: pharmacokinetics and pharmacodynamics

PsA: psoriatic arthritis

RA: rheumatoid arthritis

WHO: World Health Organization

Declarations

Author contributions

LNM and DM: Writing—original draft, Writing—review & editing. SRF: Conceptualization, Supervision, Writing—review & editing. All authors read and approved the submitted version.

Conflicts of interest

Steven R. Feldman has received research, speaking and/or consulting support from a variety of companies including Galderma, GSK/Stiefel, Almirall, Leo Pharma, Boehringer Ingelheim, Mylan, Celgene, Pfizer, Valeant, Abbvie, Samsung, Janssen, Lilly, Menlo, Merck, Novartis, Regeneron, Sanofi, Novan, Qurient, National Biological Corporation, Caremark, Advance Medical, Sun Pharma, Suncare Research, Informa, UpToDate, and National Psoriasis Foundation. He is the founder and majority owner of http://www.drscore.com/ and founder and part-owner of Causa Research, a company dedicated to enhancing patients' adherence to treatment. The other authors have no conflicts to disclose.

Ethical approval

Not applicable.

Consent to participate

Not applicable.

Consent to publication

Not applicable.

Availability of data and materials

Not applicable.

Funding

Not applicable.

Publisher's note

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