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Cost comparison of dupilumab and omalizumab for the treatment of severe allergic asthma patients from the Brazilian private healthcare system perspective

Comparação dos custos de dupilumabe e omalizumabe para o tratamento de pacientes com asma alérgica grave na perspectiva do sistema de saúde privado brasileiro

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Keywords:
asthma, costs and cost analysis, omalizumab, dupilumab

ABSTRACT

Objective: To compare the costs of dupilumab and omalizumab for treating severe allergic asthma patients from the perspective of the Brazilian private healthcare system. **Methods:** Using clinical and demographic inputs from the literature, we simulated a cohort of 5,000 severe allergic asthma patients and estimated the treatment cost with omalizumab. **Results:** In the simulated cohort, 81.3% were female, the mean body weight was 75.1 kg (SD 13.1), and the mean serum IgE was 532 IU/mL (SD 688). All patients were eligible for treatment with dupilumab, but 830 (16.6%) were ineligible for treatment with omalizumab due to serum IgE level and/or body weight combinations, according to the product label. Over four weeks, the mean dose of omalizumab was 537 mg (SD 285). The annual mean per-patient cost for treatment with omalizumab was BRL 110,783.89 (SD 58,385.81), ranging from BRL 31,797.49 to BRL 246,643.15. The treatment cost with dupilumab is BRL 111,724.21 for the first year and BRL 107,599.91 for subsequent years. **Conclusions:** We observed slightly lower mean treatment costs with dupilumab than with omalizumab. However, while the treatment cost with dupilumab is fixed and predictable, the treatment cost with omalizumab is highly variable, depending on patients' characteristics. Health managers should consider these findings for reimbursement and clinical protocol development decisions.

Palavras-chave:
asma, custos e análise de custo, omalizumabe, dupilumabe

RESUMO

Objetivo: Comparar os custos de dupilumabe e omalizumabe para o tratamento de pacientes com asma alérgica grave na perspectiva do sistema de saúde privado brasileiro. **Métodos:** Utilizando parâmetros clínicos e demográficos a partir de dados da literatura, simulamos uma coorte com 5.000 pacientes com asma alérgica grave e estimamos o custo de tratamento com o omalizumabe. **Resultados:** Na coorte simulada, 81,3% eram do sexo feminino, com peso médio de 75,1 kg (DP 13,1) e IgE sérica de 532 IU/mL (DP 688). Todos os pacientes eram elegíveis para o tratamento com dupilumabe, porém 830 (16,6%) não eram elegíveis para o tratamento com omalizumabe devido a combinações específicas de IgE sérica e/ou peso corporal, de acordo com a bula do produto. Para o período de 4 semanas, a dose média de omalizumabe foi de 537 mg (DP 285). O custo médio

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anual por paciente do tratamento com omalizumabe foi de R$ 110.783,89 (DP 58.385,81), variando de R$ 31.797,49 a R$ 246.643,15. O custo do tratamento com dupilumabe é de R$ 111.724,21 no primeiro ano e R$ 107.599,91 nos anos seguintes. **Conclusões:** Foi observado que o custo médio do tratamento com dupilumabe é ligeiramente menor que o custo com omalizumabe. Todavia, enquanto o custo do tratamento com dupilumabe é fixo e previsível, o custo do tratamento com omalizumabe é altamente variável, dependendo de características dos pacientes. Esses achados devem ser considerados pelos gestores de saúde para decisões sobre reembolso e desenvolvimento de protocolos clínicos.

Introduction

Asthma is a complex chronic disease characterized by airway inflammation and hyperresponsiveness, resulting in variable airway remodeling and airflow limitation (GINA, 2022; Pizzichini *et al*., 2020). It affects around 334 million people worldwide (Papi *et al*., 2018), has a critical impact on quality of life (Cançado *et al*., 2019), and accounts for approximately 495,000 deaths per year (Viegi *et al*., 2020). In Brazil, data from a national health survey (*Pesquisa Nacional de Saúde* – PNS) identified that around 5.3% of the population has a medical diagnosis of asthma (PNS, 2019), representing more than 10 million individuals. According to the Brazilian Unified Health System database (DATASUS), between 2010 and 2019, there were more than 1.2 million hospitalizations due to asthma, and, on average, 2,370 patients died per year due to asthma.

Severe asthma is defined as an uncontrolled disease even though optimized treatment with high-dose inhaled corticosteroid (ICS) and long acting β2 agonist (LABA), or that worsens when high-dose treatment is decreased (GINA, 2022; Pizzichini *et al*., 2020). It affects around 3.6% of patients (Hekking *et al*., 2015). It is associated with significant physical, mental, emotional, social, and economic burdens, responsible for over 60% of asthma-related costs (Carvalho-Pinto *et al*., 2012). The disease is complex and heterogeneous, with distinct underlying pathological mechanisms and clinical presentations. The recognition of different phenotypes of asthma allowed the development of targeted therapies and, therefore, the achievement of better asthma control (Papi *et al*., 2018). At least half of the patients with persistent moderate-to-severe asthma present type 2 inflammation (Fahy, 2015), characterized by activation of T helper type 2 cells leading to eosinophilia and increased serum IgE, with essential roles of IL-4, IL-5, and IL-13 pathways (Fajt & Wenzel, 2015). Asthma with type 2 inflammation includes the allergic phenotype, which usually has a childhood onset and is associated with a history of other allergic conditions, such as eczema, rhinitis, or food allergy (Papi *et al*., 2018). The presence of atopy, identified by skin prick testing or measuring specific serum IgE levels, is a good marker of allergic asthma (GINA, 2022).

In Brazil, considering the perspective of private healthcare system, two immunobiological drugs are available for treating severe allergic asthma: dupilumab (Dupixent®, Sanofi) and omalizumab (Xolair®, Novartis). Dupilumab inhibits both IL-4 and IL-13 signaling pathways and is approved for use in children (≥ 6 years old), adolescents, and adults with severe asthma with type 2 inflammation. Omalizumab is an anti-IgE approved for moderate-to-severe allergic asthma in children (≥ 6 years old) and adults with serum IgE ≥ 30 IU/mL and ≤ 1,500 IU/mL. No head-to-head trials compare these technologies, but Bateman *et al.* recently published a network meta-analysis comparing immunobiological drugs for uncontrolled asthma, including dupilumab and omalizumab (Bateman *et al*., 2020). For annualized severe asthma exacerbation rate, dupilumab was superior to omalizumab, but the difference did not reach statistical significance (exacerbation rate ratio 0.73; 95% confidence interval [95%CI] 0.38-1.42). Similar results were observed for pre-bronchodilator forced expiratory volume in 1 second (FEV1 (L); mean difference 0.06; 95%CI -0.04-0.17).

Despite the similarities of clinical response, the treatment cost can be very different when comparing these two immunobiological drugs. While dupilumab dosage is fixed and does not vary according to the patient's characteristics or level of biomarkers, omalizumab dosage and frequency (and, therefore, its treatment cost), vary according to the patient's body weight and serum IgE level. Patients with serum IgE levels < 30 IU/mL or > 1,500 IU/mL, body weight > 150 kg, or a specific combination of body weight and IgE (e.g., > 60 kg and > 1,000 IU/mL or > 90 kg and > 600 IU/mL) may not be eligible for treatment with omalizumab. This fact is critical for decision-making because it directly impacts the treatment cost with each drug since omalizumab posology varies depending on the patient's characteristics, meaning that the treatment cost with omalizumab can be lower or significantly higher than the treatment cost with dupilumab. Therefore, this study aims to compare the treatment costs of dupilumab and omalizumab in patients (≥ 18 years old) with severe allergic asthma in the perspective of the Brazilian private healthcare system.

Methods

A stochastic model (i.e., a probabilistic model formulated based on random variables with assumed distributions, where the results obtained are different for each simulation performed) (Nikolova, 2020) was developed to simulate a cohort of patients with severe allergic asthma using

demographic and clinical inputs obtained from the literature. Thus, 5,000 virtual patients were randomly sampled considering the following characteristics: sex, body weight, and serum IgE. Demographical and clinical inputs for analyses were obtained from the ProAr Brazilian cohort of asthma patients (Table 1), which included 544 patients with severe asthma from Salvador - Bahia (Cruz *et al.*, 2020).

The recommended posology of dupilumab is an initial dose of 400 mg followed by 200 mg every two weeks, except for patients on oral corticosteroids or with comorbidities (such as moderate-to-severe atopic dermatitis or chronic rhinosinusitis with nasal polyposis), for whom the recommended posology is an initial dose of 600 mg followed by 300 mg every two weeks. Omalizumab dosage depends on the patient's serum IgE level and body weight. The range of possible dosages varies from 75 mg every four weeks (q4w) to 600 mg every two weeks (q2w), as presented in Figure 1A.

For each simulated patient, the treatment cost with omalizumab was estimated, and the proportion of ineligible patients for omalizumab was according to the on-label proposed dosage, which varies with body weight and serum IgE level. These analyses were conducted considering the perspective of the Brazilian private healthcare system. Therefore, only the costs related to immunobiological drugs and drug administration were considered; costs not covered by health insurance plans (such as transportation, other medicines, patients' productivity loss, and caregivers, among others) were not contemplated in the analyses. All costs are presented in Brazilian Real (BRL), with the conversion rate of the Brazilian Central Bank from 31 August 2021 (1 BRL = 0.1945 USD); reference costs are from the same date. Reference price (per syringe or vial) was BRL 4,025.45 for dupilumab 200 mg and dupilumab 300 mg presentations; and BRL 1,169.37 for omalizumab 75 mg (half the price of 150 mg, BRL 2,338.73); drug administration cost was BRL 98.85 (D-TISS database, code 20104421 – Subcutaneous immunotherapy, inflation-adjusted for 31 August 2021) (*Agência Nacional de Saúde Suplementar*, 2021). The treatment cost with dupilumab is BRL 111,724.21 for the first year and BRL 107,599.91 for subsequent years, regardless of the presentation. The treatment cost for each possible omalizumab dosage is presented in Figure 1B, and it varies from BRL 16,543.48 to BRL 246,643.15. All analyses were conducted on MS Excel.

Results

In the simulated cohort of Brazilian allergic asthma patients, 81.3% were female, the mean body weight was 75.1 kg (SD 13.1), and the mean serum IgE was 532 IU/mL (SD 688; median 328; interquartile range [IQR] 171-621).

Out of the 5,000 simulated patients, 830 (16.6%) were ineligible for treatment with omalizumab due to serum IgE < 30 IU/mL or > 1,500 IU/ml, or a combination of a very high serum IgE and/or body weight, according to the medicine label (Figure 1). Of note, all simulated patients were eligible for treatment with dupilumab since the eligibility does not depend upon these characteristics.

Table 1. Variables used in the stochastic simulation

Variable	Input	Comments and source
Sex	Male: 18.4% Female: 81.6%	According to the ProAr cohort (Cruz *et al.*, 2020).
Body weight	Men: 85.3 ± 13.7 kg Women: 72.9 ± 11.7 kg Distribution: normal	Estimated from the mean BMI from the ProAr cohort (29 ± 4,66 kg/m^2; Cruz *et al.*, 2020), considering the proportion of men and women in the sample and the mean height for each sex. Mein height was obtained from 2019 PNS, in which for individuals between 40 and 59 years, the observed mean was 171.5 m and 158.5 m for men and women, respectively (Ministério da Saúde, 2019).
Serum IgE (IU/mL)	2.5117 ± 0.4327 IU/mL Distribution: lognormal	Values defined according to the mean serum IgE from the ProAr cohort (533 ± 695 IU/mL; Cruz *et al.*, 2020), assuming lognormal distribution of the data (Gergen *et al.*, 2009).
Drug cost	Dupilumab: BRL 4,025.45 per pre-filled syringe of 200 mg or 300 mg Omalizumab: BRL 1,169.37 per pre-filled syringe/vial of 75 mg and BRL 2,338.73 per pre-filled syringe/vial of 150 mg	Maximum selling price (*Preço de fábrica* – PF) with ICMS 18%, according to the *Câmara de Regulação do Mercado de Medicamento*s (CMED), from August 2021 (Ministério da Saúde, 2021).
Drug administration cost	BRL 98.85	Average reimbursement price for subcutaneous medicine administration. The reference price for the year 2019 was obtained from *Painel de dados do TISS* D-TISS), considering the code 20104421 *("Terapia imunobiológica subcutânea ambulatorial, por sessão"*) and corrected for inflation rate up to 31 August 2021 (Agência Nacional de Saúde Suplementar, 2021).

Conversion rate: 1 BRL = 0.1945 USD (Brazilian Central Bank – 31 August 2021).

A

OMALIZUMABE DOSAGE		BODY WEIGHT (KG)										
		≥ 20-35	> 25-30	> 30-40	> 40-50	> 50-60	> 60-70	>70-80	> 80-90	> 90-125	> 125-150	> 150
IgE (IU/mL)	≥ 30-100	75	75	75	150	150	150	150	150	300	300	NA
	> 100-200	150	150	150	300	300	300	300	300	450	600	NA
	> 200-300	150	150	225	300	300	450	450	450	600	375	NA
	> 300-400	225	225	300	450	450	450	600	600	450	525	NA
	>400-500	225	300	450	450	600	600	375	375	525	600	NA
	>500-600	300	300	450	600	600	375	450	450	600	NA	NA
	> 600-700	300	225	450	600	375	450	450	525	NA	NA	NA
	>700-800	225	225	300	375	450	450	525	600	NA	NA	NA
	>800-900	225	225	300	375	450	525	600	NA	NA	NA	NA
	>900-1000	225	300	375	450	525	600	NA	NA	NA	NA	NA
	>1000-1100	225	300	375	450	600	NA	NA	NA	NA	NA	NA
	>1100-1200	300	300	450	525	600	NA	NA	NA	NA	NA	NA
	>1200-1300	300	375	450	525	NA	NA	NA	NA	NA	NA	NA
	>1300-1500	300	375	525	600	NA	NA	NA	NA	NA	NA	NA
	>1500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

B

ANNUAL COST		BODY WEIGHT (KG)										
		≥ 20-35	> 25-30	> 30-40	> 40-50	> 50-60	> 60-70	>70-80	> 80-90	> 90-125	> 125-150	> 150
IgE (IU / mL)	≥ 30-100	BRL 16,543.51	BRL 16,543,48	BRL 16,543,48	BRL 31,797.49	BRL 31,797.49	BRL 31,797.49	BRL 31,797.49	BRL 31,797.49	BRL 62,305.52	BRL 62,305,.52	NA
	> 100-200	BRL 31,797.49	BRL 31,797.49	BRL 31,797.49	BRL 62,305.52	BRL 62,305.52	BRL 62,305.52	BRL 62,305.52	BRL 62,305.52	BRL 92,813.55	BRL 123,.321.58	NA
	> 200-300	BRL 31,797.49	BRL 31,797.49	BRL 47,051.51	BRL 62,305.52	BRL 62,305.52	BRL 92,813.55	BRL 92,813.55	BRL 92,813.55	BRL 123,321.58	BRL 155,119.07	NA
	> 300-400	BRL 47,051.51	BRL 47,051.51	BRL 62,305.52	BRL 92,813.55	BRL 92,813.55	BRL 92,813.55	BRL 123,321.58	BRL 155,119.07	BRL 216,135.12	BRL 216,135.12	NA
	>400-500	BRL 47,051.51	BRL 62,305.52	BRL 92,813.55	BRL 92,813.55	BRL 123,321.58	BRL 123,321.58	BRL 155,119.07	BRL 155,119.07	BRL 216,135.12	BRL 246,643.15	NA
	>500-600	BRL 62,305.52	BRL 62,305.52	BRL 92,813.55	BRL 123,321.58	BRL 123,321.58	BRL 155,119.07	BRL 185,627.09	BRL 185,627.09	BRL 246,643.15	NA	NA
	> 600-700	BRL 62,305.52	BRL 94,103.01	BRL 92,813.55	BRL 123,321.58	BRL 155,119.07	BRL 185,627.09	BRL 185,627.09	BRL 216,135.12	NA	NA	NA
	>700-800	BRL 94,103.01	BRL 94,103.01	BRL 124,611.04	BRL 155,119.07	BRL 185,627.09	BRL 185,627.09	BRL 216,135.12	BRL 246,643.15	NA	NA	NA
	>800-900	BRL 94,103.01	BRL 94,103.01	BRL 124,611.04	BRL 155,119.07	BRL 185,627.09	BRL 216,135.12	BRL 246,643.15	NA	NA	NA	NA
	>900-1000	BRL 94,103.01	BRL 124,611.04	BRL 155,119.07	BRL 185,627.09	BRL 216,135.12	BRL 246,643.15	NA	NA	NA	NA	NA
	>1000-1100	BRL 94,103.01	BRL 124,611.04	BRL 155,119.07	BRL 185,627.09	BRL 246,643.15	NA	NA	NA	NA	NA	NA
	>1100-1200	BRL 124,611.04	BRL 124,611.04	BRL 185,627.09	BRL 216,135.12	BRL 246,643.15	NA	NA	NA	NA	NA	NA
	>1200-1300	BRL 124,611.04	BRL 155,119.07	BRL 185,627.09	BRL 216,135.12	NA	NA	NA	NA	NA	NA	NA
	>1300-1500	BRL 124,611.04	BRL 155,119.07	BRL 216,135.12	BRL 246,643.15	NA	NA	NA	NA	NA	NA	NA
	>1500	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

NA: not applicable (i.e., omalizumab not indicated according to label). Omalizumab's dose varies widely depending on the patient's body weight and serum IgE. For instance, for a 40 kg patient and serum IgE < 100 IU/mL, the recommended dose is 75 mg q4w, resulting in a cost of BRL 16,543.48. On the other hand, for an 80 kg patient and serum IgE > 700 IU/mL, the recommended dose is 600 mg q2w, resulting in a cost of BRL 246,643.15, representing a variability of 1,600%. In comparison, the recommended dose of dupilumab is an initial dose of 400 mg or 600 mg, followed by 200 mg or 300 mg every two weeks. The annual cost of treatment with dupilumab is BRL 111,724.21 for the first year and BRL 107,599.91 for subsequent years for both doses All presented prices considered the cost of the biological drug and drug application. The conversion rate is 1 BRL = 0.1945 USD (Brazilian Central Bank – 31 August 2021).

Figure 1. Posology of omalizumab (a) and yearly cost of treatment with omalizumab (b) according to body weight and serum IgE.

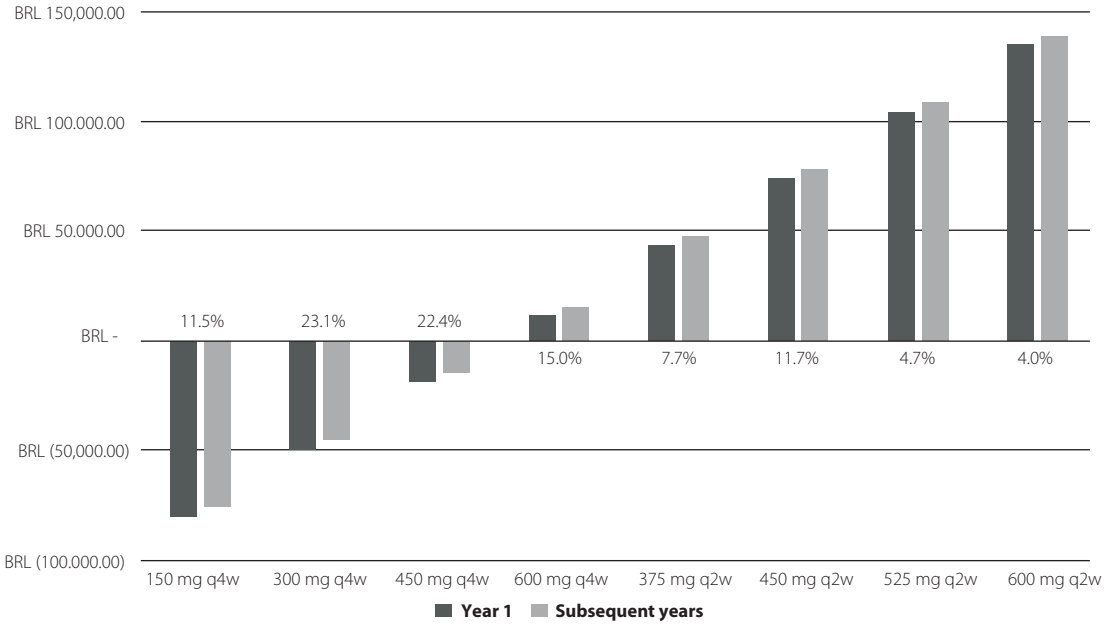
The proportion of patients from the simulated cohort in each drug regimen for omalizumab is presented in Table 2. Over four weeks, the mean dose of omalizumab was 537 mg (SD 285; median 450 mg; IQR 300 - 750). Annually, the mean treatment cost with omalizumab was BRL 110,783.89 (SD 58,385.81; median 92,813.55; IQR 62,305.52 - 155,119.07). In the simulated cohort, the annual treatment cost of omalizumab ranged from BRL 31,797.49 to BRL 246,643.15. In five years, the mean treatment cost with omalizumab is BRL 553,919.46. In comparison, the annual price of dupilumab is fixed and predictable, BRL 111,724.21 for the first year and BRL 107,599.91 for the subsequent years. In five=years, the treatment cost with dupilumab is BRL 542,123.85. The cost difference between dupilumab and omalizumab was BRL 940.31 in year 1, BRL -3,183.98 in year 2, and BRL -11,795.61, considering five years of treatment.

Three omalizumab dosages were less expensive than dupilumab (150, 300, and 450 mg q4w), representing 57% of the simulated cohort. Five regimens resulted in higher costs than dupilumab (375, 450, 525, 600 mg q2w, and 600 mg q4w), representing the remaining 43% of simulations. Although the treatment cost with omalizumab was lower for a more significant number of simulated patients, the average cost with dupilumab was lower because the magnitude of a price difference is higher when omalizumab is more expensive than dupilumab (Figure 2).

Table 2. Proportion of patients in each drug regimen, according to the simulation model

Dosage	Proportion of patients	Annual cost *
Omalizumab n = 4.170 (83,4% of simulated cohort) †‡		
150 mg every 4 weeks	478 (11.5%)	BRL 31,797.49
300 mg every 4 weeks	965 (23.1%)	BRL 62,305.52
450 mg every 4 weeks	936 (22.4%)	BRL 92,813.55
600 mg every 4 weeks	625 (15.0%)	BRL 123,321.58
375 mg every 2 weeks	320 (7.7%)	BRL 155,119.07
450 mg every 2 weeks	486 (11.7%)	BRL 185,627.09
525 mg every 2 weeks	195 (4.7%)	BRL 216,135.12
600 mg every 2 weeks	165 (4.0%)	BRL 246,643.15
Dupilumab n = 5,000 (100% of simulated cohort)		
Year 1 - loading dose of 400 or 600 mg and therefore 200 or 300 mg every 2 weeks	5,000 (100%)	BRL 111,724.21
Subsequent years - 200 or 300 mg every 2 weeks	5,000 (100%)	BRL 107,599.91

* Conversion rate: 1 BRL = 0.1945 USD (Brazilian Central Bank – 31 August 2021). † 830 patients were ineligible to treatment with omalizumab due to serum IgE < 30 IU/mL very high body weight and/or serum IgE. ‡ Some possible omalizumab's dosage schemes are not presented in the table (75 mg q4w, 225 mg qw4; 225 qw2, and 300 q2w) because no patient in the simulated cohort attended the required combination of serum IgE and body weight for these schemes – dosages usually for pediatric population.



Although a higher proportion of simulations is less expensive with omalizumab, the magnitude of the price difference is higher when omalizumab is more costly than dupilumab; as a result, the mean cost of treatment is expected to be more favorable to dupilumab. The conversion rate is 1 BRL = 0.1945 USD (Brazilian Central Bank – 31 August 2021).

Figure 2. Cost difference between dupilumab and omalizumab, according to omalizumab dosage.

Discussion

Asthma is a chronic disease with high health and economic burden. Recognizing distinct disease phenotypes allowed the development of target therapies that show high efficacy in treating patients with moderate-to-severe asthma (Papi *et al.*, 2018). However, the effectiveness of these treatments and their cost should be accounted for in the decision-making coverage and reimbursement.

In this study, we highlighted the critical variability of the cost of treatment with omalizumab in patients with allergic asthma, contrasting with costs of treatment with dupilumab, which are fixed and predictable. On average, the cost of treatment with omalizumab is slightly higher than dupilumab, corresponding of BRL 11,795.61 in five years. It is explained by the magnitude of the price difference between omalizumab and dupilumab, which is higher when omalizumab is used at higher doses than at lower doses. For instance, in comparison

with dupilumab and considering the first year of treatment, the observed lowest dose of omalizumab (150 q4w) would result in savings of BRL 79,926,71 and the highest dose (600 mg q2w) would result in an incremental cost of BRL 134,918.94.

Although the average treatment cost is lower with dupilumab than with omalizumab, nowadays, only omalizumab has mandatory coverage by Brazilian health insurance plans for treating patients with severe allergic asthma. It also means that patients with IgE < 30 IU/mL or > 1500 IU/mL, or a combination of body weight and IgE unsuitable for omalizumab use are not being treated; as we observed in our simulated cohort, it represented 16.6% of patients. Dupilumab is effective and safe, and its posology is not determined by serum IgE and body weight, addressing this unmet need. When drug dosages (and, therefore, the cost of treatment) vary according to the patient's characteristics, such as body weight or level of a biomarker, it is common to use an average estimate for cost analysis. Although an average weight of 70 kg is often used in economic evaluations in Brazil, it may not represent the target population; for instance, asthma is directly correlated to body weight, and using a populational average may underestimate costs (Akinbami, 2016). Furthermore, using an average weight does not ensure an average price estimate since the relation between weight and costs is not always linear. We also have serum IgE as an additional source of variability for omalizumab. Ideally, cost assessment should consider an approach considering this variability for a more accurate evaluation.

It is important to note that the observed results could differ depending on the inputs used to simulate the cohort. Our analyses were conducted considering the clinical and demographical characteristics of patients included in the ProAR study, a cohort of Brazilian asthma patients. Therefore, we understand that these results are valid for the Brazilian context but may not reflect the reality of other countries. Nevertheless, the methods used are accurate and could be replicated with different inputs.

One of the limitations of our study is that we conducted a simple cost analysis, considering only treatment-related costs and not including costs related to health events such as asthma exacerbation and hospitalization. Assessing the efficacy of both biological drugs, it is probable that dupilumab would be associated with even higher savings if we considered the reduction of these events in our analyses (Bateman *et al.*, 2020). Moreover, the demographic and clinical inputs used to simulate the patients were obtained from the ProAR study, a cohort that recruited asthma patients from a 2003 panel, using a definition of severe asthma based on older criteria that are not the same as applied today.

Conclusions

In our simulated cohort of allergic asthma patients in Brazil, the cost of treatment with dupilumab was slightly lower than the average cost of treatment with omalizumab. These findings can be helpful for policymakers, helping with coverage and reimbursement decisions for immunobiological drugs for severe allergic asthma and developing clinical practice guidelines and protocols for managing this disease.

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