Broader Health and Economic Value of 15-Valent Pneumococcal Conjugate Vaccine (PCV15) Against Antimicrobial Resistance in Brazil: An Agent-based Simulation Study

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BACKGROUND

- The World Health Organization (WHO) has identified antimicrobial resistance (AMR) as one of the top 10 threats to global health[1]

- Treatment failure due to AMR leads to prolonged illness, and increases the risk of disability, death, and healthcare costs[2-5]

- Antibiotic consumption in Brazil has been notably high, contributing to the rise of AMR[6]

- The pneumococcal conjugate vaccine (PCV) has the potential to combat AMR by reducing infections and subsequent antibiotic use; however, this impact has not yet been documented in Brazil

- This study used an agent-based model to evaluate the impact of PCV coverage on pneumococcal infections, AMR, and related health and economic outcomes in Brazil

METHODS

- The DREAMR (Dynamic Representation of the Economics of AMR) model was developed to assess the value of childhood PCV in slowing AMR progression

- The DREAMR model has two components:

  1) **Bacterial component** – simulates AMR development based on antibiotic exposure and its effect on treatment effectiveness.

  2) **Human component** – models vaccination coverage, disease incidence, care-seeking behavior, antibiotic use, health outcomes, and costs

- Epidemiologic, cost, AMR, and immunization data were obtained from various literature

- We simulated five 5-year scenarios:

  1) No vaccination (counterfactual)

  2) PCV10 with current coverage

  3) PCV15 with same coverage as PCV10

  4) PCV10 with increased coverage (95% across all regions)

  5) PCV15 with increased coverage (95% across all regions)

RESULTS

Table 1. Impact of PCV on Antimicrobial Resistance Related to Health and Economic Outcomes in Brazil, 2023-2028
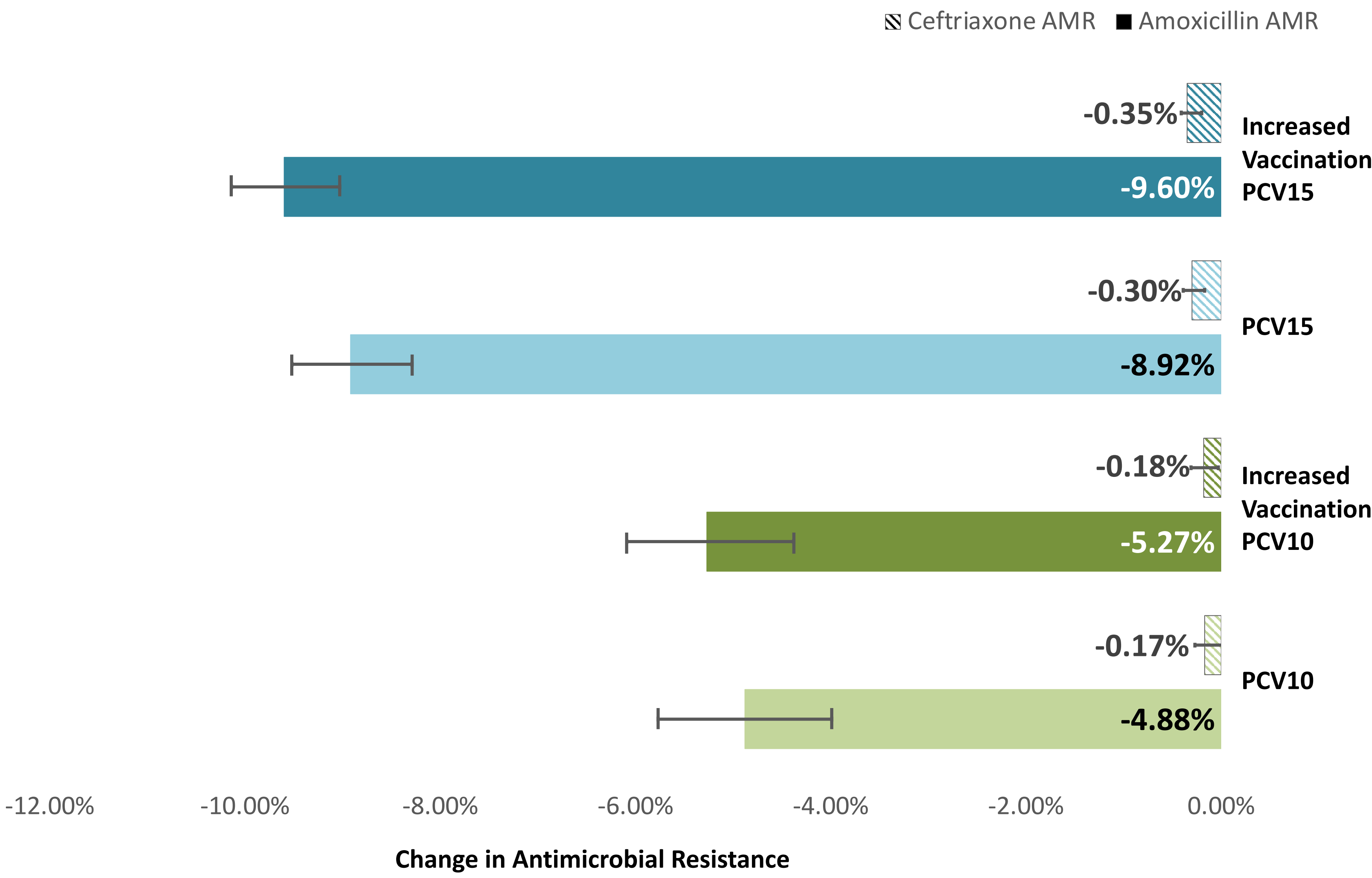
Outcomes	Counterfactual	PCV10	Increase Vaccination PCV10	PCV15	Increase Vaccination PCV15
	Value	Percent Difference			
Incremental change in resistance					
Amoxicillin, %	37.3%	-13.12%	-14.14%	-23.95%	-25.76%
Ceftriaxone, %	18.1%	-0.92%	-0.99%	-1.77%	-1.92%
Average defined daily dose, per 1,000 patient days	0.278	-32.39%	-34.69%	-61.57%	-66.05%
Average annual disease incidence					
Pneumococcal pneumonia, n	54,544	-31.92%	-34.31%	-61.15%	-65.71%
Pneumococcal meningitis, n	143	-33.29%	-35.70%	-61.53%	-63.74%
AOM, n	184,504	-32.04%	-34.29%	-61.17%	-65.67%
Average annual incidence of adverse health outcome					
Overall Deaths, n	2,226	-32.20%	-34.72%	-61.73%	-66.26%
Deaths, formal treatment, n	1,120	-30.48%	-32.58%	-59.01%	-64.49%
Deaths due to resistance, formal treatment, n	456	-36.24%	-39.98%	-66.51%	-71.05%
Deaths due to resistance, self-medication, n	650	-32.34%	-34.73%	-61.15%	-65.93%
Disabilities, n	64	-36.95%	-38.05%	-63.38%	-63.99%
Average annual treatment behaviors					
Overall treatments, n	167,579	-32.04%	-34.29%	-61.19%	-65.69%
Overall treatment failures, n	49,195	-37.02%	-39.56%	-66.44%	-70.70%
Treatment failures (pneumonia), n	11,203	-36.73%	-36.60%	-66.40%	-70.60%
Treatment failures (meningitis), n	26	-33.74%	-39.47%	-65.44%	-64.62%
Treatment failures (AOM), n	37,966	-37.10%	-39.60%	-66.46%	-70.73%
Proportion of treatment failures, %	29.4	-7.33%	-8.02%	-13.52%	-14.61%
Average annual costs incurred in 1st line treatments					
Overall costs, USD	34,547,824	-31.02%	-33.26%	-60.13%	-64.67%
Direct medical costs, USD	14,047,739	-31.87%	-33.38%	-60.22%	-64.73%
Short-term productivity losses, USD	18,622,590	-30.87%	-33.07%	-59.97%	-64.52%
Average annual costs incurred in 2nd line treatments					
Overall costs, USD	10,857,187	-37.00%	-39.53%	-66.41%	-70.65%
Direct medical costs, USD	4,107,091	-36.92%	-39.46%	-66.35%	-70.55%
Short-term productivity losses, USD	6,728,894	-37.04%	-39.57%	-66.45%	-70.71%
Long-term productivity losses, USD	75,587,964	-36.25%	-39.94%	-65.45%	-70.90%
DALYs	158,761	-32.20%	-34.72%	-61.17%	-66.26%
DALYs – discounted	61,657	-32.20%	-34.72%	-61.17%	-66.26%

- The model projected reductions across all outcomes from 2023–2028 for PCV10 (current and increased coverage) and PCV15 (current and increased coverage) compared to the counterfactual (Table 1)

  - PCV10 with increased coverage reduced pneumococcal pneumonia by 34.31%, meningitis by 35.70%, overall deaths by 34.72%, and defined daily antibiotic use by 34.69%

  - PCV15 with increased coverage showed a greater impact, reducing pneumonia by 65.71%, meningitis by 63.74%, overall deaths by 66.26%, and defined daily antibiotic use by 66.05%.

- All PCV scenarios showed reductions in pneumococcal pneumonia and meningitis incidence, mortality, and costs compared to the counterfactual

Figure 1. Incremental Change in Antimicrobial Resistance from 2023-2028

- Pneumococcal vaccination can control AMR of amoxicillin by 4.88% and ceftriaxone by 0.17% in Brazil and switching from the current PCV10 to PCV15 can lead to even greater impact (Figure 1)

- Increasing the vaccination rate to 95% across all regions of Brazil resulted in modest improvements in AMR for both the PCV10 and PCV15 scenarios

Figure 2. Average Annual Overall Costs Averted in Treatments, USD

- Pneumococcal vaccination led to annual averted costs of nearly $15 million in Brazil with even greater savings seen when switching from to PCV15 and/or increasing vaccination rates (Figure 2)
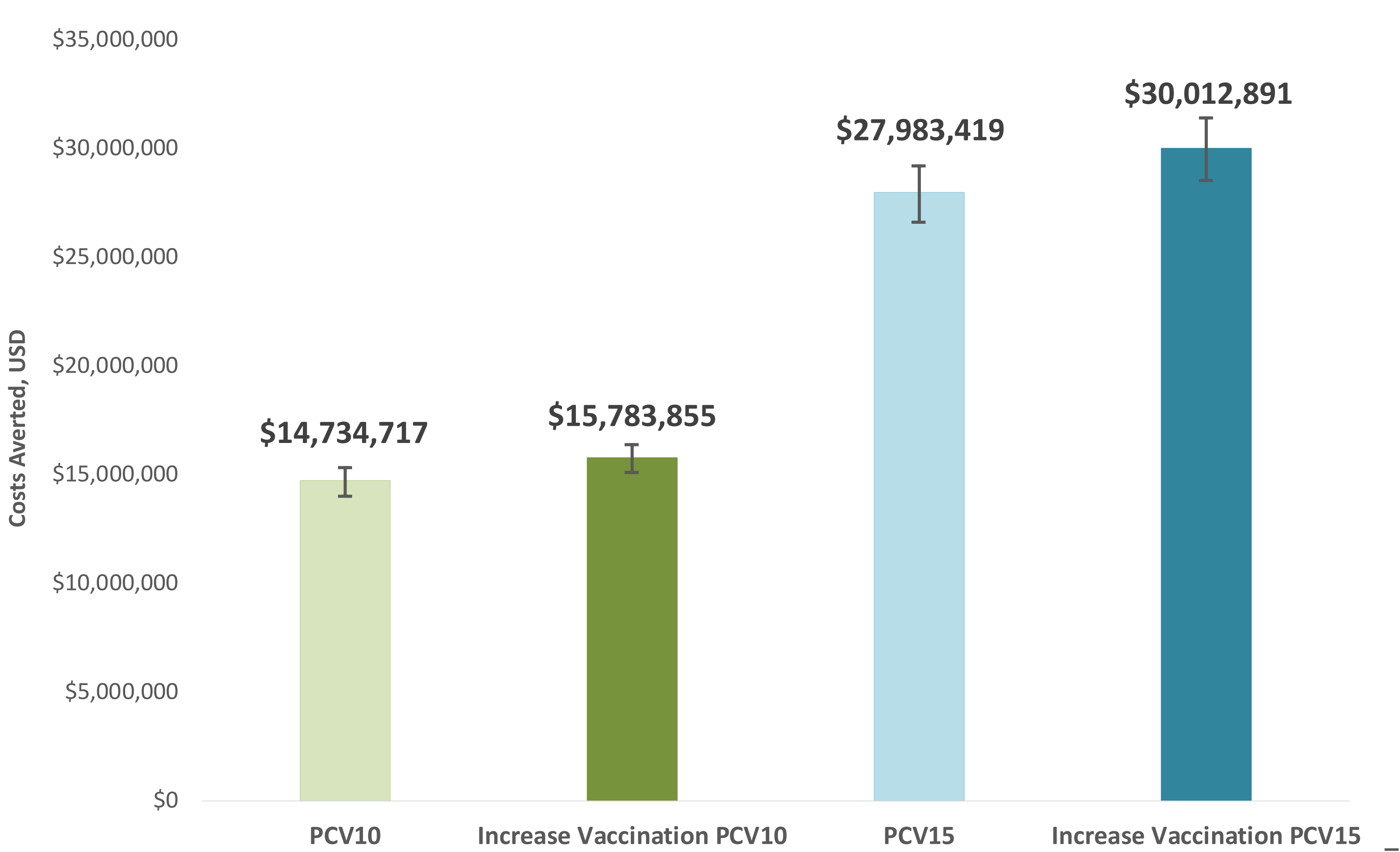
CONCLUSIONS

- Compared to no vaccination, current PCV10 vaccination reduces annual incidences of pneumococcal diseases, preventing deaths and treatments each year, and controls AMR growth

- This is the first study in Brazil to show that pneumococcal vaccination can effectively reduce antimicrobial resistance, with a transition to PCV15 offering the treater clinical and economic benefit.

- Switching to PCV15 in Brazil—and improving vaccination coverage—could increase efforts to control antibiotic resistance and reduce preventable healthcare costs associated with pneumococcal disease

- Further evidence is needed to demonstrate how vaccines reduce AMR across countries, populations, and antibiotic classes—highlighting their role in both preventing disease and protecting the effectiveness of existing treatments

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