



Cost Variation Analysis of Corticosteroids Available in India: An Observational Study

Dr. Ramya Rachamanti¹, Dr. Supriya Sanke², Dr Ch. Jhansi Vani³ and Dr Rajesh Dupaguntla^{4*}

^{1,2}Assistant professor, Department of Pharmacology, Govt. Medical College, Ongole, Andhra Pradesh

³Associate Professor, Department of Pharmacology, Govt. Medical College, Ongole, Andhra Pradesh

⁴Assistant professor, Department of Pharmacology, Siddhartha Medical College, Vijayawada Andhra Pradesh

Abstract: Pharmacoeconomics refers to the scientific discipline that compares the value of one pharmaceutical drug or drug therapy to another. Cost variation analysis on various brands of corticosteroids available in the Indian market provides information on price differences between these brands. It can decrease the price fluctuations in the market. The novelty of the current study is that it could help frame guidelines regarding price capping for various drug companies. The current study assessed cost variation analysis among all corticosteroid brands available in India. The objectives include assessment of the dose, no. of brands available, minimum and maximum price, cost ratio, percentage cost variation, and mean price of each medication. This study used the Drug Today book dated Jan 2022(DT 114), published annually. The study was done in the Department of Pharmacology at a tertiary care center named Government Medical College, Ongole, Andhra Pradesh, India. The study was done for 1 week during March 2023. All corticosteroid brands mentioned in Drug Today book, including topical, inhalational, oral, and parenteral dosage forms, both monotherapy and combination therapies, were included. Results showed a significant difference in the mean price of various oral and parenteral corticosteroid brands available in India. Price variation is maximum for prednisolone among oral preparations and triamcinolone among parenteral preparations. Our study concludes that a huge variation in pricing is seen in the Indian context for various corticosteroids. Physicians should also be made aware of the prices of various medications while encouraging them to prescribe generic medicines. It suggests that prescribing drugs in generic names will allow the pharmacist to dispense suitable and cost effective drugs to the patient.

Keywords: Branded-drugs, Corticosteroids, Dosage forms, Generic drugs, Observational study

*Corresponding Author

Dr Rajesh Dupaguntla , Assistant professor, Department of Pharmacology, Siddhartha Medical College, Vijayawada Andhra Pradesh

Date of Receiving 11 May, 2023

Date of Revision 6 July, 2023

Date of Acceptance 20 July, 2023

Date of Publishing 2 October, 2023

Funding This research did not receive any specific grant from any funding agencies in the public, commercial or not for profit sectors

Citation Dr. Ramya Rachamanti, Dr. Supriya Sanke, Dr Ch. Jhansi Vani and Dr Rajesh Dupaguntla , Cost Variation Analysis of Corticosteroids Available in India: An Observational Study.(2023).Int J Pharm Sci.14(4), p31-45 <http://dx.doi.org/10.22376/ijpbs.2023.14.4.p31-45>

This article is under the CC BY- NC-ND Licence (<https://creativecommons.org/licenses/by-nc-nd/4.0>)

Copyright @ International Journal of Pharma and Bio Sciences, available at www.ijpbs.net

Int J Pharma Bio Sci., Volume14., No 4 (October) 2023, pp p31-45



1. INTRODUCTION

Pharmacoeconomics is the science of health economics that concentrates on weighing the costs and benefits of a specific intervention compared with an analogous alternative. It refers to the scientific discipline that compares the value of one pharmaceutical drug or drug therapy to another. One of the vital tools of Pharmacoeconomics is cost variation analysis. Given the scarcity of resources, this type of analysis is vital in improving the value for patients, healthcare professionals, and society.^{1,2} Novel healthcare interventions like medical devices, drugs, and medical services have become more expensive than the existing ones. Complete pharmacoeconomic evaluations inform reimbursement or coverage decisions, which may finally lead to price negotiations.³ Cost variation analysis on different brands of corticosteroids found in the Indian market gives knowledge of price differences among these brands. Some studies previously done on cost variation analysis on antidiabetic medications, antibiotics, etc., mentioned that drug prices affect therapeutic compliance.⁴⁻⁸ The cost of a prescription can impact suppliers, users, and, most importantly, payers. Apart from providing physicians with a broader and cost-effective range of medications, studies on cost variation analysis can enhance one's adherence to their medications, leading to better clinical outcomes. They may also reduce fluctuations in the prices of various brands available in the market. One systematic review suggested that most of the studies aiming at performing economic evaluation of pharmacy services suffer from various limitations in methodology. These studies did not perform either full economic analysis or comply with accepted standards for performing economic analysis.⁹ Some of the routine limitations in determining the cost-effectiveness of interventions include: Not doing an incremental analysis that is no comparator to assess costs and outcomes; or inaccurately measuring costs of service itself.¹⁰ Certain outcome measures may only partially capture the value of complex interventions. Evidence generated from pharmacoeconomic studies should be sufficiently accurate and reliable to inform decision-making and planning of services and reflect the opportunity to expand the role of pharmacologists in healthcare.¹¹ The out-of-pocket expenditure in India as a percentage of total health expenditure was notably high, 64.2% in 2014 and 62.6% in 2015.¹² National Pharmaceutical Pricing Authority (NPPA) was started in 1997 to regulate prices of various drugs in India. Implementation of the National Pharmaceutical Pricing Policy, 2012, and Drugs Prices Control Order 2013 was brought by NPPA.¹³ It protects the interest of manufacturers and consumers by ensuring essential medicines are available at affordable prices. With the increase in raw material prices, NPPA recently increased the prices of 21 drug formulations by 50%.¹⁴ The Government of India has increased the price by around 15-20% for drugs re-launched with novel properties like reduced incidence of adverse events or techniques that improve compliance like usage of skin patches.¹⁵ To improve the availability of generic medicines to the general public, the Government of India launched the Jan Aushadhi Scheme (JAS) in 2008.¹⁶ Very few studies on the cost variation analysis of corticosteroids are available in the Indian market. Hence, the current study was undertaken. The novelty of the current study is that it could help frame guidelines regarding price capping for various drug companies. The current study assessed cost variation analysis among all corticosteroid brands available in India. The

objectives include assessment of the dose, no. of brands available, minimum and maximum price, cost ratio, percentage cost variation, and mean price of each medication.

2. MATERIALS AND METHODS

2.1 Ethical approval statement

Approval from the institutional ethical committee attached to Govt. Medical College, Ongole was taken before conducting the study. (Ref: Ethical committee registration number: ECR/135/INST/AP/2020. Ref no: IEC-GMC-OGL/19/ Dated 10/10/2022). The approval was expedited review, exempting from taking informed consent, as we are not directly dealing with any patient.

2.2 Study site and type

The study was carried out in the Department of Pharmacology at a tertiary care center named Govt. Medical College, Ongole, Andhra Pradesh, India.

2.3 Study design

This observational study was conducted after taking institutional ethics committee approval at Govt. Medical College, Ongole, Andhra Pradesh, India. The cost of various oral, parenteral, or drug formulations was collected.

2.4 Study materials

Data were collected from the Drug Today Book Jan 2022 version for all available strengths and dosage forms.

2.5 Definitions

The cost ratio is calculated as the ratio of the most expensive to the cheapest brand.

Cost ratio=Maximum Price- Minimum Price

Percentage price variation (PPV) was calculated using this formula:

Percentage cost variation or percentage price variation= Maximum Cost-Minimum cost/Minimum cost × 100.¹⁷

Duration of the study: 1 week during January 2023.

2.4 Eligibility criteria

2.4.1 Inclusion criteria

1. All corticosteroid brands mentioned in the drug today book include topical, inhalational, oral, and parenteral dosage forms.
2. Both Monotherapy and combination therapies

2.4.2 Exclusion criteria

1. Drugs that were available under a single brand were excluded.
2. Drugs whose price is not mentioned as per the strength

2.5 Methodology

The prices of particular drugs available in different strengths and dosage forms, which are manufactured under different brands, were compared. The cost ratio and the percentage price variations of similar drugs will be calculated using these formulas:

Cost ratio=Maximum Price- Minimum Price

Percentage cost variation or percentage price variation= $\frac{\text{Maximum Cost}-\text{Minimum cost}}{\text{Minimum cost}} \times 100$.¹⁷

2.6 Parameters

The following parameters were assessed for corticosteroids:

1. Doses of available oral and parenteral corticosteroids
2. Doses of available topical corticosteroids
3. Monotherapy-Drug name
4. Combination therapy- drug names
5. Minimum price, Minimum price, Cost ratio, % cost variation of oral corticosteroids
6. Minimum price, Minimum price, Cost ratio, % cost variation of parenteral corticosteroids
7. Minimum price, Minimum price, Cost ratio, % cost variation of topical corticosteroids (monotherapy and combination)

8. Mean minimum and mean maximum price of oral corticosteroids
9. Mean minimum and mean maximum price of parenteral corticosteroids
10. Mean minimum and mean maximum price of topical corticosteroids

3. STATISTICAL ANALYSIS

Results were expressed in percentage, mean, and SD. Statistical analysis was done using SPSS software, free version 23.0. Comparison in mean minimum and maximum prices of corticosteroids was done using an unpaired T-test. Pearson's correlation will be done between the number of brands and % price variation. A P value below 0.05 is considered significant statistically.

4. RESULTS

4.1 Table I: Corticosteroids available in India along with doses: Oral and Parenteral

The following doses of corticosteroids were available in India (Shown in Table I).

Table I: Corticosteroids available in India along with doses: Oral and Parenteral		
Drug	Dose used	Route of administration
Hydrocortisone acetate	100 mg	Parenteral(Injectable)
Hydrocortisone acetate	200 mg	Parenteral(Injectable)
Hydrocortisone sodium succinate	100 mg	Parenteral(Injectable)
Hydrocortisone sodium succinate	200 mg	Parenteral(Injectable)
Dexamethasone	0.5 mg	Oral
Dexamethasone	4 mg/ml	Parenteral(Injectable)
Betamethasone	1 mg	Oral
Betamethasone	0.5 mg	Oral
Betamethasone	4 mg/ml	Parenteral(Injectable)
Fludrocortisone	100mcg	Oral(tablet)
Prednisolone	1 mg	Oral(Tablet)
Prednisolone	2mg	Oral(Tablet)
Prednisolone	5 mg	Oral(Tablet)
Prednisolone	10mg	Oral(Tablet)
Prednisolone	20 mg	Oral(Tablet)
Prednisolone	30 mg	Oral(Tablet)
Prednisolone	40 mg	Oral(Tablet)
Deflazacort	6 mg	Oral(tablet)
Deflazacort	12 mg	Oral(tablet)
Deflazacort	24 mg	Oral(tablet)
Deflazacort	30 mg	Oral(tablet)
Deflazacort	6 mg/5 ml	Oral(syrup)
Triamcinolone	4 mg	Oral(tablet)
Triamcinolone	40 mg	Parenteral(Injectable)
Triamcinolone	10 mg/ml	Parenteral(Injectable)

Table I shows available oral and parenteral corticosteroids available in India. They include hydrocortisone acetate, hydrocortisone sodium succinate, dexamethasone, betamethasone, deflazacort, prednisolone, and triamcinolone. Most of these medications were available both orally and parenterally. Deflazacort, betamethasone, and dexamethasone were available as topical dosage forms also.

Table 2: Corticosteroids available in India along with doses: Topical		
Drug	Dose used	Route of administration
Beclomethasone dipropionate	0.025%	Cream
Beclomethasone dipropionate	0.05%	Cream
Betamethasone Benzoate	0.025%	Cream
Betamethasone Valerate	0.1%	Cream
Betamethasone Valerate	0.12%	Cream
Clobetasol	0.05%	Cream
Clobetasol propionate	0.5%	Cream
Clobetasol 17 butyrate	0.05%	Cream
Fluocinolone	0.01%	Cream
Fluocinolone	0.01%	Cream
Hydrocortisone 17 butyrate	1%	Cream
Fluocinolone	0.01%	Cream
Betamethasone Benzoate	0.025%	Cream
Desoxymetasone	0.25%	Cream
Mometasone	0.1%	Cream
Triamcinolone acetonyde	0.1%	Cream
Prednicarbate	0.1%	Cream
Prednicarbate	2.5%	Cream
Desonide	0.05%	Cream
Halobatesol propionate	0.05%	Cream
Dexamethasone	0.5 mg/ml	Eye drops-Topical-Pediatric
Betamethasone	0.5 mg/ml	Eye drops-Topical-Pediatric

Table 2 shows available topical corticosteroids available in India. They include beclomethasone dipropionate, betamethasone benzoate, fluocinolone, desonide, prednicarbate, mometasone, clobetasol, triamcinolone acetonyde. Dexamethasone and betamethasone are available as eye drops.

4.2 Monotherapy and combination therapies

Table 3: The following corticosteroids were available as monotherapy and combination therapies.

Table 3: monotherapy and combination therapies.		
Drug	Form	ROA
Beclomethasone dipropionate	Monotherapy	Topical- cream
Betamethasone Benzoate	Monotherapy	Topical- cream
Betamethasone Valerate	Monotherapy	Topical- cream
Clobetasol	Monotherapy	Topical- cream
Clobetasol propionate	Monotherapy	Topical- cream
Clobetasol 17 butyrate	Monotherapy	Topical- cream
Hydrocortisone 17 butyrate	Monotherapy	Topical- cream
Fluocinolone	Monotherapy	Topical- cream
Betamethasone Benzoate	Monotherapy	Topical- cream
Desoxymetasone	Monotherapy	Topical- cream
Mometasone	Monotherapy	Topical- cream
Triamcinolone acetonyde	Monotherapy	Topical- cream
Prednicarbate	Monotherapy	Topical- cream
Desonide	Monotherapy	Topical- cream
Halobatesol propionate	Monotherapy	Topical- cream
Dexamethasone	Monotherapy	Topical- cream
Betamethasone	Monotherapy	Topical- cream
Beclomethasone	Combination therapy with antimicrobials	Topical- cream
Beclomethasone dipropionate	Combination therapy with antimicrobials	Topical- cream
Betamethasone dipropionate	Combination therapy with antimicrobials	Topical- cream
Betamethasone benzoate	Combination therapy with antimicrobials	Topical- cream
Beclomethasone valerate	Combination therapy with antimicrobials	Topical- cream
Clobetasol propionate	Combination therapy with antimicrobials	Topical- cream
Clobetasol 17 butyrate	Combination therapy with antimicrobials	Topical- cream
Clobetasol trimethyl acetate	Combination therapy with antimicrobials	Topical- cream
Dexamethasone trimethyl acetate	Combination therapy with antimicrobials	Topical- cream

Fluocinolone acetamide	Combination therapy with antimicrobials	Topical- cream
Hydrocortisone	Combination therapy with antimicrobials	Topical- cream
Triamcinolone	Combination therapy with antimicrobials	Topical- cream

Table 3 shows monotherapy and combination therapeutic preparations of corticosteroids in India. Beclomethasone, Beclomethasone dipropionate, Triamcinolone, hydrocortisone, fluocinolone acetamide, dexamethasone trimethyl acetate, Clobetasol trimethyl acetate, Clobetasol 17 butyrate, Beclomethasone valerate were available in combination with antimicrobials.

4.3 Cost variation analysis

Table 4: Corticosteroids: Oral preparations

Drug name	Minimum price (INR)	Maximum price(INR)	Cost ratio	% cost variation	Dosage form	Dose	No of medicines
Prednisolone	3.82	69	18.06	472.8	Tablet	5 mg	10
Dexamethasone	2.03	2.9	1.42	70.372	Tablet	0.5 mg	10
Betamethasone	3.70	4.85	1.310	35.42	Tablet	0.5 mg	10
Deflazacort	53	90	1.6	3.203	Tablet	6 mg	10
Deflazacort	65	85	1.307	2.01	Syrup	30 ml	1
Mean and SD	25.51 ± 30.8		50.3 ± 43.13		T value		P value
Sample size(no of medicines for which price is considered)	41		2.995				0.0037

Table 4 shows a cost variation analysis of oral corticosteroids available in India. Maximum price range and % cost variation are seen for prednisolone tablets. There is a significant difference in the mean minimum price and mean maximum price, as students' t-test ($p=0.0037$)

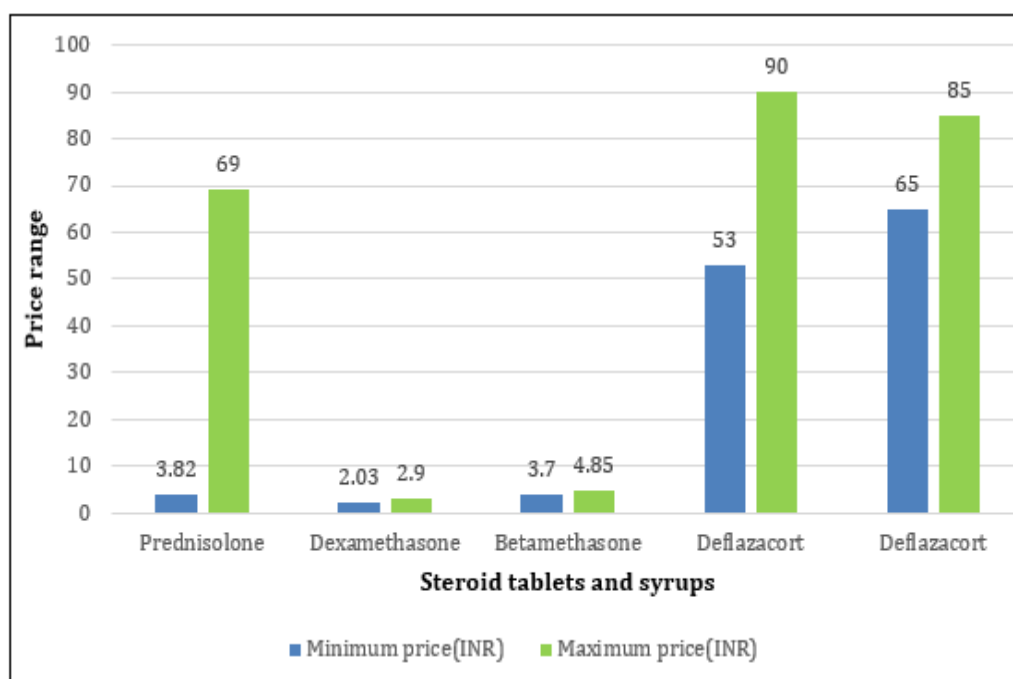


Fig 1: Price range of oral corticosteroids

Figure 1 shows the price range of oral corticosteroids available in India. The maximum price is seen for the Deflazocort tablet. The minimum price is seen as a Dexamethasone tablet.

4.4 Table 5: Cost variation analysis of parenteral corticosteroids

Table 5 shows the maximum price range and cost variation for triamcinolone injection followed by betamethasone.

Table 5: Cost variation analysis of parenteral corticosteroids

Drug name	Minimum price(INR)	Maximum price(INR)	Cost ratio	% cost variation	Dosage form	Dose	No of medicines
Hydrocortisone acetate	36.30	40	1.101	3.03	Injection	100 mg	1
Hydrocortisone sodium succinate	38.34	72	1.87	4.8	Injection	100 mg	1
Dexamethasone	5.78	9.5	1.643	28.43	Injection	4 mg/ml	1
Betamethasone	4.4	47.3	10.75	244.31	Injection	4 mg vial	1
Triamcinolone	45	106.8	18.06	472.848	Injectable	40 mg vial	1
Mean and SD	25.9±19.3		55.12±36.4		T value		P value
Sample size(no of medicines for which price is considered)	6				1.73		0.1

Table 5 shows the cost variation analysis of parenteral corticosteroids available in India. Maximum price range and cost variation are seen for triamcinolone injection followed by betamethasone. There is no significant difference in the mean minimum and mean maximum prices for parenteral corticosteroids, as per the student's t-test ($p=0.01$). The reason for the non-significance is less sample size.

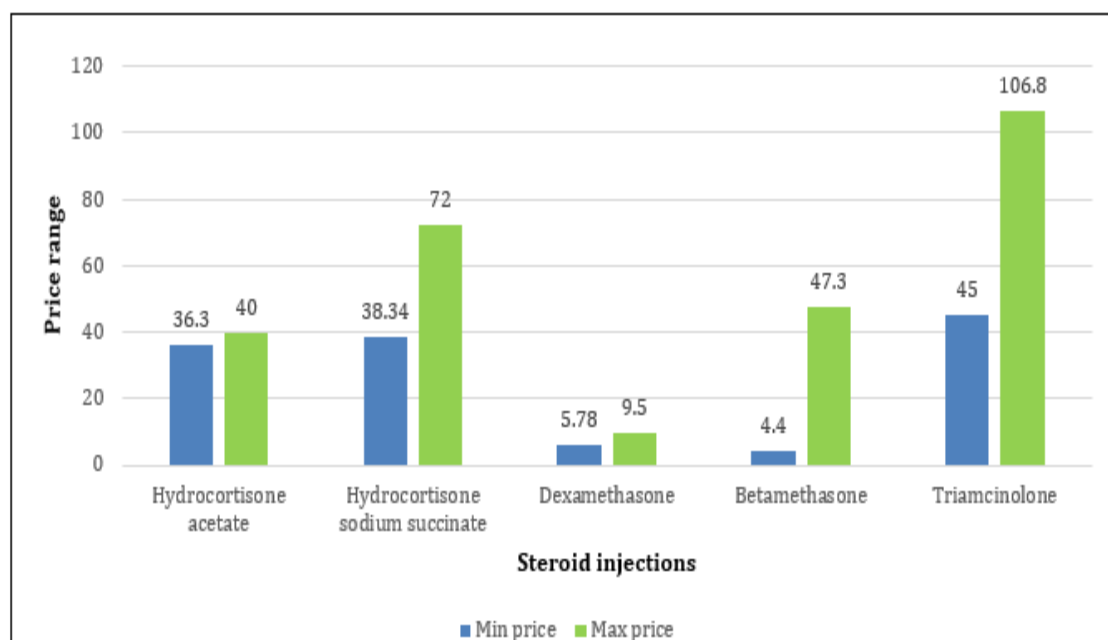
**Fig 2: Minimum and maximum price of corticosteroid injections**

Figure 2 shows the price range of parenteral corticosteroids available in India. The maximum price is seen for triamcinolone. The minimum price is seen for betamethasone.

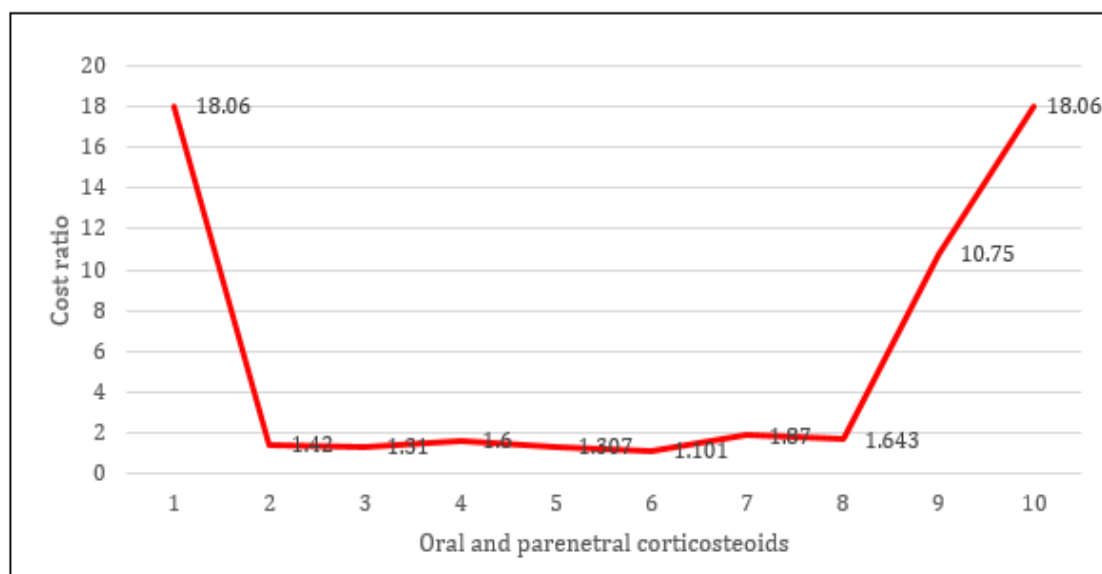


Fig 3: Cost ratio of all oral and parenteral corticosteroids

Figure 3 shows a line diagram of the cost ratio of all oral and parenteral corticosteroids. The cost ratio ranged from 1.42 to 8.06

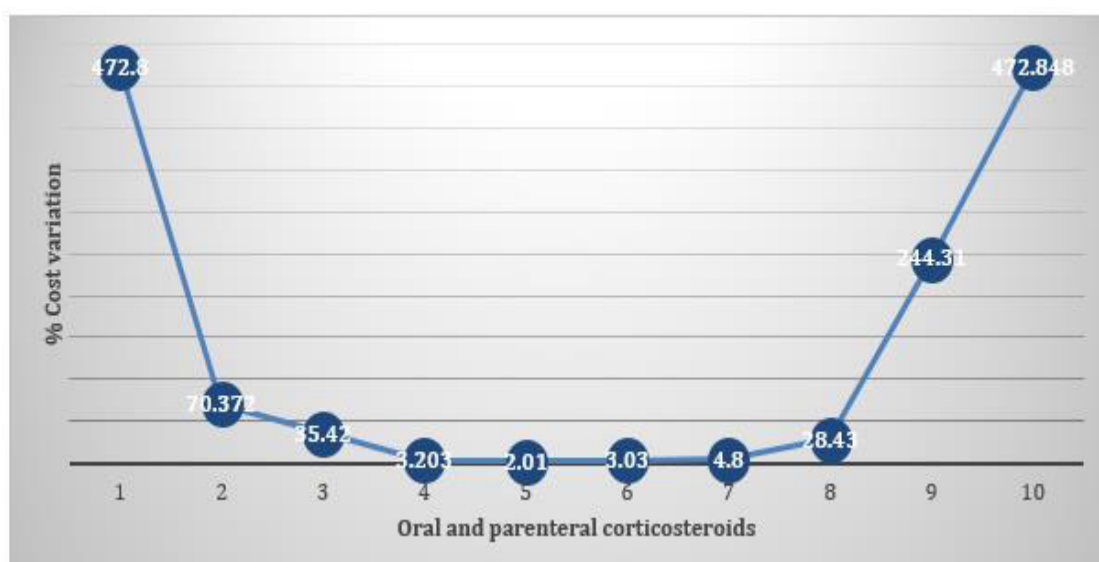


Fig 4: % Cost variation of all oral and parenteral corticosteroids

Figure 4 shows a line diagram of the % cost variation of all oral and parenteral corticosteroids. % cost variation ranged from 4.8 to 472.8

4.5 Cost variation analysis of topical steroids (creams, gels, and lotions): Monotherapy

Table 6 shows the cost variation analysis of topical corticosteroids(monotherapy)

Drug	Minimum price	Maximum price	Cost ratio	% cost variation	Strength	No.(10 grams)
Beclomethasone dipropionate	6.8	22.11	3.25	47.815	0.025%	1 tube
Betamethasone dipropionate	6.3	23.3	3.69	58.70	0.05%	1 tube
Betamethasone valerate	7.3	8.2	1.12	15.38	0.12%	1 tube
Clobetasol propionate	7.42	50	6.738	90.81	0.05%	1 tube
Mometasone	46.6	212	4.54	9.76	0.1%	1 tube

furoate						
Halcinonide	18.69	32.5	1.738	9.30	0.1%	1 tube
Fluticasone propionate	47.75	133.4	2.79	5.85	0.05%	1 tube
Desonide	130	167.8	1.293	0.99	0.05%	1 tube
Halobetasol propionate	65.3	95	1.45	2.22	0.05%	1 tube
Mean and SD	37.35 ± 41.23	82.70 ± 73.33				

Table 6 shows a cost variation analysis of topical corticosteroids(monotherapy) available in India. Maximum price range and cost variation are seen for topical clobetasol propionate followed by betamethasone dipropionate. Prices of all these topical corticosteroids were considered for 1 tube- 10 grams.

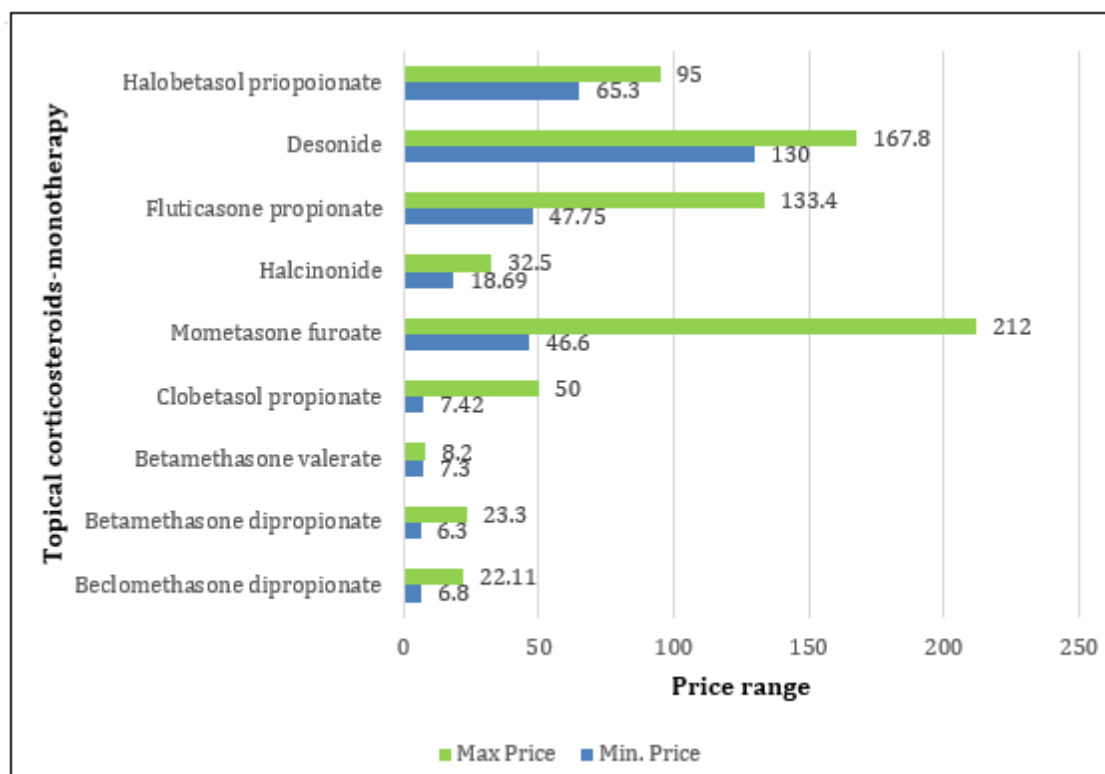


Fig 5: Price range of topical corticosteroids: Monotherapy

Figure 5 shows the price range of topical corticosteroids(monotherapy) available in India. Maximum price range and cost variation are seen for clobetasol propionate, followed by betamethasone dipropionate. Prices of all these topical corticosteroids were considered for 1 tube- 10 gram.

4.6 Cost variation analysis of topical steroids (creams, gels, and lotions): Combination therapy

Table 7 shows the cost variation analysis of topical combination corticosteroids.

Table 7 Cost variation analysis of topical steroids (creams, gels, and lotions): Combination therapy						
Drug	Minimum price	Maximum price	Cost ratio	% cost variation	Strength	No.
Halobetasol propionate	186	214	1.150	0.618	0.05%	1 tube
Halcinonide	19.63	32	1.630	8.304	0.1%	1 tube
Triamcinolone acetonide	17.6	20.26	1.151	6.540	0.1%	1 tube
Mometasone furoate	126	208	1.65	1.31	0.1%	1 tube
Hydrocortisone	8.91	47.65	5.34	60.02	1%	1 tube
Clobetasol 17 butyrate	11	55.8	5.072	46.11	0.05%	1 tube
Clobetasol	7.56	213	28.174	372.67	0.05%	1 tube
Fluocinolone acetonide	12.50	32.5	2.6	20.8	0.025%	1 tube
Fluocinolone acetonide	68.5	270	3.941	5.754	0.1%	1 tube

Betamethasone valerate	7.3	26.5	3.630	49.727	0.12%	1 tube
Betamethasone dipropionate	7.88	256	32.4896	412.275	0.05%	1 tube
Betamethasone dipropionate	10	118	11.8	118	0.25%	1 tube
Mean and SD of prices of all topical corticosteroids	39.0±36.5	106.57±84.4				
T value	3.36					
P value	0.0017					

Table 7 shows a cost variation analysis of topical combination corticosteroids available in India. Maximum price range and cost variation are seen for betamethasone dipropionate. Prices of all these topical combination corticosteroids were considered for 1 tube.

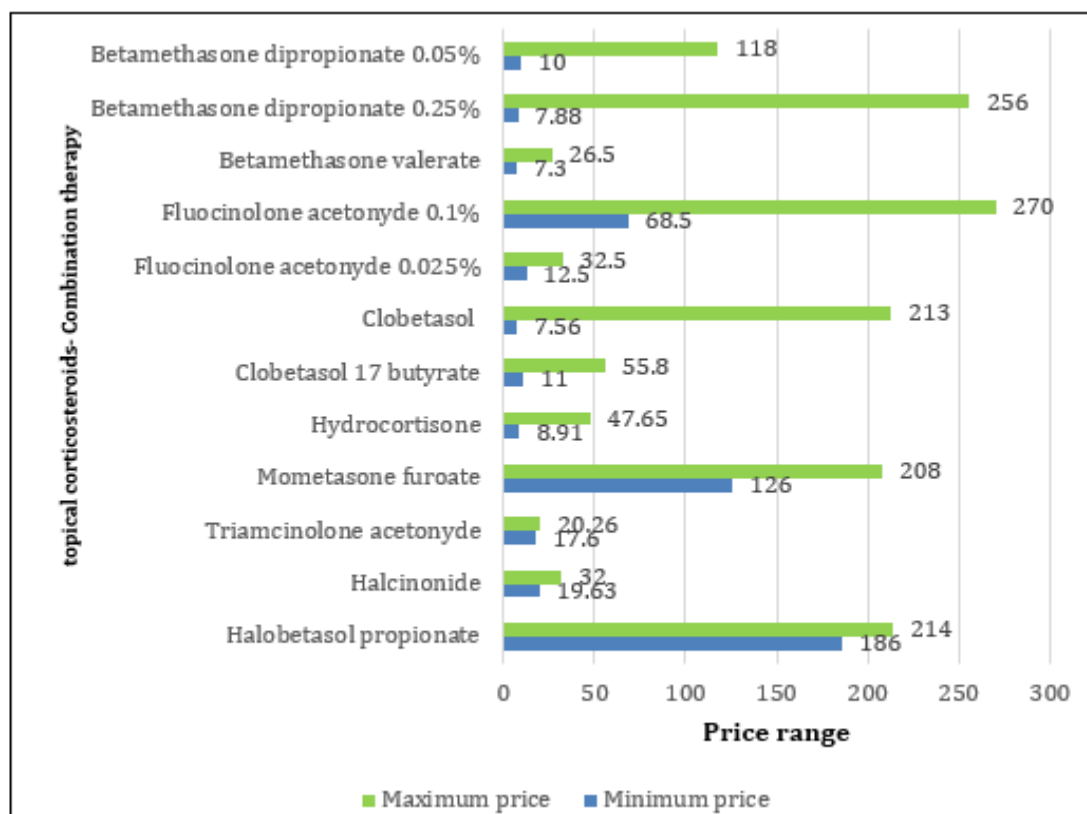


Fig 6: Price range of topical corticosteroids: Combination therapy

Figure 6 shows a cost variation analysis of topical combination corticosteroids available in India. The maximum price range is seen for Fluocinolone acetonide followed by betamethasone dipropionate. Prices of all these topical combinations of corticosteroids were considered for 1 tube.

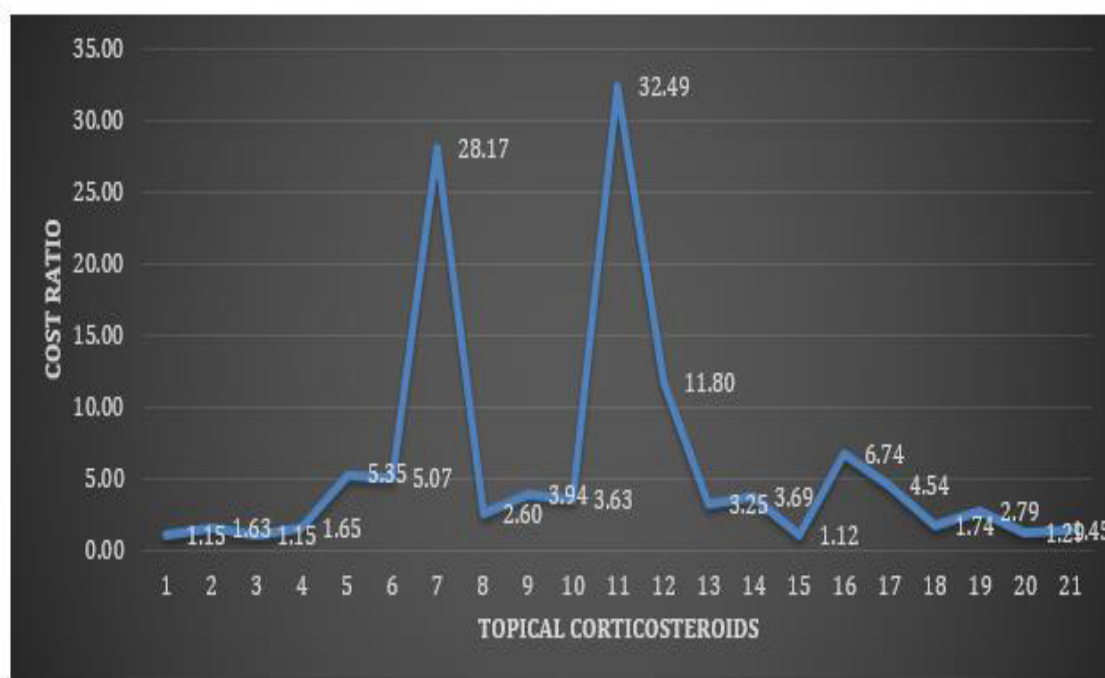


Fig 7: Cost ratio of all topical corticosteroids

Figure 7 shows a line diagram of the cost ratio of all topical corticosteroids. 1st 13 include topical corticosteroids in combination form, and the next 8 include topical corticosteroids in monotherapy form. It ranged from 1.15 to 32.49

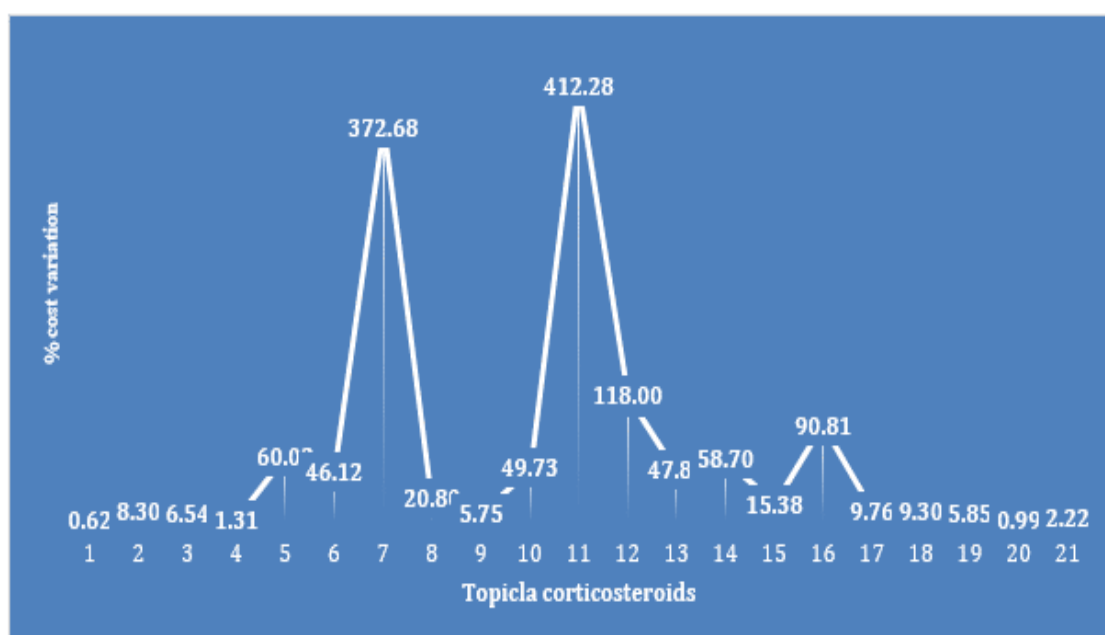


Fig 8: % cost variation of all topical corticosteroids

Figure 8 shows a line diagram of the % cost variation of all topical corticosteroids. 1st 13 include topical corticosteroids in combination form, and the next 8 include topical corticosteroids in monotherapy form. It ranged from 0.62 to 412.28

Table 8: Cost ratio of all corticosteroids

Drug name	Dosage form	Route	Minimum price (INR)	Maximum price (INR)	Cost ratio
Prednisolone	Tablet	Oral	3.82	69	18.06
Dexamethasone	Tablet	Oral	2.03	2.9	1.42
Betamethasone	Tablet	Oral	3.70	4.85	1.310
Deflazacort	Tablet	Oral	53	90	1.6
Deflazacort	Syrup	Oral	65	85	1.307
Hydrocortisone acetate	Injection	Parenteral	36.30	40	1.101
Hydrocortisone sodium	Injection	Parenteral	38.34	72	1.87

succinate					
Dexamethasone	Injection	Parenteral	5.78	9.5	1.643
Betamethasone	Injection	Parenteral	4.4	47.3	10.75
Triamcinolone	Injection	Parenteral	45	106.8	18.06
Beclomethasone dipropionate	Monotherapy	Topical	6.8	22.11	3.25
Betamethasone dipropionate	Monotherapy	Topical	6.3	23.3	3.69
Betamethasone valerate	Monotherapy	Topical	7.3	8.2	1.12
Clobetasol propionate	Monotherapy	Topical	7.42	50	6.738
Mometasone furoate	Monotherapy	Topical	46.6	212	4.54
Halcinonide	Monotherapy	Topical	18.69	32.5	1.738
Fluticasone propionate	Monotherapy	Topical	47.75	133.4	2.79
Desonide	Monotherapy	Topical	130	167.8	1.293
Halobetasol propionate	Monotherapy	Topical	65.3	95	1.45
Halobetasol propionate	Combination therapy	Topical	186	214	1.150
Halcinonide	Combination therapy	Topical	19.63	32	1.630
Triamcinolone acetonide	Combination therapy	Topical	17.6	20.26	1.151
Mometasone furoate	Combination therapy	Topical	126	208	1.65
Hydrocortisone	Combination therapy	Topical	8.91	47.65	5.34
Clobetasol 17 butyrate	Combination therapy	Topical	11	55.8	5.072
Clobetasol	Combination therapy	Topical	7.56	213	28.174
Fluocinolone acetonide	Combination therapy	Topical	12.50	32.5	2.6
Fluocinolone acetonide	Combination therapy	Topical	68.5	270	3.941
Betamethasone valerate	Combination therapy	Topical	7.3	26.5	3.630
Betamethasone dipropionate	Combination therapy	Topical	7.88	256	32.4896
Betamethasone dipropionate	Combination therapy	Topical	10	118	11.8

Table 8 shows the minimum price, maximum price, and cost ratio of all corticosteroids (oral, parenteral, and topical forms) available in India.

Table 9: Percentage price variation of all corticosteroids					
Drug name	Dosage form	Route	% cost variation	No of brands	Class of drugs
Prednisolone	Tablet	Oral	472.8	2	Corticosteroids
Dexamethasone	Tablet	Oral	70.372	3	Corticosteroids
Betamethasone	Tablet	Oral	35.42	4	Corticosteroids
Deflazacort	Tablet	Oral	3.203	2	Corticosteroids
Deflazacort	Syrup	Oral	2.01	3	Corticosteroids
Hydrocortisone acetate	Injection	Parenteral	3.03	4	Corticosteroids
Hydrocortisone sodium succinate	Injection	Parenteral	4.8	3	Corticosteroids
Dexamethasone	Injection	Parenteral	28.43	3	Corticosteroids
Betamethasone	Injection	Parenteral	244.31	2	Corticosteroids
Triamcinolone	Injection	Parenteral	472.848	4	Corticosteroids
Beclomethasone dipropionate	Monotherapy	Topical	47.815	2	Corticosteroids
Betamethasone dipropionate	Monotherapy	Topical	58.70	5	Corticosteroids
Betamethasone valerate	Monotherapy	Topical	15.38	4	Corticosteroids
Clobetasol propionate	Monotherapy	Topical	90.81	3	Corticosteroids
Mometasone furoate	Monotherapy	Topical	9.76	4	Corticosteroids
Halcinonide	Monotherapy	Topical	9.30	2	Corticosteroids

Fluticasone propionate	Monotherapy	Topical	5.85	3	Corticosteroids
Desonide	Monotherapy	Topical	0.99	5	Corticosteroids
Halobetasol priopionate	Monotherapy	Topical	2.22	4	Corticosteroids
Halobetasol propionate	Combination therapy	Topical	0.618	4	Corticosteroids
Halcinonide	Combination therapy	Topical	8.304	4	Corticosteroids
Triamcinolone acetonide	Combination therapy	Topical	6.540	3	Corticosteroids
Mometasone furoate	Combination therapy	Topical	1.31	3	Corticosteroids
Hydrocortisone	Combination therapy	Topical	60.02	5	Corticosteroids
Clobetasol 17 butyrate	Combination therapy	Topical	46.11	4	Corticosteroids
Clobetasol	Combination therapy	Topical	372.67	5	Corticosteroids
Fluocinolone acetonide	Combination therapy	Topical	20.8	3	Corticosteroids
Fluocinolone acetonide	Combination therapy	Topical	5.754	5	Corticosteroids
Betamethasone valerate	Combination therapy	Topical	49.727	3	Corticosteroids
Betamethasone dipropionate	Combination therapy	Topical	412.275	3	Corticosteroids
Betamethasone dipropionate	Combination therapy	Topical	118	2	Corticosteroids

Table 9 shows the percentage price variation of all corticosteroids (oral, parenteral, and topical forms) available in India. A non-significant, very small negative relationship exists between X and Y ($r(29) = .184, p = .322$). (X-axis: % price variation and y-axis: no of brands).

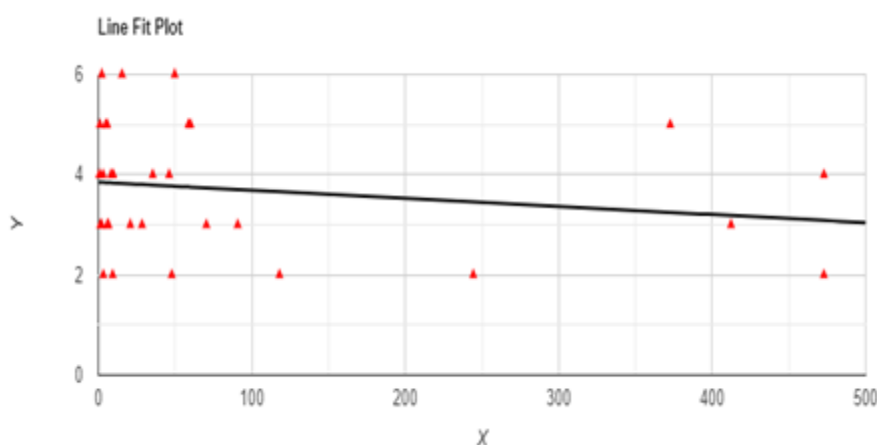


Fig 9: Correlation between % price variation and no of brands

Figure 9 shows a correlation between % price variation and the number of brands of all corticosteroids. There is a very small non-significant correlation.

5. DISCUSSION

Studies on cost variation analysis on corticosteroids were very few. Some researchers focussed on cost variations of medications like anticoagulants, antiplatelets, and fibrinolytics.^{18,19} Cost variations have also been found among other medications like antihypertensives and anxiolytics.²⁰⁻²² These studies serve as proof to formulate regularized drug-pricing policies across various nations. Some studies were done on the comparative effectiveness of generic and branded medications and found the associated clinical outcomes comparable. They concluded that instilling more

confidence among patients in the quality of generic medicines helps to reduce cost variations.^{23,24} Based on the WHO's essential medicine list, most countries follow and maintain a national list of essential medicines.²⁵ It is found that approximately 20 million people in India fall below the poverty line due to health-related expenditures each year.²⁶ So, medications should be made available for the general masses at cheaper or affordable prices. Oral corticosteroids available in India include hydrocortisone acetate, hydrocortisone sodium succinate, dexamethasone, betamethasone, deflazacort, prednisolone, and triamcinolone. Most of these medications were available both orally and

parenterally, as shown in Table 1. Deflazacort, betamethasone, and dexamethasone were available as topical dosage forms also. Topical corticosteroids available in India include beclomethasone dipropionate, betamethasone benzoate, fluocinolone, desonide, prednicarbate, mometasone, clobetasol, triamcinolone acetonide. Dexamethasone and betamethasone are available as eye drops, as shown in Table 2. Beclomethasone, Beclomethasone dipropionate, Triamcinolone, hydrocortisone, fluocinolone acetamide, dexamethasone trimethyl acetate, Clobetasol trimethyl acetate, Clobetasol 17 butyrate, Beclomethasone valerate were available in combination with antimicrobials, as shown in Table 3. As per our study results, Maximum price range and % cost variation are seen for prednisolone tablets. There is a significant difference in the mean minimum price and mean maximum price, as per the student's t-test ($p=0.0037$), as shown in Table 4. Maximum price range and cost variation are seen for triamcinolone injection followed by betamethasone. There is no significant difference in the mean minimum and maximum prices for parenteral corticosteroids, as per the student's t-test ($p=0.01$). The reason for the non-significance is less sample size. The cost ratio ranges of oral and parenteral corticosteroids % cost variation ranged from 4.8 to 472.8, as shown in Figure 4. Maximum price range and cost variation are seen for topical clobetasol propionate followed by betamethasone dipropionate(monotherapy), as shown in Table 6. Maximum price range and cost variation are seen for betamethasone dipropionate combination therapy, as shown in Table 7. The cost ratio of topical corticosteroids ranged from 1.15 to 32.49, as shown in Figure 7. % cost variation ranged from 0.62 to 412.28, as shown in Figure 8. In the study done by Simran et al.²⁷ authors did a cost variation analysis of antibiotics and corticosteroids used in the dermatology department. Results showed that tablet prednisolone showed a maximum percentage price variation, similar to our study results. Skojec et al.²⁸ found many differences in generic topical corticosteroids in the same class. There were also important differences in the cost per gram for various size tubes of the same medication drug like triamcinolone acetonide, 0.01%, which was \$0.24 per gram as a 15-g tube when compared to \$0.02 per gram in a 454-g jar. There were also cost differences among corticosteroids(topical) as per the potency or unit size. Avik Ray- did a study based on cost variation analysis of thrombolytic drugs based on the December 2019 edition of CIMS and Monthly Index of Medical Specialities Books. They calculated the cost ratio and % cost variation. Results showed that the % cost variation was highest for prasugrel 10 mg tablets and lowest for fondaparinux injection. Under the Jan Aushadhi scheme (JAS), the acenocoumarol tablet had the highest cost variation of around 680.09%. The authors concluded that there are wide variations in the costs of various medications available in the Indian market.²⁹ Sometimes, If the physician informs the reference drug to have a sub-therapeutic response or side effects for the generic drug, the patient may end up paying an excess amount for the cost variation between the preferred and the

reference drug). Medication concordance in clinical practice should be based on shared decision-making between patient and doctor.³⁰ Many nations are using this strategy to decrease enhanced pharmaceutical spending. 31 One study done in Telangana indicated that providing healthcare professionals with a manual of comparative drug prices can cause a reduction in the patient's expenditure on medications.³²

5.1 LIMITATIONS

Our study has a few limitations.

1. We considered only a few brands of different drugs, as mentioned in the drug today book though many other brands are available in the market as per CIMS and MIMS books.
2. Prices per the dosage form, like cream, gel, lotion, or ointment, were not considered for topical corticosteroids.

Similar studies should be done on a larger scale based on the same therapeutic group of medications to overcome these limitations and help us to provide a better picture of cost variation in the Indian pharmaceutical market.

6. CONCLUSION

The current study assessed the no. of brands available, minimum and maximum price, cost ratio, percentage cost variation, and mean price of corticosteroids available in the Indian market. We conclude that there is a huge variation in pricing among corticosteroids. There is also a wide variation in the costs of different brands of the same corticosteroids available in India. Decreasing the cost variation and improving the affordability of drugs helps improve medication compliance. Physicians should also be made aware of the prices of various medications while encouraging them to prescribe generic medicines.

7. ACKNOWLEDGMENTS

We want to express our sincere thanks to our college's Principal, Superintendent, and institutional ethics committee.

8. AUTHORS CONTRIBUTION STATEMENT

Dr. Ramya R planned the study and drafted the study. Dr. Supriya designed the methodology. Dr. Jhansi Vani monitored the complete process. Dr. Rajesh Dupaguntla did data analysis using statistical software. All the authors read and approved the final version of the manuscript.

9. CONFLICTS OF INTEREST

Conflicts of interest declared none.

10. REFERENCES

1. Walley T, Haycox A. Pharmacoeconomics: basic concepts and terminology. Br J Clin Pharmacol. 1997;43(4):343-8. doi: 10.1046/j.1365-2125.1997.00574.x. (PMC Free article). PMID: 9146844 [CrossRef] Google Scholar.
2. McIntosh E, Luengo-Fernandez R. Economic evaluation. Part 1: Introduction to the concepts of economic evaluation in health care. J Fam Plann Reprod Health Care. 2006;32(2):107-12.

- doi: 10.1783/147118906776276549 PMID: 16824302 [CrossRef] Google Scholar.
3. Murphy EM, Rodis JL, Mann HJ. Three ways to advocate for the economic value of the pharmacist in health care. *J Am Pharm Assoc* (2003). 2020;60(6):e116-24. doi: 10.1016/j.japh.2020.08.006 PMID: 32863183.
 4. Meena DK, Jayanthi M. Cost analysis of different antibiotic brands available in the Indian market concerning National list of essential medicines. *Indian J Community Med*. 2021 January-March;46(1):93-6. doi: 10.4103/ijcm.IJCM_296_20. PMID: 34035585 PMCID: PMC8117914.
 5. Advani M, Seetharaman R, Pawar M, Naik B. A cost-variation analysis of drugs available in the Indian market for managing diabetic nephropathy. *Cureus*. 2022 5 October;14(10):e29942. doi: 10.7759/cureus.29942 PMID: 36348866 PMCID: PMC9635218.
 6. Sarangi SC, Kaur N, Tripathi M, Gupta YK. Cost analysis study of neuropsychiatric drugs: role of National List of Essential Medicines, India. *Neurol India*. 2018 September-October;66(5):1427-33. doi: 10.4103/0028-3886.241345 PMID: 30233018.
 7. Ray A, Najmi A, Khandelwal G, Sadasivam B. A cost variation analysis of drugs available in the Indian market for the management of thromboembolic disorders. *Cureus*. 2020 5 May;12(5):e7964. doi: 10.7759/cureus.7964 PMID: 32523821 PMCID: PMC7273361.
 8. Tonin FS, Aznar-Lou I, Pontinha VM, Pontarolo R, Fernandez-Llimos F. Principles of pharmacoeconomic analysis: the case of pharmacist-led interventions. *Pharm Pract (Granada)*. 2021;19(1):2302. doi: 10.18549/PharmPract.2021.1.2302 PMID: 33727994.
 9. Elliott RA, Putman K, Davies J, Annemans L. A review of the methodological challenges in assessing the cost-effectiveness of pharmacist interventions. *Pharmacoeconomics*. 2014;32(12):1185-99. doi: 10.1007/s40273-014-0197-z PMID: 25145799 [CrossRef] Google Scholar.
 11. Pontinha VM, Wagner TD, Holdford DA. Point-of-care testing in pharmacies-An evaluation of the service from the lens of resource-based theory of competitive advantage. *J Am Pharm Assoc* (2003). 2021;61(2):e45-54. doi: 10.1016/j.japh.2020.11.005 PMID: 33309067.
 12. Newman TV, San-Juan-Rodriguez A, Parekh N, et al. Impact of community pharmacist-led interventions in chronic disease management on clinical, utilization, and economic outcomes: An umbrella review. *Res Soc Admin Pharm*. 2020;16(9):1155-65. doi: 10.1016/j.sapharm.2019.12.016 PMID: [CrossRef]. Google Scholar.
 13. National health accounts; 2004-05 [Internet]. People's Archive of Rural India. 2018. Accessed 11 May 2023. <https://ruralindiaonline.org/library/resource/national-health-accounts-2004-05/>.
 14. The drugs (prices control) order; 2013 [Internet]. Nic.in. Accessed 11 May 2023. http://www.nppaindia.nic.in/wp-content/uploads/2018/12/DPCO2013_03082016.pdf.
 15. Bureau ET. NPPA hikes 21 formulations' prices by 50% [Internet]. *Economic Times*; 2019. Accessed 11 May 2023. https://economictimes.indiatimes.com/industry/healthcare/biotech/pharmaceuticals/nppa-hikes-21-formulations-prices-by-50/articleshow/72574471.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst.
 16. Chandna H. Modi Govt allows 15-20% price hike in medicines that have 'innovations' [Internet]. *The Print*; 2019. Accessed 11 May 2023. <https://theprint.in/health/modi-govt-allows-15-20-price-hike-in-medicines-that-have-innovations/337346/>.
 17. Mukherjee K. A cost analysis of the Jan Aushadhi scheme in India. *Int J Health Policy Manag*. 2017 1 May;6(5):253-6. doi: 10.15171/ijhpm.2017.02 PMID: 28812812 PMCID: PMC5417146.
 18. Ray A, Najmi A, Khandelwal G, Sadasivam B. A cost variation analysis of drugs available in the Indian market for the management of thromboembolic disorders. *Cureus*. 2020;12(5):e7964. (PMC Free article). doi: 10.7759/cureus.7964 PMID: 32523821 Google Scholar.
 19. Price variation analysis of various brands of anticoagulants, fibrinolytics, and antiplatelet drugs currently available in Indian pharmaceutical market. Deepak KR, Geetha A. *Natl J Physiol Pharm Pharmacol*. 2019;9:368-72. Google Scholar.
 20. Price variation analysis of various drugs used for thromboembolic disorders currently available in Indian pharmaceutical market. Kanani NJ, MistryVR. *Int J Res Pharmacol Pharmacother*. 2019;8:294-301. Google Scholar.
 21. Jadhav NB, Bhosale MS, Adhav CV. Cost analysis study of oral antidiabetic drugs available in Indian market. *Int J Med Res Health Sci*. 2013;2:63-9.
 22. Kumar R, Manu C, Singh DJ, Lakhani P, Tutu S, Dixit R. The extent of price variation amongst branded antihypertensive drugs and its association with a number of pharmaceutical companies. *Int J Res Med Sci*. 2015;3:2800-6. doi: 10.18203/2320-6012.ijrms20150689 Google Scholar.
 23. Chawan VS, Badwane SV, Gawand KV, Chhaya MU. Analysis of price variation amongst different formulations of anxiolytic drugs available in the Indian market. *Int J Res Med Sci*. 2016;4:2398-401. doi: 10.18203/2320-6012.ijrms20161821 Google Scholar.
 24. Desai RJ, Sarpatwari A, Dejene S, Khan NF, Lii J, Rogers JR, et al. Comparative effectiveness of generic and brand-name medication use: a database study of US health insurance claims. *PLOS Med*. 2019;16(3):e1002763. (PMC Free article). doi: 10.1371/journal.pmed.1002763 PMID: 30865626 Google Scholar.
 25. Singal GL, Nanda A, Kotwani A. A comparative evaluation of price and quality of some branded versus branded-generic medicines of the same manufacturer in India. *Indian J Pharmacol*. 2011;43(2):131-6. (PMC Free article). doi: 10.4103/0253-7613.77344 PMID: 21572645 Google Scholar.
 26. IFPMA. A new study reveals how the essential medicines list operates [Internet]. IFPMA; 2015. Accessed 11 May 2023. <https://www.ifpma.org/news/new-study-reveals-how-the-essential-medicines-list-operates/>.
 27. Selvaraj S, Farooqui HH, Karan A. Quantifying the financial burden of households' out-of-pocket payments on medicines in India: a repeated cross-sectional analysis of National Sample Survey data, 1994-2014. *BMJ*, (Open). 2018 31 May;8(5):e018020.

- doi: 10.1136/bmjopen-2017-018020 PMID: 29858403 PMCID: PMC5988077.
28. Simran S, Chandrashekar SB, Anil A, Jerold Joel J, Shanmukha Girisha B. Cost Analysis of Various Brands of Antibiotics and Corticosteroids in Dermatology Department. *J Young Pharm.* 2020;12(2):178-81. doi: 10.5530/jyp.2020.12.36.
29. Skojec A, Foulke G, Kirby JS. Variation in the cost of generic topical corticosteroids. *JAMA Dermatol.* 2015 November;151(11):1255-6. doi: 10.1001/jamadermatol.2015.2394 PMID: 26288382.
30. Ray A, Najmi A, Khandelwal G, Sadasivam B. A cost variation analysis of drugs available in the Indian market for the management of thromboembolic disorders. *Cureus.* 2020 5 May;12(5):e7964. doi: 10.7759/cureus.7964 PMID: 32523821 PMCID: PMC7273361.
31. Atal S, Sadasivam B, Ahmed SN, Ray A. Medication concordance in modern medicine - a critical appraisal from an Indian perspective. *J Fam Med Prim Care.* 2019;8(4):1313-8. (PMC Free article). doi: 10.4103/jfmpc.jfmpc_176_19 PMID: 31143713 Google Scholar.
32. Lee JL, Fischer MA, Shrank WH, Polinski JM, Choudhry NK. A systematic review of reference pricing: implications for US prescription drug spending. *Am J Manag Care.* 2012 1 November;18(11):e429-37. PMID: 23198752.
33. Acosta A, Ciapponi A, Aaserud M, Vietto V, Austvoll-Dahlgren A, Kösters JP et al. Pharmaceutical policies: effects of reference pricing, other pricing, and purchasing policies. *Cochrane Database Syst Rev.* 2014 16 October;2014(10):CD005979. doi: 10.1002/14651858.CD005979.pub2 PMID: 25318966 PMCID: PMC6703418.