Clinical and economic burden attributable to serotypes in current pneumococcal conjugate vaccines in Turkey

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INTRODUCTION

- Pneumococcal disease (PD), caused by streptococcus pneumoniae, is associated with over 100 serotypes, of which only a limited number are responsible for most PD cases. [1]
- Turkey has a long history of using pneumococcal conjugate vaccination (PCV) within National Immunization Program (NIP), starting in 2008 with PCV7, switching to PCV13 in 2011, and adopting 2+1 schedule in 2019 which lead to a significant reduction in PD cases.[2-5] Additionally, in 2016, adult vaccination with PCV13 was included. [6]
- However, even in countries with routine PCV vaccination, disease remains, especially disease due to serotypes not covered by currently implemented vaccines.



Figure 2: Vaccine-Typed Serotype Coverage

• The introduction of higher-valency PCVs would be expected to further reduce the burden of PD and are being made available in the Turkish population.

OBJECTIVE

 This study aims to estimate annual clinical and economic burden associated with pneumococcal serotypes included in PCV13, PCV15 and PCV20 in Turkish populations.

METHODS

Model Overview

- A decision-analytic model was used to quantify annual number of pneumococcal cases, deaths, and associated costs resulting from Invasive PD (IPD), and non-invasive PD, including hospitalized pneumonia, non-hospitalized pneumonia, and acute otitis media (AOM), caused by PCV serotypes among Turkish population. (Figure 1)
- Clinical burden of disease was estimated by comparing the number of pneumococcal disease cases and deaths cause by serotypes contained in pneumococcal conjugate vaccines (PCVs) in the current situation.
- The economic burden was estimated by comparing the direct and indirect medical costs associated with cases of IPD, hospitalized and non-hospitalized pneumonia and AOM caused by PCVs serotypes.
- Population data from 2024 were sourced from the Turkish Statistical Institute. [7]
- Serotype distribution was extracted from a local study starting from 2015 representing 24 different centers located in all geographical regions of Turkey. [8,9] (Figure 2)
- Age-specific epidemiologic inputs (incidence rates for invasive pneumococcal disease, non/hospitalized pneumonia, otitis media) were sourced from United States due to lack of active surveillance data in Turkey and similarity between vaccine implementation in US in terms of valency and schedules. [10] (Table 1)
- Direct and indirect medical costs were mainly derived from local reports. [11-13] Indirect costs were measured using the human capital approach which captured productivity losses due to illness. All costs were inflated to 2024 values in Turkish Lira. [7]
- IPD and hospitalized pneumonia carry a risk of death, and their respective case fatality rates (CFRs) were taken from published reports and literature. [14]

0.070	<5 years	5 to 17 years	18 to 64 years	65+ years
■ PCV-13	43.5%	40.0%	60.6%	62.5%
PCV-15	43.5%	40.0%	62.8%	66.0%
PCV-20	52.2%	57.1%	70.3%	78.1%

RESULTS

- PCV13 serotypes are responsible for 673,273 annual PD cases with 2,349 deaths, corresponding to ₹5.15 billion in direct medical costs and ₹1.94 billion in indirect medical costs across all age groups.
- PCV15 serotypes are responsible for 679,154 annual PD cases with 2,468 deaths, corresponding to ₹5.35 billion in direct medical costs and ₹1.96 billion in indirect medical costs across all age groups
- PCV20 serotypes are responsible for 860,259 annual PD cases with 2,882 deaths, corresponding to \$6.27 billion in direct medical costs and \$2.46 billion in indirect medical costs across all age groups
- PCV20 serotypes account for 27.8% more PD cases, 22.7% more deaths, 5.5% higher direct medical costs, and 26.8% higher indirect medical costs compared to PCV13 for the entire population. When compared to PCV15, PCV20 serotypes account for 26.7% more PD cases, 22.7% more deaths, 17.1% higher direct medical costs, and 25.6% higher indirect medical costs across all individuals.

Table 2: Estimated annual clinical burden caused by serotypes contained in different PCVs

	Age < 1 year	Age 1-4 years	Age 5-17 years	Age 18-64 years	Age 65+ years
		Meni	ngitis		
PCV13	4	8	7	168	90
PCV15	4	8	7	175	95
PCV20	5	9	9	195	113
		Bacte	eremia		
PCV13	52	102	88	2,235	1,198
PCV15	52	102	88	2,318	1,267
PCV20	62	123	125	2,591	1,498
		Hospitalized	d pneumonia		
PCV13	633	1,466	1,445	16,035	18,350
PCV15	633	1,466	1,445	16,624	19,392
PCV20	760	1,760	2,065	18,592	22,934
		Non-hospitaliz	zed pneumonia		
PCV13	1,859	14,817	19,148	56,120	35,583
PCV15	1,859	14,817	19,148	58,186	37,603
PCV20	2,230	17,780	27,354	65,072	44,472
		A	MC		
PCV13	69,454	224,970	209,441	-	-
PCV15	69,454	224,970	209,441	-	-
PCV20	83,345	269,964	299,201	-	-
		Total Deaths	due to disease		
PCV13	12	11	24	658	1,644
PCV15	12	11	24	683	1,738
PCV20	15	14	34	764	2,055

The clinical and economic burden were calculated, and the results were stratified into <1 1-4years, 5-17 years, 18 – 64 years and 65 years and above (Table 2,3 and 4)

Figure 1: Derivation of clinical and cost outcomes in the model



Abbreviations: CFR, case fatality rate; IPD, invasive pneumococcal disease; AOM, acute otitis media; PCV, pneumococcal conjugate vaccine; SPn, Streptococcus pneumoniae

Table 1: Key Inputs

				Ag	e Group					
	<12	12-23	24-35	36-47	48-59	5 - 17	18 - 34	35 - 49	50 - 64	65± voars
	months	months	months	months	months	years	years	years	years	UST years
				Population	(in thousar	nds) *				
	934.22	1,031.30	1,078.49	1,116.76	1,187.29	1,6857.98	21,787.86	18,720.68	13,935.00	8,722.81
			Disease	incidence p	er 100,000 i	ndividuals	10]			
IPD	13.70	10.40	4.30	4.30	4.30	1.40	2.30	6.90	15.60	23.70
Hospitalized PNE	684.00	485.00	453.00	235.00	192.00	94.00	122.80	122.80	475.90	1,477.20
Non- hospitalized PNE	2,007.00	3,774.50	3,268.00	3,268.00	3,268.00	1,245.40	622.90	622.90	1,104.30	2,864.50
AOM	64,770.00	62,218.00	38,974.00	38,974.00	38,974.00	11,765.00	-	-	-	-
	_			Case fatal	ity rates, %	[14]				
IPD	7.01	5.26	3.45	3.45	3.45	4.62	4.88	7.91	11.1	14.17
Hospitalized PNE	1.30	0.53	0.40	0.42	0.61	1.34	1.40	1.40	3.80	7.97
			Direct I	Medical Cos	t (per episo	de), も [11-1:	3]			
IPD	247,815.6	247,815.6	247,815.6	247,815.6	247,815.6	247,815.6	259,661.0	259,661.0	259,661.0	150,718.3
Hospitalized PNE	10,596.1	30,900.3	30,900.3	30,900.3	30,900.3	51,204.4	68,687.2	68,687.2	68,687.2	68,687.2
Non- hospitalized PNE	2,070.8	6,038.8	6,038.8	6,038.8	6,038.8	10,006.8	13,423.4	13,423.4	13,423.4	13,423.4
AOM	588.4	538.4	538.4	538.4	538.4	488.4	-	-	-	-
			Indirect	Medical Co	st (per epis	ode), も [11-1	13]			
IPD	62,247.7	62,247.7	62,247.7	62,247.7	62,247.7	62,247.7	70,070.6	70,070.6	70,070.6	70,070.6
Hospitalized PNE	7,574.3	11,189.8	11,189.8	11,189.8	11,189.8	14,805.3	8,547.4	8,547.4	8,547.4	-
Non- hospitalized PNE	1,623.9	2,399.1	2,399.1	2,399.1	2,399.1	3,174.2	1,084.6	1,084.6	1,084.6	-
AOM	2,757.5	2,757.5	2,757.5	2.757.5	2.757.5	2.757.5	-	-	-	-

Table 3: Estimated annual economic burden (direct medical costs) for serotypes contained in PCVs

	Age < 1 year	Age 1-4 years	Age 5-17 years	Age 18-64 years	Age 65+ years
		Menin	ngitis		
PCV13	も 965,309	も 1,905,952	も 1,637,646	も 43,688,810	も 13,595,944
PCV15	も 965,309	も 1,905,952	も 1,637,646	も 45,296,986	も 14,367,831
PCV20	も 1,158,370	も 2,287,142	も 2,339,495	も 50,657,577	も 16,992,245
		Bacter	remia		
PCV13	も 12,824,814	も 25,321,932	も 21,757,303	も 580,437,042	も 180,631,826
PCV15	も 12,824,814	も 25,321,932	も 21,757,303	も 601,802,823	も 190,886,891
PCV20	も 15,389,776	も 30,386,319	も 31,081,861	も 673,022,092	专 225,754,113
		Hospitalized	pneumonia		
PCV13	も 6,712,085	も 45,308,221	も 74,000,643	も1,101,368,596	专1,260,398,702
PCV15	も 6,712,085	も 45,308,221	も 74,000,643	も1,141,909,771	も 1,331,955,698
PCV20	も 8,054,502	も 54,369,866	も 105,715,204	も1,277,047,021	も 1,575,249,484
		Non-hospitalize	ed pneumonia		
PCV13	专 3,848,902	も 89,475,111	も 980,461,279	も 753,324,911	专 477,646,401
PCV15	专 3,848,902	专 89,475,111	も 191,610,147	も 781,054,663	专 504,763,964
PCV20	专 4,618,682	も 107,370,134	も 273,728,781	も 873,487,166	专 596,963,679
		AO	M		
PCV13	专 40,864,146	专 121,123,943	も 102,298,763	-	-
PCV15	专 40,864,146	专 121,123,943	も 102,298,763	-	-
PCV20	も 49,036,975	专 145,348,731	も 146,141,090	-	-

Table 4: Estimated annual economic burden (indirect costs) caused by serotypes contained in PCVs

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	Age < 1 year	Age 1-4 years	Age 5-17 years	Age 18-64 years	Age 65+ years
		Menir	ngitis		
PCV13	も 242,471	も 478,747	も 411,353	も 11,789,612	も 6,382,463
PCV15	も 242,471	も 478,747	も 411,353	も 12,223,586	も 6,744,816
PCV20	も 290,966	も 574,497	も 587,647	も 13,670,164	も 7,976,818
		Bacte	remia		
PCV13	も 3,221,406	も 6,360,500	も 5,465,117	も 156,633,428	も 84,795,579
PCV15	も 3,221,406	も 6,360,500	も 5,465,117	も 162,399,075	も 89,609,704
PCV20	も 3,865,687	も 7,632,600	も 7,807,310	も 181,617,900	も 105,977,729
		Hospitalized	pneumonia		
PCV13	も 4,797,880	も 16,407,273	も 21,396,660	も 137,053,910	ŧ -
PCV15	も 4,797,880	も 16,407,273	も 21,396,660	も 142,098,839	ŧ -
PCV20	も 5,757,456	も 19,688,728	も 30,566,657	も 158,915,270	ŧ -
		Non-hospitaliz	ed pneumonia		
PCV13	专 3,018,269	も 35,546,009	も 60,779,649	も 60,864,942	も -
PCV15	专 3,018,269	も 35,546,009	专 60,779,649	专 63,105,370	も -
PCV20	も 3,621,922	も 42,655,211	も 86,828,070	も 70,573,461	も -
		AC	M		
PCV13	も 191,517,528	专 596,672,731	も 533,443,554	ŧ	ŧ
PCV15	专 191,517,528	も 596,672,731	专 533,443,554	も -	ŧ -

*Population data was extracted from local reports. Proportion of IPD due to meningitis is 7%, and the proportion due to bacteremia is 93% [10] across all age groups Abbreviations: IPD, invasive pneumococcal disease; PNE, pneumonia; AOM, acute otitis media **IPD includes both meningitis and Bacteremia

CONCLUSIONS

- Among all PCV serotypes, PCV20-serotypes account for the highest proportion of clinical and economic burdens of PD in Turkey for individuals aged less than one year, 1-4 years, 5-17 years, 18-64 years and 65 years and older.
- Adopting PCV20 in Turkey is anticipated to provide the highest disease impact by lowering PD cases, deaths and associated medical costs.

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