

# Economic evaluation of extending the Danish age-based pneumococcal polysaccharide vaccination programme to include individuals aged 50-54 and 55-59

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## Background

- Invasive pneumococcal disease (IPD), which in the most severe cases leads to pneumococcal meningitis and/or pneumococcal septicaemia, increases with age, places a substantial burden on the health-care sector, and is associated with excess mortality
- In March 2020, the Danish Parliament decided to offer free vaccination with the 23-valent pneumococcal polysaccharide vaccine (PPSV23) to all persons aged 65 and above and to individuals at an increased risk of pneumococcal disease, aiming for a vaccine coverage rate of 75%
- However, Danish age-level data on IPD incidence suggest that persons in the age range 50-64 years also face an elevated risk of IPD. Hence, it becomes relevant to study the cost-effectiveness of offering vaccination to younger age groups

## Objective

- To evaluate the impact of PPSV23 vaccination on individuals in their 50s by modelling the health economic consequences of an extension of the programme to include individuals aged 50-54 and 55-59 compared with a strategy where no vaccination is offered to these age groups<sup>a</sup>

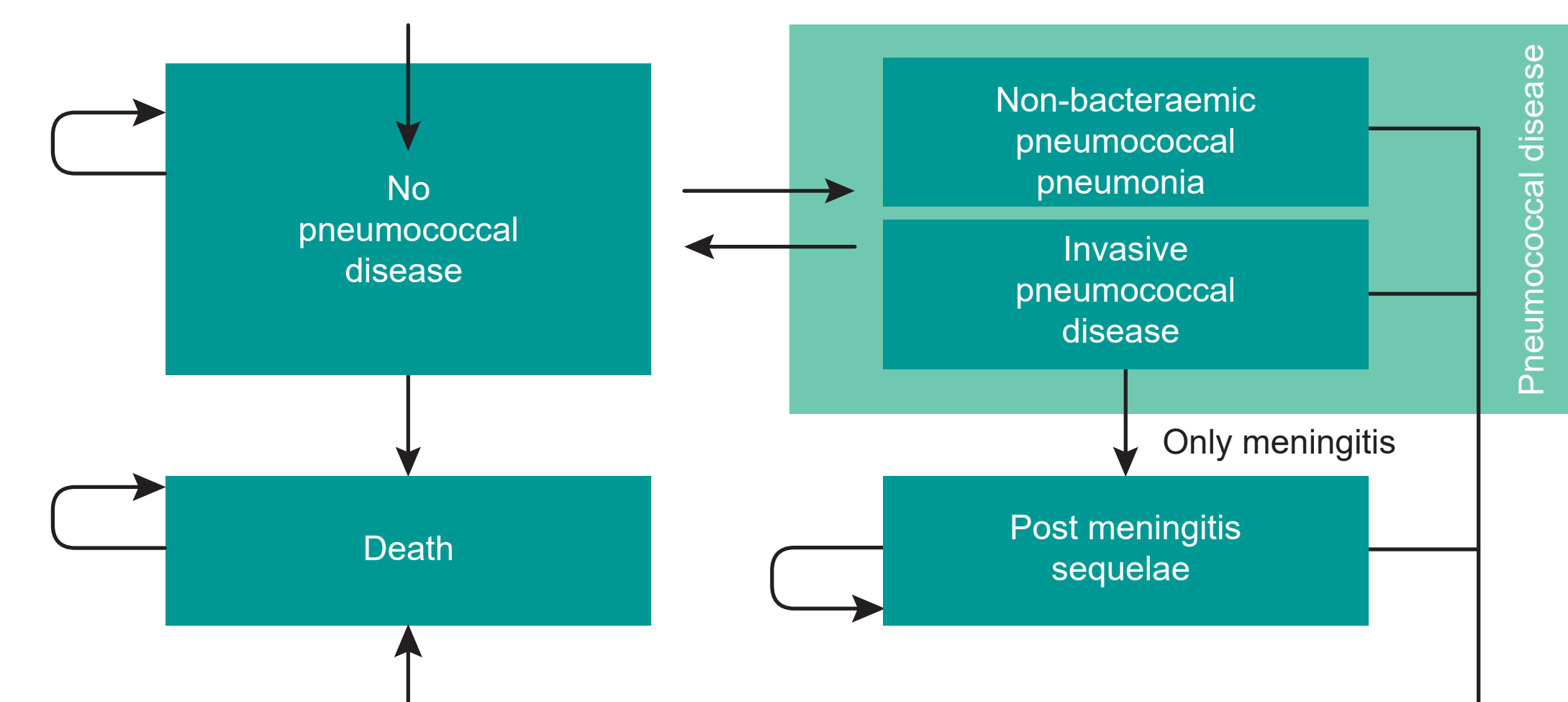
<sup>a</sup>An analysis of inclusion of the 60- to 64-year-olds in the programme has previously been performed.<sup>1</sup>

## Methods

- A Markov model, previously applied for simulation of PPSV23 vaccination of persons aged 60+,<sup>a</sup> was expanded to include 50- to 54- and 55- to 59-year-olds. The model simulates the incidence of IPD and non-bacteraemic pneumococcal pneumonia (NBPP) and their attributable costs. Transition between five health states, including no pneumococcal disease, IPD, NBPP, post-meningitis sequelae (PMS), and death was modelled. The structure of the model is graphically illustrated in **Figure 1**.

<sup>a</sup>An analysis of inclusion of the 60- to 64-year-olds in the programme has previously been performed.<sup>1</sup>

**Figure 1. Model structure**



- The model was populated with Danish input data and followed all Danish adults aged 50-59 for 5 years or until death. Age-specific input data were taken into account. All individuals entered the model with no pneumococcal disease. A 5-year time horizon was applied, and in the first model cycle (year 1), individuals faced a risk of developing IPD or NBPP. The mortality rate for patients who developed IPD or NBPP then followed the case fatality rate for the respective disease. In the next model cycle, a proportion of patients who had IPD in the form of meningitis developed PMS. Patients who survived and recovered then returned to the “no pneumococcal disease” health state.
- Based on serotype surveillance data from the Danish health authorities, the IPD serotype distribution showed that 73.2% of IPD cases were the result of serotypes included in PPSV23. Mortality rates by age group and vaccine effectiveness was based on published data, and is presented in **Table 1**. The key economic inputs are presented in **Table 2**.

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**Table 1. Key clinical inputs**

Input		EURO	Source
<b>IPD</b>			
Incidence per 100,000	Age 50-54	12.40	2
	Age 55-59	25.12	2
Case fatality rate in adults		18%	3
<b>NBPP</b>			
Incidence per 100,000	Age 50-54	232	4-6
	Age 55-59	340	4-6
Case fatality rate	Age 50-54	0.41%	7
	Age 55-59	0.53%	7
<b>IPD serotype distribution</b>			
% serotypes included in PCV13		12.0%	8
% serotypes included in PPSV23		73.2%	8
% non-vaccine serotypes		26.8%	8
<b>Vaccination effectiveness (VE)</b>			
PPSV23 against IPD		73.0%	8
PPSV23 against NBPP		33.0%	9
Waning of VE		10 years	10

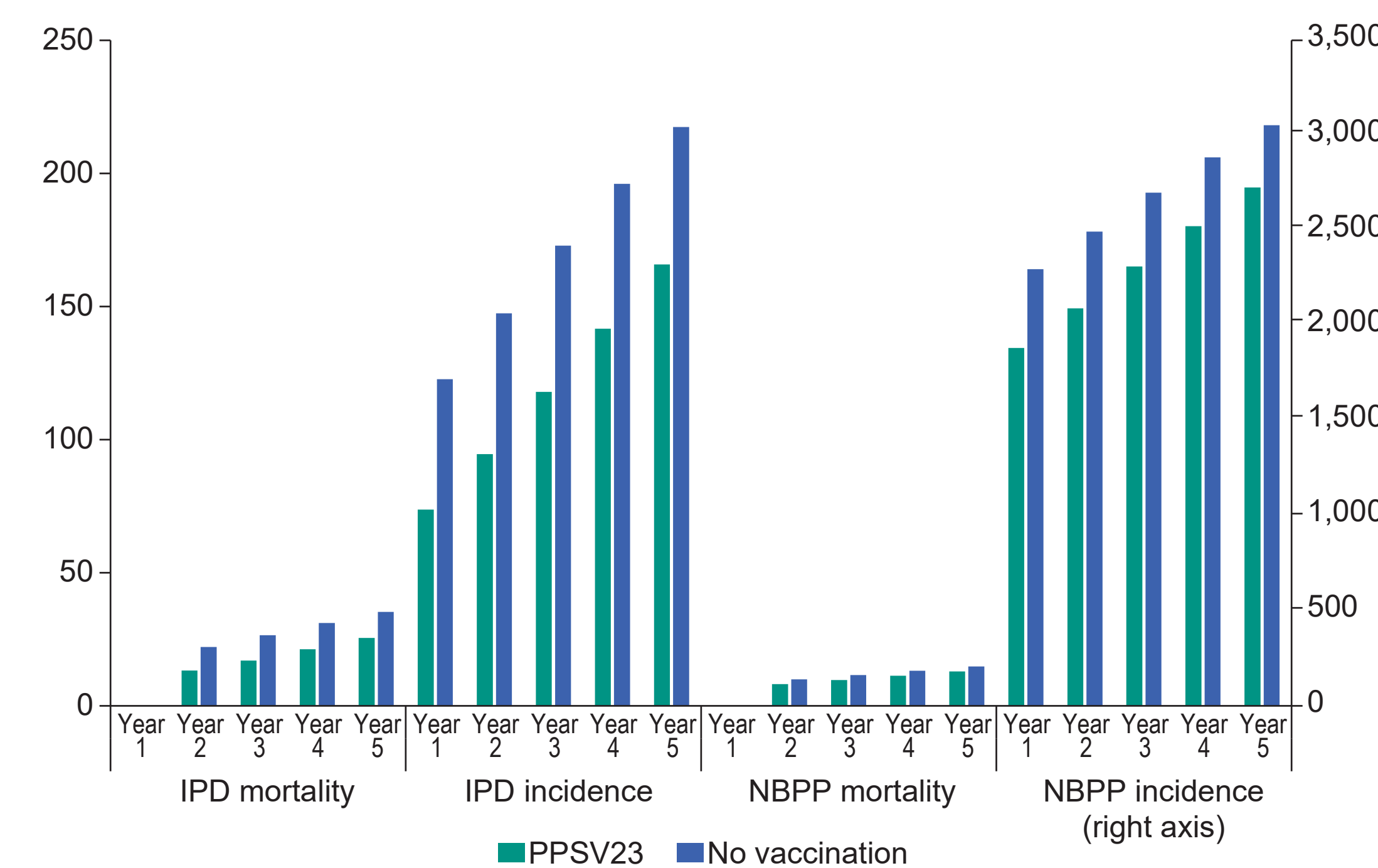
**Table 2. Key economic input**

Input		EURO	Source
<b>Vaccination costs</b>			
Pneumovax® 0.5 mL vial		21.21	11
Cost of administration		19.25	12
<b>Health-care costs</b>			
Cost of IPD		24,342	13
Inpatient cost of NBPP	Age 50-59	21,008	14
	Age 60-64	19,589	14
Outpatient cost of NBPP		58	
Cost of PMS		1,444	13
Productivity loss per day absent	Age 50-54	139	15
	Age 55-59	130	15
<b>Days of absenteeism</b>			
IPD		28	
NBPP		14	
PMS		365.25	
Yearly discount rate		4%	16

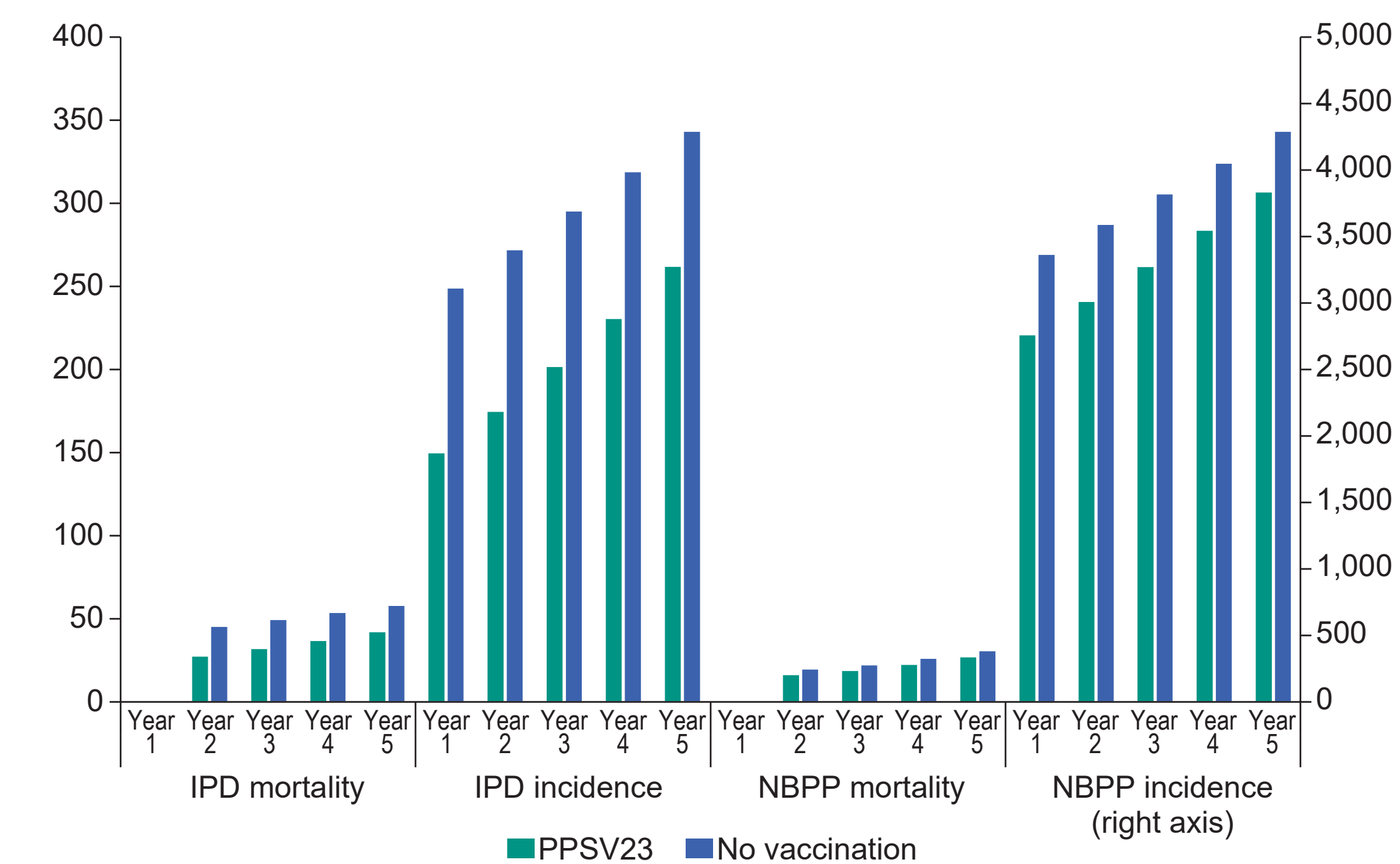
## Results

- Figure 2** and **Figure 3** present the incidence of pneumococcal disease and its associated mortality for years 1-5 in the scenario where PPSV23 is offered to all 50- to 54- and 55- to 59-year-olds with a vaccine uptake of 75%, respectively, compared to the scenario where no vaccination is offered. For the 50- to 54-year-olds, we find that the introduction of a PPSV23-based vaccination programme prevents 263 cases and 38 deaths per 1 million persons in this age group caused by IPD as well as 1,894 cases and 7 deaths per 1 million persons caused by NBPP. Similarly, for the 55- to 59-year-olds, we find that the introduction of a PPSV23-based vaccination programme prevents 461 cases and 68 deaths per 1 million persons in this age group caused by IPD as well as 2,700 cases and 14 deaths per 1 million persons caused by NBPP (**Table 3**).
- From **Table 3**, it can be seen that an extension of the Danish age-based PPSV23 programme to include persons aged 55-59 would lead to saved costs of EUR 522,000 over a 5-year period per 1 million persons in this age group. For the 50- to 54-year-olds, an incremental societal cost of EUR 9.8 million is estimated, corresponding to a net cost of €4,541 per avoided case of pneumococcal disease.

**Figure 2. Yearly incidence of pneumococcal diseases and expected number of annual deaths caused by IPD and NBPP for persons in the age group 50-54 over a 5-year period per 1 million persons**



**Figure 3. Yearly incidence of pneumococcal diseases and expected number of annual deaths caused by IPD and NBPP for persons in the age group 55-59 over a 5-year period per 1 million persons**



**Table 3. Results: Incremental cases (IPD/NBPP incidence and mortality) and incremental costs (vaccination, health-care, and productivity costs) for 50- to 54- and 55- to 59-year-olds (€1,000) over a 5-year period per 1 million persons in each age group**

	Vaccination strategy: No vaccination		Vaccination strategy: PPSV23 (75% uptake)		Incremental cases	
	Age 50-54	Age 55-59	Age 50-54	Age 55-59	Age 50-54	Age 55-59
<b>Incidence</b>						
IPD	857	1,478	594	1,017	-263	-461
NBPP	13,429	19,115	11,536	16,415	-1,894	-2,700
<b>Mortality</b>						
IPD	115	204	77	136	-38	-68
NBPP	50	96	42	82	-7	-14
Disease-free life-years	4,937,090	4,896,912	4,939,358	4,900,270	2,268	3,357
<b>Incremental costs</b>						
<b>Vaccination costs</b>						
Pneumovax® (PPSV23) 0.5 mL vial	–	–	15,906	15,906	15,906	15,906
Cost of administration	–	–	14,440	14,440	14,440	14,440
<b>Health-care cost</b>						
Cost of IPD	20,386	35,143	14,141	24,212	-6,246	-16,289
	[18,679]	[32,352]	[12,898]	[22,186]	[-5,780]	[-15,305]
Cost of NBPP	62,666	89,196	53,829	76,598	-8,837	-82,853
	[57,705]	[82,201]	[49,485]	[70,473]	[-8,219]	[-77,640]
Cost of PMS	532	946	355	627	-177	-271
	[478]	[853]	[318]	[564]	[-160]	[-247]
Productivity loss	30,447	38,393	25,155	31,371	-5,292	-7,021
	[27,971]	[35,380]	[23,080]	[28,873]	[-4,890]	[-6,507]
Total costs	114,031	163,677	123,825	163,155	9,795	-522
	[104,832]	[150,785]	[116,128]	[152,442]	[11,296]	[1,657]

Note: 2019 price level. The results in square brackets are discounted costs.

## Discussion

- The findings from this study show that an introduction of an age-based vaccination programme for persons aged 50-54 and 55-59 leads to significant health gains in terms of reduced IPD incidence and mortality, and consequently reduced healthcare resource utilization. In addition, for the age group of 55-59 years, PPSV23 vaccination also leads to saved costs. The analysis identified the reduction in incidences of NBPP to be a key driver of the cost savings.
- As a result of implemented preventive measures, the incidence of NBPP and IPD have significantly declined during the COVID-19 pandemic. The results presented in this poster represent the expected health economic consequences of extending the current vaccination programme to include persons in the age groups 50-54 and 55-59 in a stable disease period. For pneumococcal disease, carrier stage in children and transmission to older adults and risk groups is expected to rebound after the COVID-19 pandemic, when social distancing is reduced. Therefore, the results extend to a post-COVID-19 period, where the incidence of NBPP and IPD have returned to pre-COVID-19 levels.

## Conclusions

- Currently, persons aged 65+ and some defined groups having an elevated risk of IPD are included in the publicly financed PPSV23 vaccination programme. However, this analysis suggests that an age-based inclusion of 50- to 54- and 55- to 59-year-olds may be beneficial. Vaccination of 50- to 54- and 55- to 59-year-olds leads to health gains in terms of reduced NBPP and IPD incidence and mortality. In addition, for the age group of 55-59 year-olds, PPSV23 vaccination also leads to saved costs.