

Setting priorities for new vaccination programs: An Analysis of Pneumococcal and Herpes Zoster Vaccines

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Objectives

Vaccination is one of the most cost-effective public-health measures and a key tool for primary prevention. Public-health decision-makers seeking to maximize population health subject to given budget constrain. To boost demand for merit goods, financial incentives such as free vaccination programs or co-payments can improve coverage and health equity. This cost comparison analysis evaluates which of two vaccination-programs should be prioritized in Austria: herpes-zoster or pneumococcal-infection. Both currently require out-of-pocket payment. Economic efficiency is assessed by maximizing outcomes under the secondary condition of the rational use of scarce resources. The goal is to quantify medical costs and cases avoided to compare them with vaccination costs.

Methods

The analysis compares direct and indirect costs and cases of both infections with and without vaccination (budget-impact). In the vaccination group, 22% of adults age ≥ 50 are vaccinated; this year or years before. Two structured multi-cohort, population-based models were developed, including the following health-states: healthy, illness due to infection, complications, and death. Costs (in 2023 Euros) are determined from a bottom-up approach for one year based on the health-care-systems and societal perspective. Vaccination costs are based on the pharmacy selling price.

Pneumococcal infection

Epidemiology

Community-Acquired Pneumonia (CAP) cases

- According to DRG data (on-file), an average of 44,420 stationary pneumonias (J12-J18; HDG05.03) ≥ 50 years of age were treated in acute care hospitals.
- In addition, there are outpatient CAP cases to the extent of 5.51/1,000 (Schnoor et al. 2007)

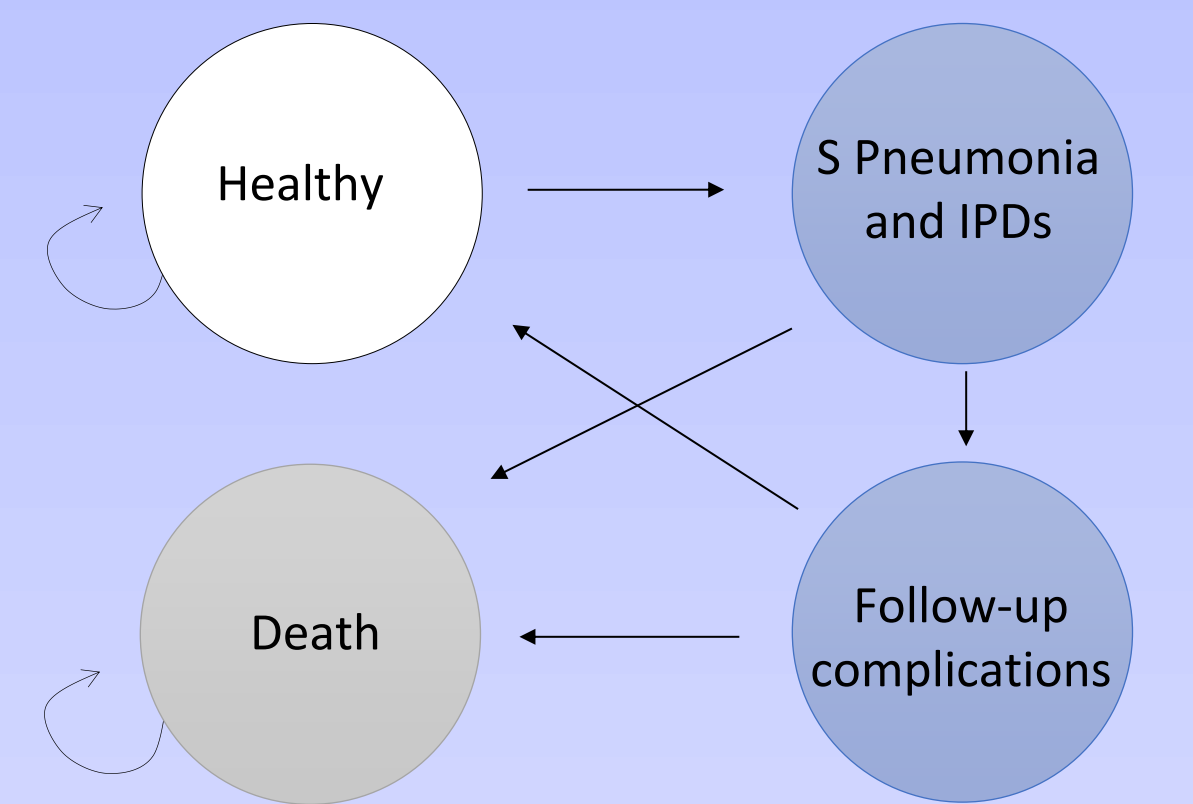
Invasive pneumococcal disease (IPD) cases

- In 2019-2021, an average of 377 cases of IPD were recorded in the ≥ 50 -year-old age group.
- An average incidence rate was used for the analysis as fluctuating rates were observed in recent years.
- This results in an incidence rate of 9.8 / per 100,000 inhabitants.

Source: Pneumococcal annual report 2019-2021

Modeling approach

Fig. 3: Model design of pneumococcal infection



- The cost analysis includes the following health conditions:
 - Healthy
 - S Pneumonia (CAPs)
 - Invasive Pneumococcal Diseases (IPDs)
 - Follow-up complications (epilepsy and deafness)
 - Death from IPDs and S pneumonia

CAP = Community acquired pneumonia;
IPD = Invasive pneumococcal disease

Source: own developed

Vaccine effectiveness

- The analysis considers the vaccine effectiveness (VE) of the sequential vaccination: 1 x PCV15 or PCV20 (conjugated pneumococcal vaccines) and after ≥ 1 year 1 x PPV23 (23-valent polysaccharide vaccines).
- The VE were derived from the CAPTA study and a current budget impact analysis (BIA) of the PCV20 vaccination.
- According to the BIA we assumed an analogous VE for the seven additional serotypes of PCV20 of those recorded in PCV13 (Mugwagwa et al. 2022).

Direct costs

The analysis includes costs of inpatient and outpatient pneumonia treatment, IPD treatment (Pneumonia, Meningitis and Sepsis) including treatment of subsequent complications (neurological problems and deafness). The costs are assessed with reimbursement tariffs. The costs of pneumococcal vaccination are borne by vaccinated people (44.23 € for PPV23, 110.95 € for PCV15 and 119.75 € for PCV20 ; pharmacy selling price).

Indirect costs

Indirect costs include sick leave. Indirect costs are calculated on the basis of the employment rate by age group (share of the working-age population). The duration of work loss is calculated based on ICD-10 for the pneumococcal diseases and for the subsequent complications.

Herpes-Zoster infection

Epidemiology

Herpes-zoster (HZ) cases

- In the adult population, the annual HZ cases are estimated at around 36,900 events. German insurance data were transferred to Austria. Individuals aged ≥ 50 years who were diagnosed with acute HZ in 2007 or 2008 were documented in the insurance data (Ultsch et al. 2011).
- The incidence per 1,000 people in the age group over 50 years is 9.7 and rises to 14.8 cases (ICD-10 code "B02.*" and "G53.0") in the age group over 85 years (Ultsch et al. 2011).

Postherpetic Neuralgia (PHN) cases

- Based on the same data set, there are around 3,280 cases of PHN in the ≥ 50 -year-old age group (Ultsch et al. 2011).
- The incidence per 1,000 people is 1.14 in the over 50 age group and rises to over 1.77 in the over 85 age group (Ultsch et al. 2011).

Fig. 1: CAP cases per year

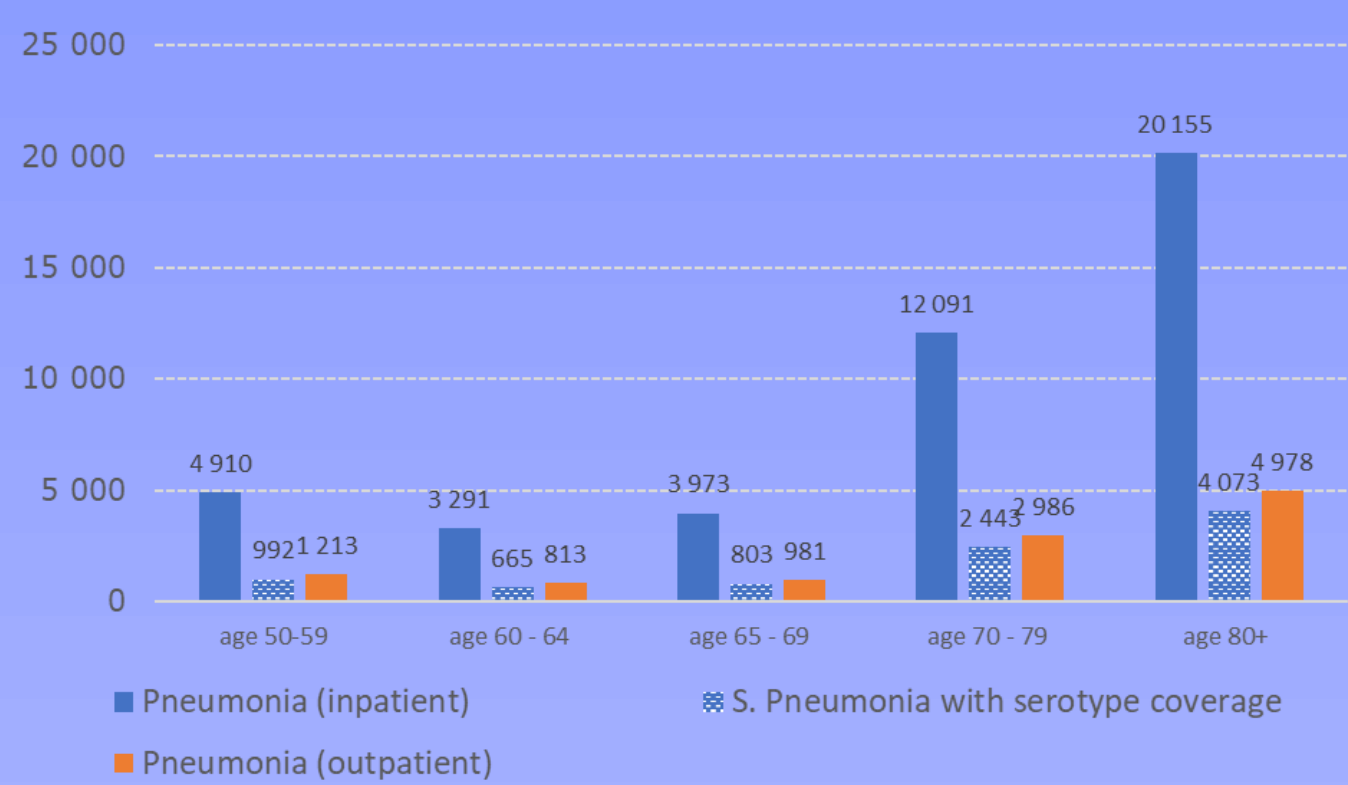
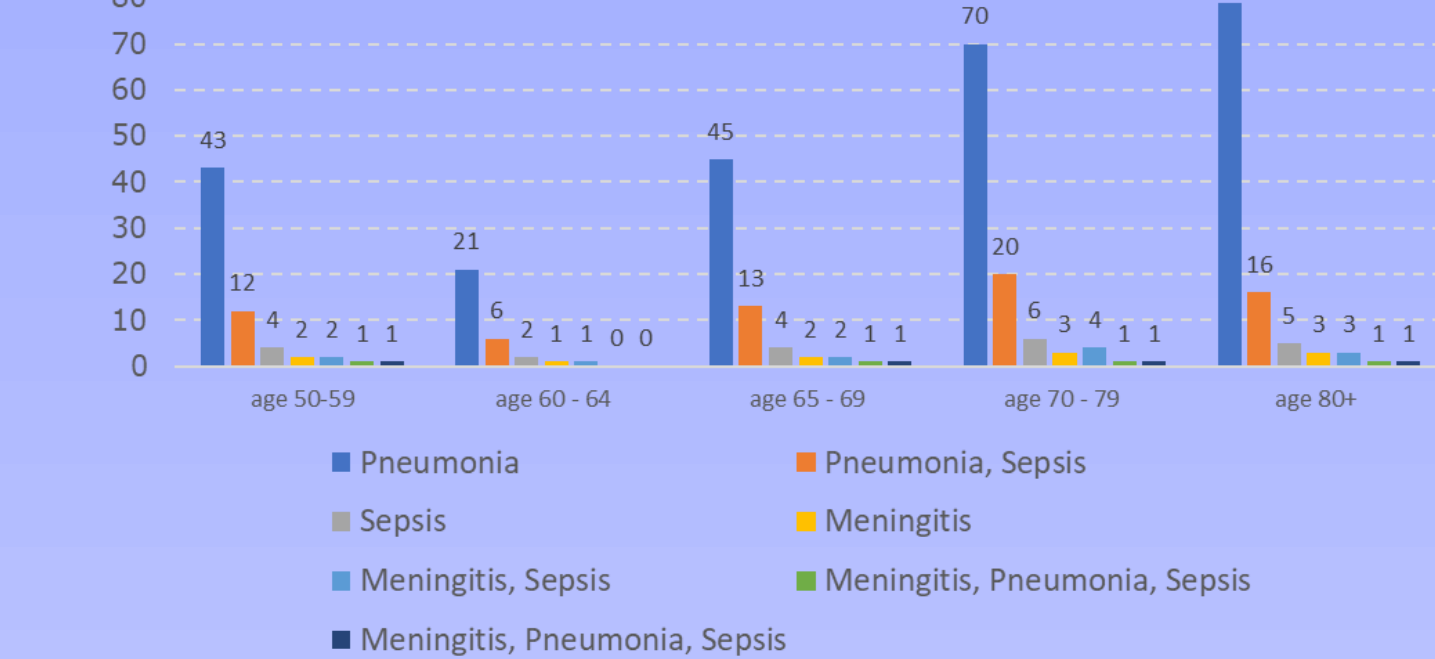


Fig. 2: IPD cases per year



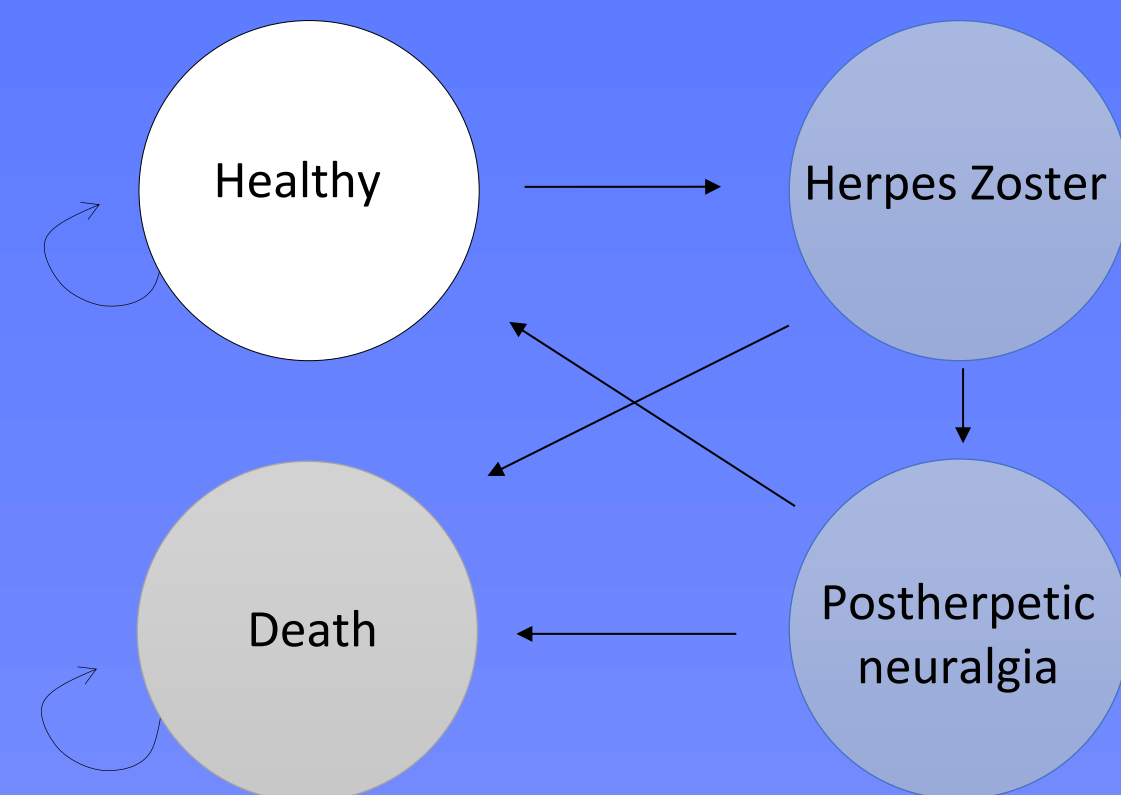
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Funding: This study was funded by a grant from
Pfizer Corporation Austria Gesellschaft m.b.H., Vienna, Austria
Merck Sharp & Dohme Gesellschaft m.b.H., Vienna, Austria

Modeling approach

Fig. 3: Model design of herpes zoster



- The cost analysis includes the following health conditions:
 - Healthy
 - Herpes Zoster (HZ)
 - Follow-up complications considers postherpetic neuralgia (PHN)
 - Death from HZ and PHN

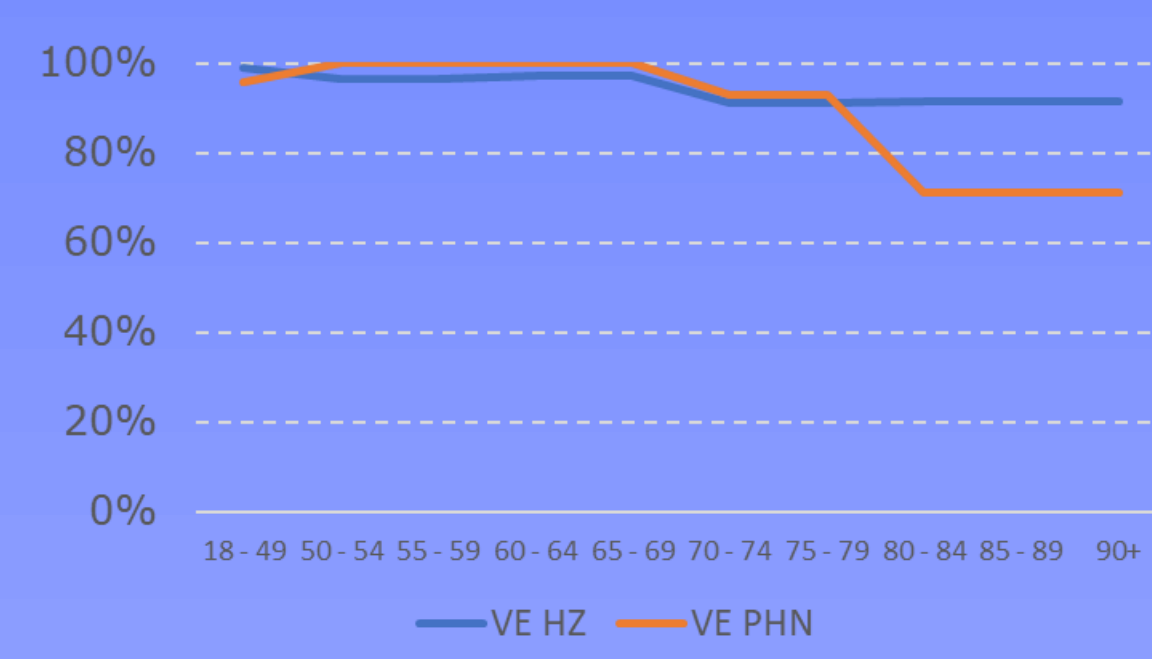
PHN = Postherpetic neuralgia
HZ = Herpes Zoster

Source: own developed

Vaccine effectiveness

- The analysis considers the VE of the recombinant, adjuvanted subunit inactivated vaccine (Shingrix®), against HZ and PHN by age groups .
- It shows a high level of VE in all age groups (between 98.9% and 91.4%) (SmPC Shingrix®, Ultsch et al. 2017).
- Shingrix® demonstrates a high, long-lasting effectiveness (Strezova et al. 2022) in the prevention of HZ and PHN.

Fig. 6: Vaccine effectiveness (VE) against HZ and PHN



Source: SmPC Shingrix®, Ultsch et al. 2017

Direct costs

The analysis includes costs of inpatient and outpatient treatment due to HZ including treatment of subsequent complication of PHN, medication and cost of the remedies (Transcutaneous Electrical Nerve Stimulation and Low-Frequency Electrostimulation Devices). The costs are assessed with reimbursement tariffs. The costs of Shingrix® are borne by vaccinated people (252.25 €; pharmacy selling price).

Indirect costs

Indirect costs include sick leave. Indirect costs are calculated on the basis of the employment rate by age group (share of the working-age population). The duration of work loss is calculated based on ICD-10 for HZ and for the subsequent complication PHN.

Results

Results show that spending 1 € on pneumococcal vaccination saves 1.86 €* in healthcare costs, compared to 0.13 €* for HZ vaccination. From a societal perspective, the savings are 2.24 € and 0.24 €, respectively. To save 1 million euro in healthcare costs, private spending of 7.1 million euro is needed in case of HZ vaccination, but only 43,000 € in case of pneumococcal vaccination. In terms of costs per avoided case, it takes 3,610 € to prevent one case of HZ or PHN, compared to 869 € to prevent one case of pneumococcal disease.

Table 2: Budget-Impact due to HZ and pneumococcal vaccination

Cost components	Impact HZ	Impact PNC
Difference direct costs	-3.9 mill €	-10.0 mill €
Difference indirect costs	-3.0 mill €	-2.1 mill €
Vaccination costs	27.6 mill €	4.3 Mill €
Savings Health care system	-3.9 mill €	-10.0 mill €
Savings Society	-6.9 mill €	-12.1 mill €

* Costs of vaccination including vaccination fee

Cases avoided:

- To prevent a single case of HZ or PHN, the vaccination cost is 3,610 € per case. In comparison, preventing one case of pneumococcal disease, including S. pneumoniae and IPD, requires an investment of 869 €.
- For each hospital stay avoided through HZ vaccination, an investment of 45,577 € is needed, while for pneumococcal vaccination, only 1,889 € is required to prevent one hospital stay.
- Pneumococcal diseases can result in avoidable deaths through vaccination (net reduction of 294 deaths). In contrast, HZ is not associated with significant mortality.

Avoided loss of work:

- To prevent one case of work absenteeism due to HZ or PHN, the vaccination cost is 49,972 €.
- In comparison, avoiding one case of absenteeism due to pneumococcal disease (including S. pneumoniae and invasive pneumococcal disease, IPD) requires an investment of 8,214 €.
- The cost per sick day avoided is 3,314 € for HZ vaccination, compared to 764 € for pneumococcal vaccination.

Sensitivity Analysis

Fig. 10: One-way-sensitivity-analysis pneumococcal vaccination

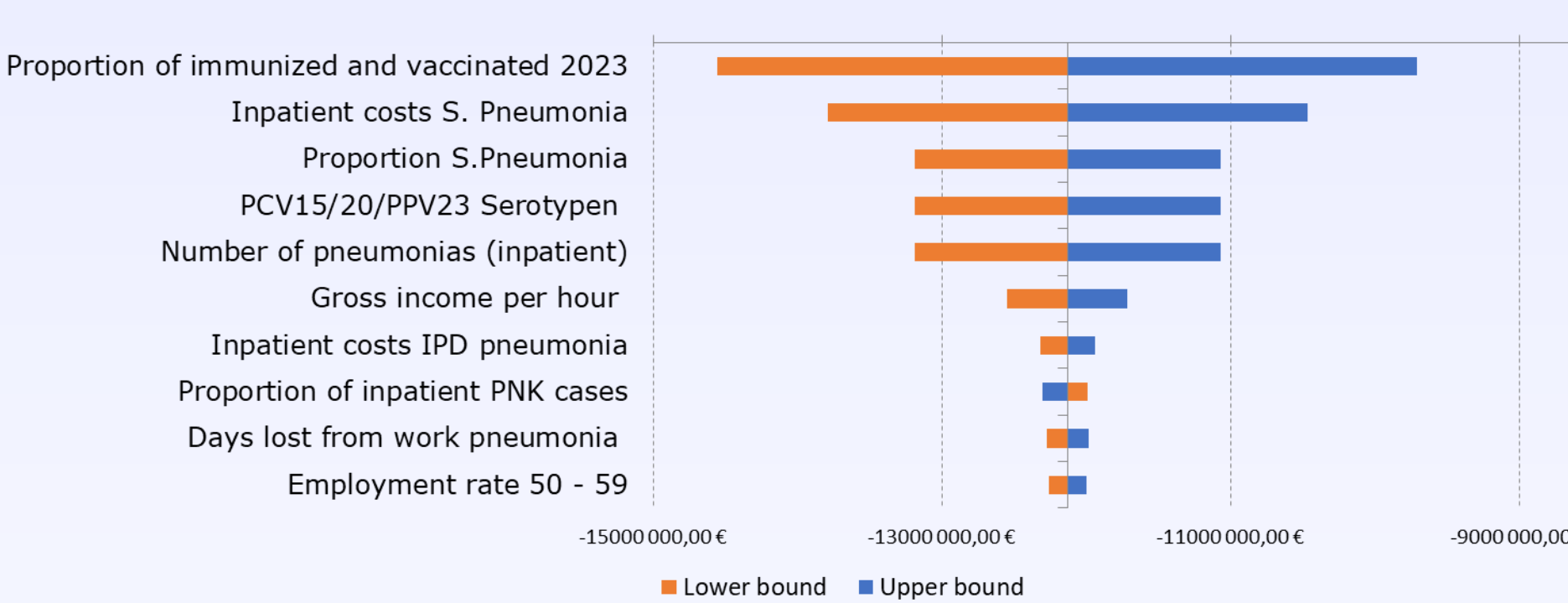
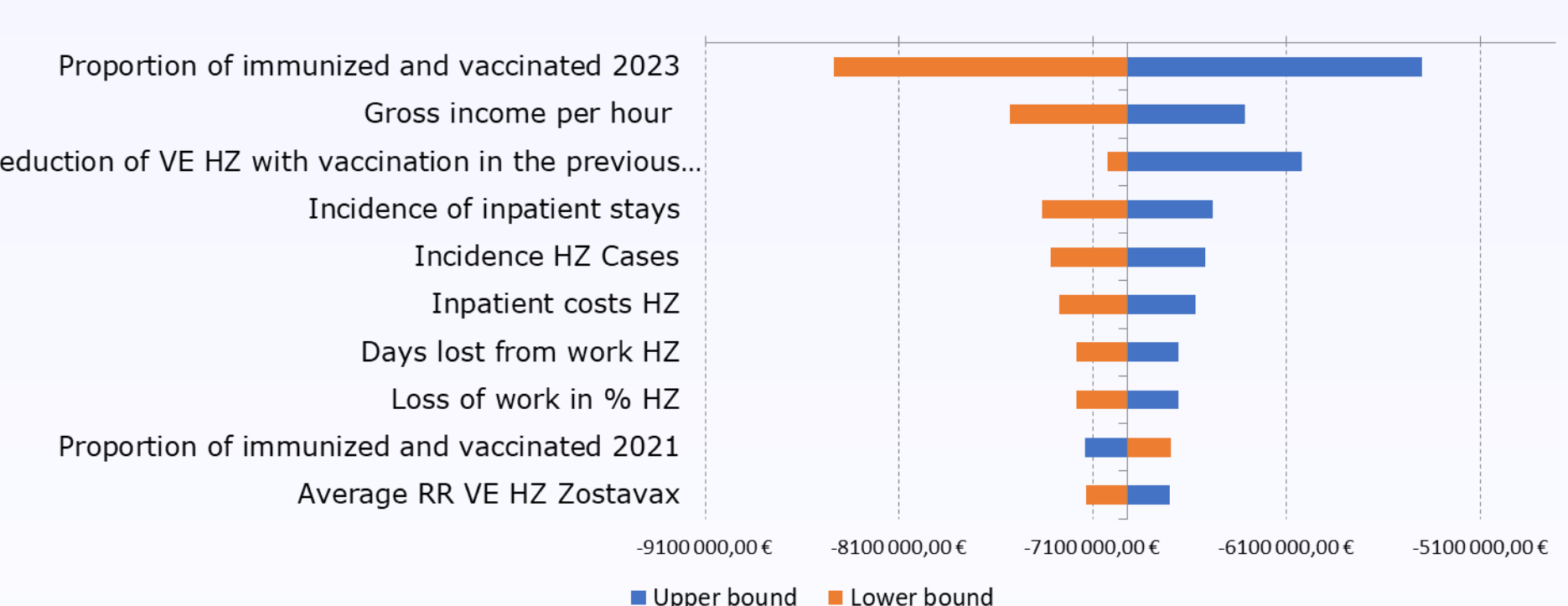


Fig. 9: One-way-sensitivity-analysis HZ vaccination



- The one-way-sensitivity-analysis (OWSA) allows to assess the impact of a certain input parameter on the total budget-impact.
- In the case of pneumococcal vaccination, the following input parameters have the greatest influence on the budget impact:
 - Proportion of immunized and vaccinated 2023
 - Inpatient costs S. Pneumonia
 - Proportion S.Pneumonia
- In case of HZ vaccination, the following input parameters have the greatest influence on the budget impact:
 - Proportion of immunized and vaccinated 2023
 - Gross income per hour
 - Reduction of VE HZ with vaccination in the previous year

Source: own calculations

Conclusion

Overall, the analysis concludes that the return on investment in pneumococcal vaccination is several times higher than an investment in herpes-zoster vaccination.

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Additional literature with the author