Supplementary tables

Table S1: PICOST criteria for study inclusion

Criteria	Inclusion Criteria
Population(s)	Adult population included in pneumococcal vaccination recommendations
Interventions	All pneumococcal vaccines indicated for adults (PCV13 and PPV23)
Comparisons	Not applicable

Outcomes	• Consideration of change to NIP for adults
	• Recommendation
	  ○ NIP decision
	  ○ Target populations implemented (Age group, health status)
	  ○ Planned dates for any future recommendations (if available)
	• Presence of epidemiological data of IPD/Pneumonia (Yes/No)
	  ○ Incidence
	  ○ Prevalence
	  ○ Mortality
	  ○ % Attributable to *S. pneumoniae*
	• Economic data
	  ○ Description of health economic models
	  ○ Description of major assumptions in model
	  ○ Model inputs for costs, utilities, epidemiologic, resource use, etc.
	  ○ Outcomes presented
	  ○ Conclusion
	  ○ References for SLR, if conducted
	• HTA/NITAG critiques of evidence
	• Adult VCRs

Study design	• Technology Appraisal Guidance • All types of appraisal reports, including extensions of recommendations • updates of reports and new reports • Any NITAG report providing data related to vaccine coverage rates • Any published literature reporting PV recommendations for adults Any published literature reporting VCRs
Time	Published since 1 January 2017
Other	Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, the Netherlands, Norway, Poland, Portugal, Republic of Malta, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, the UK

Table S2: List of HTA agency and NITAG websites

Country	Source	URL
Austria	LBI (1)	https://bim.lbg.ac.at/en
	AIHTA (2)	https://aihta.at/page/homepage/en
	GOeG (3)	https://goeg.at/
Belgium	KCE (4)	https://kce.fgov.be/en *Superior Health Council*: https://www.health.belgium.be/nl/advies-9519-vaccinatie-tegen-pneumokokken-kinderen *KCE*: https://kce.fgov.be/nl/een-gunstig-advies-van-het-kce-voor-de-terugbetaling-van-het-pneumokokkenvaccin
	WIV-ISP (5)	https://www.sciensano.be/en
Bulgaria	NCPHA (6)	https://ncpha.government.bg/
	NCPR (7)	https://www.ncpr.bg/bg/
Croatia	HZJZ (8)	https://www.hzjz.hr/en/
Cyprus	MOH (9)	https://www.moh.gov.cy/MOH/MOH.nsf/All/B132061A6C8F10F7C2257AFB003E0096?OpenDocument
Czech Republic	Pediatrie Cerna (10)	https://www.pediatriecerna.cz/
	SUKL (11)	http://www.sukl.eu/
Denmark	SST (12)	https://www.sst.dk/da/opgaver/forebyggelse/boernevaccinationsprogrammet/vaccinationsudvalget
	SSI (13)	www.ssi.dk
Estonia	RATERA (14)	https://tervis.ut.ee/en
Finland	THL (KRAR) (15)	https://thl.fi/fi/ https://thl.fi/fi/web/infektiotaudit-ja-rokotukset/palvelut-ja-yhteystiedot/asiantuntijaryhmat/kansallinen-rokotusasiantuntijaryhma-krar
France	CTV (16)	https://www.has-sante.fr/jcms/c_2755844/fr/commission-technique-des-vaccinations
	HCSP (17)	https://www.hcsp.fr/Explore.cgi/AvisRapports
Germany	STIKO (18)	https://www.rki.de/EN/Content/infections/Vaccination/Vaccination_node.html
	IQWIG (19)	https://www.iqwig.de/en/
	DIMDI (20)	http://www.dimdi.de/static/de/index.html
Greece	EEE (21)	https://www.moh.gov.gr/articles/health/dieythynsh-dhmosias-ygieinhs/emboliasmoi/ethnikh-epitroph-emboliasmwn
Hungary	VACSATC (22)	http://vacsatc.hu/?Information-in-English&pid=65
	OGUYÉI (23)	https://www.ogyei.gov.hu/main_page
Ireland	National Immunisation Advisory Committee (24)	https://www.rcpi.ie/policy-and-advocacy/national-immunisation-advisory-committee/
	National Immunisation Office (25)	https://www.hse.ie/eng/health/immunisation/

Country	Source	URL
	HIQA (26)	https://www.hiqa.ie/
	NCPE (27)	http://www.ncpe.ie/
Italy	ISS (28)	https://www.iss.it/
	AIFA (29)	https://www.aifa.gov.it/en/web/guest/home
Latvia	Imunizācijas valsts padome (30)	http://www.vm.gov.lv/lv/ministrija/konsultativas_padomes/imunizacijas_valsts_padome/
Lithuania	ULAC (31)	http://www.ulac.lt/
	HI (32)	http://www.hi.lt/en/
Luxembourg	CSMI (33)	https://sante.public.lu/fr/espace-professionnel/recommandations/conseil-maladies-infectieuses.html
Netherlands	Gezondheidsraad (34)	https://www.healthcouncil.nl/ or https://www.gezondheidsraad.nl/
	RIVM (35)	https://www.rivm.nl/
	Zorginstituut Nederland (36)	https://www.zorginstituutnederland.nl/
Poland	Rada sanitarno-epidemiologiczna (37)	https://gis.gov.pl/bip_list/rada-sanitarno-epidemiologiczna/
	AOTMiT (38)	http://www.aotm.gov.pl/www/
Portugal	CTV (39)	https://comissaovacinacao.webnode.pt/
	DGS (40)	https://www.dgs.pt/
Republic of Malta	DPA/MoH Malta (41)	https://deputyprimeminister.gov.mt/en/Pages/health.aspx https://deputyprimeminister.gov.mt/en/phc/pchyhi/Pages/National-Immunisation-Schedule.aspx
Romania	MS (42)	http://www.ms.ro/
	INSP (43)	https://www.insp.gov.ro/
	CNSCBT (44)	http://www.cnscbt.ro/
Slovakia	Ministry of Health (45)	http://kategorizacia.mzsr.sk/Lieky/Common/Details/9376
Slovenia	PSC (46)	http://www.nijz.si/
	JAZMP (47)	https://www.jazmp.si/en/
	MoH (48)	http://www.mz.gov.si/en/
Spain	Ponencia de Programa y Registro de Vacunaciones (49)	https://www.mscbs.gob.es/organizacion/consejoInterterri/home.htm
	AETS (50)	https://www.isciii.es/QuienesSomos/CentrosPropios/AETS/Paginas/default.aspx
	AEMPS (51)	https://www.aemps.gob.es/
Sweden	Public Health Agency of Sweden (52)	https://www.folkhalsomyndigheten.se/the-public-health-agency-of-sweden/
NON-EU		

Country	Source	URL
Iceland	Directorate of Health (Embaetti Landlaeknir) (53)	https://www.landlaeknir.is/
Norway	FHI (54)	https://www.fhi.no/en/
	HDIR (55)	https://helsedirektoratet.no/english
	NOMA (56)	www.legemiddelverket.no
Switzerland	FOPH (57)	https://www.bag.admin.ch/bag/de/home/krankheiten/krankheiten-im-ueberblick/pneumokokken-erkrankungen.html
	CFV (58)	https://www.bag.admin.ch/bag/fr/home/das-bag/organisation/ausserparlamentarische-kommissionen/eidgenoessische-kommission-fuer-impffragen-ekif.html
United Kingdom	JCVI (59)	https://www.gov.uk/government/groups/joint-committee-on-vaccination-and-immunisation
	NICE (60)	https://www.nice.org.uk/
	SMC (61)	https://www.scottishmedicines.org.uk/
	AWMSG (62)	http://www.awmsg.org/
	HTW (63)	https://www.healthtechnology.wales/
	NIHR (64)	https://www.nihr.ac.uk/

Table S3: PubMed® search terms

Facet No	Objective	Search terms	Hits
1	Population	"Austria"[Title/Abstract] OR "Austrian"[Title/Abstract] OR "Belgium"[Title/Abstract] OR "Belgian"[Title/Abstract] OR "Bulgaria"[Title/Abstract] OR "Bulgars"[Title/Abstract] OR "Bulgarian"[Title/Abstract] OR "Croatia"[Title/Abstract] OR "Croats"[Title/Abstract] OR "Croatians"[Title/Abstract] OR "Cyprus"[Title/Abstract] OR "Cypriot"[Title/Abstract] OR "Czech republic"[Title/Abstract] OR "Czechs"[Title/Abstract] OR "Denmark"[Title/Abstract] OR "Danish"[Title/Abstract] OR "Danes"[Title/Abstract] OR "Estonia"[Title/Abstract] OR "Estonian"[Title/Abstract] OR "Finland"[Title/Abstract] OR "Finns"[Title/Abstract] OR "Finnish"[Title/Abstract] OR "France"[Title/Abstract] OR "French"[Title/Abstract] OR "Germany"[Title/Abstract] OR "Germans"[Title/Abstract] OR "Greece"[Title/Abstract] OR "Greek"[Title/Abstract] OR "Hungary"[Title/Abstract] OR "Hungarian"[Title/Abstract] OR "Magyar"[Title/Abstract] OR "Iceland"[Title/Abstract] OR "Icelander"[Title/Abstract] OR "Icelandic"[Title/Abstract] OR "Ireland"[Title/Abstract] OR "Irish"[Title/Abstract] OR "Italy"[Title/Abstract] OR "Italian"[Title/Abstract] OR "Latvia"[Title/Abstract] OR "Letts"[Title/Abstract] OR "Latvian"[Title/Abstract] OR "Lithuania"[Title/Abstract] OR "Lithuanian"[Title/Abstract] OR "Luxembourg"[Title/Abstract] OR "Luxembourgish"[Title/Abstract] OR "Netherland"[Title/Abstract] OR "Dutch"[Title/Abstract] OR "Nederlander"[Title/Abstract] OR "Norway"[Title/Abstract] OR "Norwegian"[Title/Abstract] OR "Poland"[Title/Abstract] OR "Polish"[Title/Abstract] OR "Poles"[Title/Abstract] OR "Portugal"[Title/Abstract] OR "Portuguese"[Title/Abstract] OR "Malta"[Title/Abstract] OR "Maltese"[Title/Abstract] OR "Romania"[Title/Abstract] OR "Romanians"[Title/Abstract] OR "Slovakia"[Title/Abstract] OR "Slovak"[Title/Abstract] OR "Slovenia"[Title/Abstract] OR "Slovenian"[Title/Abstract] OR "Slovenes"[Title/Abstract] OR "Spain"[Title/Abstract] OR "Spanish"[Title/Abstract] OR "Sweden"[Title/Abstract] OR "Swedish"[Title/Abstract] OR "Switzerland"[Title/Abstract] OR "Swiss"[Title/Abstract] OR "United Kingdom"[Title/Abstract] OR "UK"[Title/Abstract] OR "British"[Title/Abstract] OR "Europe"[MeSH Terms] OR "Europe"[Title/Abstract] OR "europa"[Title/Abstract] OR "european"[Title/Abstract] OR "Europe"[Title/Abstract] OR "EU"[Title/Abstract]	2,227,752
2	Exposure	"PCV"[Title/Abstract] OR "Pneumococcal Conjugate Vaccine"[Title/Abstract] OR (("pneumococcal vaccines"[MeSH Terms] OR ("pneumococcal"[All Fields] AND "vaccines"[All Fields]) OR "pneumococcal vaccines"[All Fields] OR "pneumococcal"[All Fields]) AND "vaccines, conjugate"[MeSH Terms])	10,891
3	Study design*	"Health technology assessment" [Title/Abstract] OR "HTA" [Title/Abstract] OR "cost-effective"[Title/Abstract] OR "health economic"[Title/Abstract] OR "recommendation"[Title/Abstract] OR NITAG[Title/Abstract] OR "National Immunization Technical Advisory Groups"[Title/Abstract]	172,257

4	Epidemiology	inciden*[Title/Abstract] OR prevalen*[Title/Abstract] OR mortality [Title/Abstract] OR casualit*[Title/Abstract] OR death[Title/Abstract] OR deaths[Title/Abstract] OR died[Title/Abstract] OR "New cases"[Title/Abstract]	3,322,299
5	Burden (costs, resource use and HRQoL)	"cost of illness"[All Fields] OR "costs and cost analysis"[MeSH Terms] OR "cost analysis"[All Fields] OR "economic burden"[All Fields] OR "burden of disease"[All Fields] OR "health resources"[MeSH Terms] OR "health resources"[All Fields] OR "resource use"[All Fields] OR "burden"[All Fields] OR "Healthcare resource utilization"[All Fields] OR "expenditure"[All Fields] OR "indirect cost"[All Fields] OR "healthcare cost"[All Fields] OR "hospital cost"[All Fields] OR "hospital costs"[All Fields] OR "in-patient"[All Fields] OR "inpatient"[All Fields] OR "out-patient"[All Fields] OR "outpatient"[All Fields] OR "quality of life"[MeSH Terms] OR "quality of life"[All Fields] OR (("health-related"[All Fields] OR "health related"[All Fields]) AND "quality"[All Fields] AND "life"[All Fields]) OR "health-related quality of life"[All Fields] OR "health related quality of life"[All Fields] OR "hrqol"[All Fields] OR "Patient-reported outcomes"[All Fields] OR "EQ-5D"[All Fields] OR "SF-36"[All Fields]	1,252,073
6	VCR for PCV	((("vaccination coverage"[MeSH Terms] OR ("vaccination"[All Fields] AND "coverage"[All Fields]) OR "vaccination coverage"[All Fields]) AND "rate"[All Fields]) OR (("vaccin"[Supplementary Concept] OR "vaccin"[All Fields] OR "vaccination"[MeSH Terms] OR "vaccination"[All Fields] OR "vaccinable"[All Fields] OR "vaccinal"[All Fields] OR "vaccinate"[All Fields] OR "vaccinated"[All Fields] OR "vaccinates"[All Fields] OR "vaccinating"[All Fields] OR "vaccinations"[All Fields] OR "vaccination s"[All Fields] OR "vaccinator"[All Fields] OR "vaccinators"[All Fields] OR "vaccine s"[All Fields] OR "vaccined"[All Fields] OR "vaccines"[MeSH Terms] OR "vaccines"[All Fields] OR "vaccine"[All Fields] OR "vaccins"[All Fields]) AND "rate"[All Fields]) OR ("vaccin*"[All Fields] AND ("rate"[All Fields] OR ("coverage"[All Fields] OR "coverages"[All Fields]) OR ("frequency"[All Fields] OR "frequence"[All Fields] OR "frequences"[All Fields] OR "frequencies"[All Fields]))))	61,884
7	Filters	**Publication date** since Jan 1st, 2017 **Age**: Adolescent: 13-18 years, Adult: 19+ years, Adult: 19-44 years, Middle Aged + Aged: 45+ years, Middle Aged: 45-64 years, Aged: 65+ years, 80 and over: 80+ years, Young Adult: 19-24 years	N/A
	1 AND 2 - Population		***1,625***
	1 AND 2 AND 3 – Study design		***87***
	1 AND 2 AND 3 AND 4 – Epidemiology		*45*
	1 AND 2 AND 3 AND 5 – Burden		*60*
	1 AND 2 AND 6 – VCRs		***490***
	1 AND 2 AND 6 – VCRs (Time and age limits)		*74*
	1 AND 2 AND 3 (Time and age limits)		*16*
	Total hits – (1 AND 2 AND 3) OR (1 AND 2 AND 6)		***550***
	Total hits (Time limit – since Jan 1st, 2017)		***182***
	Total hits (Time & age limit)		***85***

Search date: 20th May 2022

*Please be aware that the authors used the "study design" category to create search terms for the literature focusing on evaluating decisions by HTAs/NITAGs. However, we are aware that these are not the actual study designs of the records we are hoping to identify.

Table S4: Embase® search terms

Search No.	Query	Hits
#1	austria':ab,ti,kw OR 'austrian':ab,ti,kw OR 'belgium':ab,ti,kw OR 'belgian':ab,ti,kw OR 'bulgaria':ab,ti,kw OR 'bulgars':ab,ti,kw OR 'bulgarian':ab,ti,kw OR 'croatia':ab,ti,kw OR 'croats':ab,ti,kw OR 'croatians':ab,ti,kw OR 'cyprus':ab,ti,kw OR 'cypriot':ab,ti,kw OR 'czech republic':ab,ti,kw OR 'czechs':ab,ti,kw OR 'denmark':ab,ti,kw OR 'danish':ab,ti,kw OR 'danes':ab,ti,kw OR 'estonia':ab,ti,kw OR 'estonian':ab,ti,kw OR 'finland':ab,ti,kw OR 'finns':ab,ti,kw OR 'finnish':ab,ti,kw OR 'france':ab,ti,kw OR 'french':ab,ti,kw OR 'germany':ab,ti,kw OR 'germans':ab,ti,kw OR 'greece':ab,ti,kw OR 'greek':ab,ti,kw OR 'hungary':ab,ti,kw OR 'hungarian':ab,ti,kw OR 'magyar':ab,ti,kw OR 'iceland':ab,ti,kw OR 'icelander':ab,ti,kw OR 'icelandic':ab,ti,kw OR 'ireland':ab,ti,kw OR 'irish':ab,ti,kw OR 'italy':ab,ti,kw OR 'italian':ab,ti,kw OR 'latvia':ab,ti,kw OR 'letts':ab,ti,kw OR 'latvian':ab,ti,kw OR 'lithuania':ab,ti,kw OR 'lithuanian':ab,ti,kw OR 'luxembourg':ab,ti,kw OR 'luxembourgish':ab,ti,kw OR 'netherland':ab,ti,kw OR 'dutch':ab,ti,kw OR 'nederlander':ab,ti,kw OR 'norway':ab,ti,kw OR 'norwegian':ab,ti,kw OR 'poland':ab,ti,kw OR 'polish':ab,ti,kw OR 'poles':ab,ti,kw OR 'portugal':ab,ti,kw OR 'portuguese':ab,ti,kw OR 'malta':ab,ti,kw OR 'maltese':ab,ti,kw OR 'romania':ab,ti,kw OR 'romanians':ab,ti,kw OR 'slovakia':ab,ti,kw OR 'slovak':ab,ti,kw OR 'slovenia':ab,ti,kw OR 'slovenian':ab,ti,kw OR 'slovenes':ab,ti,kw OR 'spain':ab,ti,kw OR 'spanish':ab,ti,kw OR 'sweden':ab,ti,kw OR 'swedish':ab,ti,kw OR 'switzerland':ab,ti,kw OR 'swiss':ab,ti,kw OR 'united kingdom':ab,ti,kw OR 'uk':ab,ti,kw OR 'british':ab,ti,kw OR 'europe'/exp OR 'europa':ab,ti,kw OR 'european':ab,ti,kw OR 'europe':ab,ti,kw OR 'eu':ab,ti,kw	309556
#2	'pneumococcus vaccine'/exp OR pcv:ab,ti,kw OR 'pneumococcal conjugate vaccine':ab,ti,kw OR (('pneumococcal vaccines'/exp OR ('pneumococcal' AND 'vaccines':ab,ti,kw) OR 'pneumococcal vaccines':ab,ti,kw OR 'pneumococcal':ab,ti,kw) AND 'vaccines, conjugate'/exp)	30587
#3	'health technology assessment':ab,ti,kw OR hta:ab,ti,kw OR 'cost-effective':ab,ti,kw OR 'health economic':ab,ti,kw OR 'recommendation':ab,ti,kw OR nitag:ab,ti,kw OR 'national immunization technical advisory groups':ab,ti,kw OR 'national immunisation technical advisory groups':ab,ti,kw	245001
#4	'incidence'/exp OR 'prevalence'/exp OR inciden*:ab,ti,kw OR prevalen*:ab,ti,kw OR mortality:ab,ti,kw OR casualit*:ab,ti,kw OR death:ab,ti,kw OR deaths:ab,ti,kw OR died:ab,ti,kw OR 'new cases':ab,ti,kw	5006192
#5	'cost of illness':ab,ti,kw OR 'costs and cost analysis'/exp OR 'cost analysis':ab,ti,kw OR 'economic burden':ab,ti,kw OR 'burden of disease':ab,ti,kw OR 'health resources'/exp OR 'health resources':ab,ti,kw OR 'resource use':ab,ti,kw OR 'burden':ab,ti,kw OR 'healthcare resource utilization':ab,ti,kw OR 'expenditure':ab,ti,kw OR 'indirect cost':ab,ti,kw OR 'healthcare cost':ab,ti,kw OR 'hospital cost':ab,ti,kw OR 'hospital costs':ab,ti,kw OR 'in-patient':ab,ti,kw OR 'inpatient':ab,ti,kw OR 'out-patient':ab,ti,kw OR 'outpatient':ab,ti,kw OR 'quality of life'/exp OR 'quality of life':ab,ti,kw OR (('health-related':ab,ti,kw OR 'health related':ab,ti,kw) AND 'quality':ab,ti,kw AND 'life':ab,ti,kw) OR 'health-related quality of life':ab,ti,kw OR 'health related quality of life':ab,ti,kw OR 'hrqol':ab,ti,kw OR 'patient-reported outcomes':ab,ti,kw OR 'eq-5d':ab,ti,kw OR 'sf-36':ab,ti,kw	2009050
#6	('vaccination coverage'/exp OR ('vaccination':ab,ti,kw AND 'coverage':ab,ti,kw) OR 'vaccination coverage':ab,ti,kw) AND 'rate':ab,ti,kw OR (('vaccination'/exp OR 'vaccination':ab,ti,kw OR 'vaccinable':ab,ti,kw OR 'vaccinal':ab,ti,kw OR 'vaccinate':ab,ti,kw OR 'vaccinated':ab,ti,kw OR 'vaccinates':ab,ti,kw OR 'vaccinating':ab,ti,kw OR 'vaccinations':ab,ti,kw OR 'vaccination s':ab,ti,kw OR 'vaccinator':ab,ti,kw OR 'vaccinators':ab,ti,kw OR 'vaccine s':ab,ti,kw OR 'vaccined':ab,ti,kw OR 'vaccines'/exp OR 'vaccines':ab,ti,kw OR 'vaccine':ab,ti,kw OR 'vaccins':ab,ti,kw) AND 'rate':ab,ti,kw) OR ('vaccin*':ab,ti,kw AND ('rate':ab,ti,kw	74871

	OR 'coverage':ab,ti,kw OR 'coverages':ab,ti,kw OR 'frequency':ab,ti,kw OR 'frequence':ab,ti,kw OR 'frequences':ab,ti,kw OR 'frequencies':ab,ti,kw))	
#8	#1 AND #2 AND #3	284
#11	#1 AND #2 AND #6	1280
#14	#8 OR #11	1470
#15	(#8 OR #11) AND [2017-2022]/py	496
#16	(#8 OR #11) AND ([adult]/lim OR [young adult]/lim OR [middle aged]/lim OR [aged]/lim OR [very elderly]/lim) AND [2017-2022]/py	236

Table S5: Included records with recommendation information, by country (n=42)

Country	Issuing body/Author	Title	Year	Position taken	PCV
Belgium	Superior Health Council (65)	Avis 9674-Vaccination against pneumococcal disease (adults)	2022	Positive	PCV13, PCV15 or PCV20 followed by PPV23
	De Burghgraeve et al. 2021 (66)	The incidence of lower respiratory tract infections and pneumococcal vaccination status in adults in Flemish primary care	2021	Positive	PCV13 followed by PPV23 (sequential vaccination)
Denmark	SST (67)	Offer of pneumococcal vaccination for special risk groups	2020	Positive	PPV23 (free vaccination) PCV13 (provided subsidy) followed by PPV23
	SSI (68)	Pneumococcal vaccine 23-valent (Pneumowax) - Inactivated vaccine against serious pneumococcal infections in children over 2 years and adults	2022	Positive	PPV23 (free) PCV13, PCV20 (subsidized in risk group)
	SST (69)	Subsidies for vaccines for certain groups of people	2022	Positive	PPV23
Estonia	RATERA (70)	Vaccination of adults: Immunodeficient people can be vaccinated with inactivated vaccines	N/A	Positive	PCV13, PPV23
European countries	Esposito et al. 2018 (71)	The public health value of vaccination for seniors in Europe	2018	Positive	PCV13 followed by PPV23 (sequential vaccination) PCV13 PPV23
	Bhavsar et al. 2019 (72)	PIN33 Cost-effectiveness of current pneumococcal vaccines in older adults in European settings: a systematic literature review	2019	Positive	NR
Finland	THL – (KRAR) (73)	Pneumococcal vaccination strategy	2018	Positive	PCV13 followed by PPV23 (sequential vaccination)
	THL – (KRAR) (74)	Pneumococcal vaccinations for at-risk groups	2022	Positive	PCV13 followed by PPV23 (sequential vaccination)
France	HCSP (75)	Pneumococcal infections: vaccination recommendations for adults	2017	Positive	PCV13 followed by PPV23 (sequential vaccination)
	HAS (76)	Vaccination against pneumococcal infections in the context of a shortage of 23-valent unconjugated pneumococcal vaccine	2017	Positive	PCV13 followed by PPV23 (sequential vaccination)

Country	Issuing body/Author	Title	Year	Position taken	PCV
	Wyplosz et al. 2022 (77)	Pneumococcal and influenza vaccination coverage among at-risk adults: A 5-year French national observational study	2022	Positive	PCV13 followed by PPV23 (sequential vaccination) PCV13 PPV23
	Kopp et al. 2021 (78)	Pneumococcal vaccination coverage in France by general practitioners in adults with a high risk of pneumococcal disease	2021	Positive	PCV13 followed by PPV23 (sequential vaccination) PCV13 PPV23
Germany	Kuchenbecker et al. (79)	Estimating the cost-effectiveness of a sequential pneumococcal vaccination program for adults in Germany	2018	Positive	PCV13 followed by PPV23 (sequential vaccination)
	Paparoupa 2017 (80)	Pneumococcal vaccination in adults	2017	Positive	PCV13 followed by PPV23 (sequential vaccination) PCV13 PPV23
	Mohr et al. 2021 (81)	Adherence to STIKO recommendations in patients with pulmonary disease in southeast Germany	2021	Positive	PPV23 PCV13 followed by PPV23
Greece	Papagiannis et al. 2020 (82)	Vaccination Coverage of the Elderly in Greece: A Cross-Sectional Nationwide Study	2020	Positive	PCV10, PCV13, PPV23
Hungary	VACSATC (83)	Vaccinations recommended for adults	2017	Positive	PCV13 followed by PPV23 (sequential vaccination)
Iceland	Directorate of Health (84)	Pneumococcal infection, invasive	2019	Positive	PPV23
Ireland	National Immunisation Office (85)	Pneumococcal Infection	2018	Positive	PPV23 PCV10+PPV23 or PCV13+PPV23
Italy	ISS (86)	Contraindications Guide to vaccinations (update 2018)	2018	Positive	PCV13 followed by PPV23 (sequential vaccination)
	AIFA (87)	The use of Medicines in Italy National Report Year 2020	2020	Positive	PCV13 followed by PPV23 (sequential vaccination)
	Guerrini et al. 2020 (88)	Italian recommendations for influenza and pneumococcal vaccination in adult patients with autoimmune rheumatic diseases	2020	Positive	PCV13 followed by PPV23 (sequential vaccination)

Country	Issuing body/Author	Title	Year	Position taken	PCV
Lithuania	ULAC (89)	The number of people vaccinated against pneumococcal infection has increased	2021	Positive	PCV13
Luxemburg	CSMI (90)	Invasive pneumococcal infections	2022	Positive	PCV13 followed by PPV23 (sequential vaccination)
Netherlands	RIVM (91)	Pneumococcal Vaccination - Factsheet	2022	Positive	PPV23
	Zorginstituut (92)	Vaccination of pneumococci over 60s is financed outside the Health Insurance Act	2018	Positive	PPV23
	Zorginstituut (93)	Report of the Scientific Advisory Board (WAR) meeting on 13-valent pneumococcal polysaccharide conjugate vaccine (Prevenar®)	2021	Positive	PCV13
	RIVM (94)	Pneumococcal Disease Guideline	2022	Positive	PPV23
	RIVM (95)	Monitor vaccination coverage national program pneumococcal vaccination adults (NPPV) 2020	2020	Positive	PPV23
Norway	Folkehelseinstituttet (96)	Pneumococcal vaccine for risk groups	2020	Positive	PPV23
Poland	AOTMiT (97)	Protocol No. 15/2022 from the Transparency Council meeting on April 19, 2022 in the form of a videoconference	2022	Positive	PCV13 followed by PPV23 (sequential vaccination)
	AOTMiT (98)	President's opinion Agency for Health Technology Assessment and Tariff System No. 25/2021 of April 30, 2021 about the draft health policy program "Infection prevention program pneumococcal disease in people over 65	2021	Positive	NR
Portugal	DGS (99)	National program of vaccination	2022	Positive	PPV23
Romania	INSP (100)	National VACCINATION Awareness Month April 2022	2022	Discussion only	PPV23
Slovakia	Ministry of Health (101)	Pharmaco-economic analysis of the drug (for the purpose of drug categorization)	2017	Positive	PCV13
Slovenia	PSC (102)	Summary of the main characteristics of the medicinal product	2021	Positive	NR

Country	Issuing body/Author	Title	Year	Position taken	PCV
	PSC (103)	Vaccination recommendations adults and children aged 5 years and over against pneumococcal infections	2019	Positive	PCV13 followed by PPV23 (sequential vaccination)
Spain	AEMPS (104)	Inter-territorial council of the national Health system specific vaccination in adult people (≥18 years old) with risk conditions	2022	Positive	PCV13 followed by PPV23 (sequential vaccination)
Switzerland	CFV (105)	Federal Commission for Vaccination Issues	2022	Positive	PCV13
United Kingdom	JCVI (106)	Minute of the JCVI Pneumococcal Sub-Committee meeting	2022	Discussion only	PCV13, PCV15, PCV20, PPV23

Key: AEMPS=Agencia Española de Medicamentos y Productos Sanitarios; AIFA=Agenzia Italiana del Farmacot; AOTMiT=AGENCJA OCENY TECHNOLOGII MEDYCZNYCH I TARYFIKACJI; BIM=Budget Impact Analysis; CSMI=Conseil Supérieur des Maladies Infectieuses; DGS=Direção-Geral da Saúde; EKIF=Eidgenössische Kommission für Impffragen; FHI=Folkehelseinstituttet; HAS=Haute Autorité de Santé; HCSP=Haut Conseil de la santé publique; INSP=INSTITUTUL NAȚIONAL DE SĂNĂTATE PUBLICĂ; ISS=ISTITUTO SUPERIORE DI SANITÀ; JCVI=Joint Committee on Vaccination and Immunisation; N/A=Not available; NIJZ=Nacionalni inštitut za javno zdravje; NPPV=Nationaal Programma Pneumokokkenvaccinatie Volwassenen; PCV=Pneumococcal Conjugate Vaccines; PCV7=7-valent Pneumococcal Conjugate Vaccine; PCV13=13-valent Pneumococcal Conjugate Vaccine; PCV15=15-valent Pneumococcal Conjugate Vaccine; PCV20=20-valent Pneumococcal Conjugate Vaccine; PPV23=23-valent Pneumococcal Polysaccharide Vaccine, PSC= POVZETEK GLAVNIH ZNAČILNOSTI ZDRAVILA, RIVM=Rijksinstituut voor Volksgezondheid en Milieu; SSI=Statens Serum Institut; SST=Sundhedsstyrelsen; STIKO=Ständige Impfkommission; THL=Terveyden ja hyvinvoinnin laitos; ULAC=Užkrečiamųjų ligų ir AIDS centro; WAR=Wetenschappelijke Adviesraad

Table S6: Records describing changes to pneumococcal NIP recommendations

Author (Ref.)	Country	Pub. year	Available information for the current/original NIP	Recommendation and rationale
Superior Health Council (65)	Belgium	2022	Original recommendation (CSS 9562): For adults 50 to 85 years of age with comorbidity, revaccination with PPV23 is now recommended 5 years after the primary vaccination using PCV13 followed by PPV23 after a minimum of 8 weeks. A vaccination repeated every 5 years by the PPV23 is recommended in the event of serious underlying comorbidity. In healthy adults aged 65-85 years, the preferential pattern is vaccination with PCV13 followed by PPV23	Update to the existing NIP, to recommend PCV20, with PCV15 + PPV23 as an alternative schedule. It included recommendations for adults at increased risk of pneumococcal infection (e.g., immunocompromised, or adults with anatomical and/or functional asplenia, sickle cell disease or hemoglobinopathy etc.), and for adults with comorbidities. Rationale: The opinion is based on a review of the scientific literature, published both in scientific journals and reports of national and international organizations competent in the field (peer-reviewed), as well as on the opinion of experts.
Danish health authority (67)	Denmark	2020	These groups of people who are at increased risk of developing severe pneumococcal disease (residents of care homes, people who have reached the age of 65 with a chronic illness, as well as people under 65 with a particularly high risk of serious pneumococcal disease (e.g., people without a spleen) did not previously receive free vaccination	Free vaccination with PPV23 was recommended for groups of people who are at increased risk of developing severe pneumococcal disease (residents of care homes, people who have reached the age of 65 with a chronic illness, as well as people under 65 with a particularly high risk of serious pneumococcal disease (e.g., people without a spleen). The Ministry of Health and the Elderly also stated that the recommendation is expected to extend to include other groups (people over 65 who do not belong to a risk group, as well as other groups of people under 65 with an increased risk of IPD) from autumn 2020. Rationale: The offer is intended to help reduce the number of patients affected by serious and treatment-demanding infectious diseases, as well as prevent the healthcare system from being overburdened during the outbreak of the new coronavirus in Denmark.
HCSP (75)	France	2017	In 2013, pneumococcal vaccine obtained its marketing authorization (AMM) in adults at very high risk or over the age of 50 years and in children from 2 to 17 years old. Recommendations on pneumococcal vaccination of adults have been revised in 2017.	Recommendations on pneumococcal vaccination of adults have been revised. Two vaccines are available: • Primary vaccination with a dose of VPC 13, followed by a dose of PPV23 with a minimum delay of eight weeks. • People who have previously received only the VPP23 vaccine will be able to receive an injection of PCV13 (at least one year after the VPP23). • Another injection of VPP23 may be performed within five years of the first injection of VPP23.

Author (Ref.)	Country	Pub. year	Available information for the current/original NIP	Recommendation and rationale
				Rationale: The HCSP took into account PCV13 efficacy data on pneumococcal pneumonia (Capita study), recent literature, international recommendations and relied on medico-economic modeling which assessed different vaccination scenarios for population according to their age or risk factors. With the aim of obtaining a reduction in the frequency of pneumonia and invasive pneumococcal infections, and in line with previous recommendations, the High Council for Public Health extends to adults of all ages at high risk of invasive infections and non-immunocompromised pneumonia.
Paparoupa et al (80)	Germany	2017	These STIKO recommendations contradict those of the updated S3 guideline for the treatment and prevention of community-acquired pneumonia and the internationally defined vaccination recommendations	In order to achieve the best possible protection, the STIKO recommends sequential vaccination with the 13-valent pneumococcal conjugate vaccine (PCV13) followed by vaccination with PPV23 in 6 to12 months. Vaccination with PPV23 alone is recommended for patients with other chronic diseases and seniors over the age of 60, which must be repeated at least every 6 years due to the lack of immunity." Rationale: "Due to the observation that the PCV13 vaccine has better immunogenicity in immunocompromised patients, the recommendation of sequential vaccination in the most vulnerable risk groups (adults with immunosuppression or immunodeficiencies, adults at risk of pneumococcal meningitis) was formulated.
Kuchenbecker et al (79)	Germany	2018	"PPV23 is recommended for all elderly (60+) and all patients 16+ with at least one chronic disease not associated with immune suppression. For all other patients at risk (high-risk representing (congenital or acquired) immunocompromised/ immunosuppressed patients, with or without chronic medical conditions), sequential immunization with PCV13 first is recommended, followed by PPV23. Repeated vaccination with PPV23 is recommended for patients in all risk groups. Elderly are recommended revaccination every 6 years with PPV23 following individual assessment by the physician."	"Our study indicates that a sequential vaccination strategy independent of underlying risks might be optimal in minimizing the burden of pneumococcal disease." Rationale: "Our model disclosed that within each scenario every case avoided, has its own price. However, in more than two-third of the hypothetical scenarios the ICERs were below the present maximum WTP of €50,000. Although there is no clear-cut margin in the German health care system, a cost-effectiveness threshold of $50,000 for a life year or QALY gained is assumed internationally. With respect to our study, results seem well below the boundaries of societies' and payers' WTP "
Netherlands institute for Health	Netherlands	2020	It was previously recommended to receive a combination of PCV+PPV23	In 2018, the Health Council recommended that elderly people aged 60 and over be vaccinated with the vaccine PPV23. This vaccination should be repeated every 5 years until the age of 75 years. On 24 June 2019,

Author (Ref.)	Country	Pub. year	Available information for the current/original NIP	Recommendation and rationale
Services research (95)				the State Secretary for Health, Welfare and Sport decided to adopt the Health Council's advice, and the House of Representatives were informed that from autumn 2020 all adults aged 60, 65, 70 and 75 will receive an invitation from their GP for a pneumococcal vaccination once every 5 years.
Directorate-General for Health (99)	Portugal	2022	Vaccination against *S. Pneumoniae* infections for adults belonging to a risk group started in 2015.	The present update of Standard 011/2015 aims to expand the risk groups for which vaccination is recommended and the risk groups for which vaccination is free. The main updates included PPV23 for all adults aged 65 and over against *S. pneumoniae* infections. Also, free vaccination was provided to selected risk groups including people with chronic respiratory failure, and transplant candidates
Joint Committee on Vaccination and Immunization (106)	UK	2022	"The committee previously did not advise PCV13 in the adult program because modelling showed indirect protection from the childhood program." "Members commented that the current adult vaccination program may not be optimal, in terms of the schedule and the vaccine being used."	Rationale: "It was noted that if PPV23 was simply replaced with a higher valency PCV, this would only be offered at 65 years of age which was not the same as vaccinating everyone over age 65 with the higher valency PCV. To see the impact on elderly disease all age groups over 65 would need to be vaccinated." "The use of PPV23 alongside a PCV was suggested. It was noted that it was not straightforward to compare the impact of PCV13 and PPV23. PCV13 may have high efficacy but only for 13 serotypes, whereas PPV23 may have lower efficacy but it covers more serotypes. Higher valency PCVs would make a better comparison to PPV23 and may make a bigger difference for CAP. The committee agreed that it would be useful to have a model on the impact of PCV15/20 introduction in the next two years. The model could assist in answering whether a catch-up program was needed and what the schedule should be"

Abbreviation: CAP = community-acquired pneumonia; IPD = invasive pneumococcal disease; GP = general practitioner; NIP = national immunization policy; Pub. = publication; STIKO=Ständige Impfkommission (standing committee on vaccination)

Table S7: Epidemiological evidence: Summary of evidence in detail based on the type of outcome (n=22)

				Outcome Type	
				Incidence/Prevalence	
Country	**Author**	**Title (Publication year)**	**Type of vaccine**	**IPD**	**Pneumonia**
Austria	Walter et al. 2019 (107)	A public health and budget impact analysis (BIA) of vaccinating adults against pneumococcal diseases in Austria (2019)	PCV13 + PPV23	Cases based on pneumococcal annual report 2016- 2017 18-34 years Pneumonia: 7 Pneumonia and sepsis: 4 35-49 years Pneumonia: 19 Pneumonia and sepsis: 9 50-64 years Pneumonia: 41 Pneumonia and sepsis: 20 ≥65 years Pneumonia: 95 Pneumonia and sepsis: 54	
Belgium	Superior Health Council (65)	Report 9674 - Vaccination against pneumococcal disease (adults)- 2022	PPV2; PCV13; PCV15; PCV20		pneumonia with bacteremia ≥65 years: 40/100,000
	De Burghgraeve et al. (66)	The incidence of lower respiratory tract infections and pneumococcal vaccination status in adults in Flemish primary care (2021)	PCV13 followed by PPV23		overall incidence rate 5.8/1000py
	Marbaix et al. 2018 (108)	Cost-effectiveness of PCV13 vaccination in Belgian adults aged 65-	PCV13		Pneumococcal CAP Inpatient 65-74 years - 105.9/100,000 Outpatient 65-74 years - 73.48/100,000

				Outcome Type	
				Incidence/Prevalence	
Country	**Author**	**Title (Publication year)**	**Type of vaccine**	**IPD**	**Pneumonia**
		84 years at elevated risk of pneumococcal infection (2018)			Inpatient 75-84 years - 152.7/100,000 Outpatient 75-84 years - 110.21/100,000 Inpatient 85+ years - 332.8/100,000 Outpatient 85+ years - 164.43/100,000
Denmark	Birck et al. 2021 (109)	Health economic evaluation of introducing a PPV23-based vaccination program to adults aged 65 and above, and an extension to the 60-64 age group in Denmark (2021)	PPV23	60-64 years: 39.43/100,000 ≥65 years: 48/100,000	Non-bacteremic pneumococcal pneumonia: 60-64 years: 485/100,000 65-74 years: 1,455/100,000 75-84 years: 3,499/100,000 ≥85 years: 7,438/100,000
European countries	Esposito et al. 2018 (71)	The public health value of vaccination for seniors in Europe (2018)	Not specified	≥65 years: 13.8/100,000	
Finland	THL (KRAR) (73)	Pneumococcal vaccination strategy (2018)	PCV13 +PPV23	2016-2017: 18-49 years - 6.63/100,000 50-64 years - 18.13/100,000 65-74 years - 30.38/100,000 75-84 years - 38.13/100,000 ≥65 years - 37.11/100,000 ≥85 years - 65.48/100,000	Hospital-treated primary pneumonia: 2012-2017: 18-49 years - 1.35/100,000 2016-2017: 18-49 years - 1.49/100,000 2012-2017: 50-64 years - 3.65/100,000 2016-2017: 50-64 years - 3.73/100,000 2012-2017: 65-74 years - 8.91/100,000 2016-2017: 65-74 years - 9.1/100,000 2012-2017: 75-84 years - 22.62/100,000 2016-2017: 75-84 years - 22.41/100,000 2012-2017: ≥85years - 51.12/100,000 2016-2017: ≥85 years - 50.67/100,000
France	HCSP (75)	Pneumococcal infections: vaccination	PPV23 + PCV13	**Incidence** 2017: adults (≥18 years) - 10/100,000	2017: bacteraemia in hospitalized adults ≥18 years: 9.1/100,000

				Outcome Type	
				Incidence/Prevalence	
Country	**Author**	**Title (Publication year)**	**Type of vaccine**	**IPD**	**Pneumonia**
		recommendations for adults (2017)		**Prevalence** 2017: baseline risk: ≥18 years - 1,866 18-49 years - 550 50-64 years - 382 65-79 years - 386 ≥80 years - 547	18-49 years: 3.2/100,000 50-64 years: 8.6/100,000 65-79 years: 14.7/100,000 ≥80 years: 39.1/100,000
Germany	STIKO (79)	Estimating the cost-effectiveness of a sequential pneumococcal vaccination program for adults in Germany (2018)	PCV13 + PPV23	18-49 years Bacteraemia: 2/100,000	18-49 years Inpatient: 198/100,000 Outpatient: 280/100,000
	Storch et al. 2022 (110)	The effect of influenza and pneumococcal vaccination in the elderly on health service utilization and costs: a claims data-based cohort study (2022)	PCV		2013: Pneumonia: 2.59% (n=138,877)
Ireland	National Immunisation Office (85)	Pneumococcal Infection (2018)	PCV13 + PPV23	Incidence rates are shown in a graph, no actual numbers reported	
Italy	Boccalini et al. 2017 (111)	Economic studies applied to vaccines against invasive diseases: An updated budget impact analysis of age-based pneumococcal vaccination strategies in the elderly in Italy (2017)	PCV13		CAP >64 years: 3.34/1,000
	Sanduzzi et al. 2019 (112)	Impact of 13valent vaccine for prevention of	PCV13		CAP incidence: 3.34%

				Outcome Type	
				Incidence/Prevalence	
Country	**Author**	**Title (Publication year)**	**Type of vaccine**	**IPD**	**Pneumonia**
		pneumococcal diseases in children and adults at risk: Possible scenarios in Campania region (2019)			
Netherlands	RIVM (91)	Pneumococcal Vaccination – Factsheet (2022)	PPV23	2013: All ages - 2152/100,000 ≥50 years - 1788/100,000	
	Zorginstituut (92)	Vaccination of pneumococci over 60s is financed outside the Health Insurance Act (2018)	PPV23	≥60 years: 45/100,000	
	RIVM (94)	Pneumococcal Disease Guideline (2022)	PPV23	2015-2017: All ages - 14.7/100,000	It is estimated that there are at least 60,000 to 70,000 cases of non-invasive pneumococcal disease, including pneumonia, in all age groups
Poland	Wróbel et al. 2017 (113)	Invasive pneumococcal disease among patients above 65 years old (2017)	PCV13 + PPV23	2016: ≥65 years: 4.76/100,000	
Portugal	Gouveia et al. 2019 (114)	Cost-effectiveness of the 13-valent pneumococcal conjugate vaccine in adults in Portugal versus "no vaccination" and versus vaccination with the 23-valent pneumococcal polysaccharide vaccine (2019)	PCV13 + PPV23	Bacteraemia and sepsis Total: 8.86/100,000 18-49 years: 3.49/100,000 50-64 years: 8.51/100,000 65-74 years: 11.07/100,000 75-84 years: 21.32/100,000 >84 years: 54.47/100,000	Pneumonia inpatient Total: 467.84/100,000 18-49 years: 53.87/100,000 50-64 years: 199.68/100,000 65-74 years: 548.20/100,000 75-84 years: 1,780.73/100,000 >84 years: 5,243.96/100,000 Pneumonia outpatient Total: 838.16/100,000 18-49 years: 315.76/100,000 50-64 years: 754.21/100,000 65-74 years: 1,325.38/100,000 75-84 years: 2,449.95/100,000

				Outcome Type	
				Incidence/Prevalence	
Country	**Author**	**Title (Publication year)**	**Type of vaccine**	**IPD**	**Pneumonia**
					>84 years: 3,349.64/100,000
Slovakia	Ministry of Health (101)	Pharmaco-economic analysis of the drug (for the purpose of drug categorization) 2017	PCV13	Pneumococcal disease: 18-34 years: 1.51/100,000 35-49 years: 3.92/100,000 50-64 years: 8.69/100,000 ≥65 years: 23.05/100,000	
Sweden	Wolff et al. (115)	Cost-effectiveness of pneumococcal vaccination for elderly in Sweden (2020)	PCV13 + PPV23	65-year-olds: 32/100,000 75-year-olds: 42/100,000	CAP (inpatient) 65-year-olds: 162/100,000 75-year-olds: 397/100,000 CAP (outpatient) 65-year-olds: 315/100,000 75-year-olds: 525/100,000
				Mortality	
Denmark	Birck et al. 2021 (109)	Health economic evaluation of introducing a PPV23-based vaccination program to adults aged 65 and above, and an extension to the 60-64 age group in Denmark (2021)	PPV23	No vaccination, 60-64 years: 342 No vaccination, ≥65 years: 417 PPV23 (75% uptake), 60-64 years: 228 PPV23 (75% uptake), ≥65 years: 276	Non-bacteremic pneumococcal pneumonia: No vaccination, 60-64 years: 496 No vaccination, ≥65 years: 7,940 PPV23 (75% uptake), 60-64 years: 425 PPV23 (75% uptake), ≥65 years: 6,772
France	HCSP (75)	Pneumococcal infections: vaccination recommendations for adults (2017)	PPV23 + PCV13	IPD: 2017: <65 years - 12.7% 2017: ≥65 years - 18.6%	CAP: 2017: 18-64 years - 0.2% 2017: ≥65 years - 0.7% Hospitalized bacteremic pneumonia: 2017: 18-64 years - 1.2% 2017: ≥65 years - 8.6%
Germany	Kuchenbecker et al. 2018 (79)	Estimating the cost-effectiveness of a	PCV13 + PPV23	18-49 years Bacteraemia: 20/100	Pneumonia inpatient , 18-49 years: 14/100

				Outcome Type	
				Incidence/Prevalence	
Country	**Author**	**Title (Publication year)**	**Type of vaccine**	**IPD**	**Pneumonia**
		sequential pneumococcal vaccination program for adults in Germany (2018)			
Portugal	Gouveia et al. 2019 (114)	Cost-effectiveness of the 13-valent pneumococcal conjugate vaccine in adults in Portugal versus "no vaccination" and versus vaccination with the 23-valent pneumococcal polysaccharide vaccine (2019)	PCV13 + PPV23	IPD: Bacteraemia and sepsis Total: 4.37% 18-49 years: 4.26% 50-64 years: 3.80% 65-74 years: 2.79% 75-84 years: 7.65% >84 years: 7.4%	Pneumonia inpatient Total: 10.54% 18-49 years: 5.37% 50-64 years: 11.04% 65-74 years: 16.81% 75-84 years: 22.44% >84 years: 30.82% Pneumonia outpatient Total: 838.16/100,000 18-49 years: 315.76/100,000 50-64 years: 754.21/100,000 65-74 years: 1,325.38/100,000 75-84 years: 2,449.95/100,000 >84 years: 3,349.64/100,000
Slovakia	Ministry of Health (101)	Pharmaco-economic analysis of the drug (for the purpose of drug categorization) 2017	PCV13		Pneumonia (hospitalized) 18-34 years: 1.73% 35-49 years: 5.81% 50-64 years: 9.88% ≥65 years: 20.64%
Netherlands	Thorrington et al. 2018 (116)	Impact and cost-effectiveness of different vaccination strategies to reduce the burden of pneumococcal disease among elderly in the Netherlands (2018)	PCV13 or PPV23	PCV13 minus PCV10 types 60-64 years: 11% 65-69 years: 16% 70-74 years: 25% 75-79 years: 17% ≥80 years: 24% PPV23 minus PCV13 types 60-64 years: 11% 65-69 years: 10%	CAP 60-69 years: 9.6% 70-79 years: 13.9% 80-89 years: 19.1% ≥90 years: 25.5%

				Outcome Type	
				Incidence/Prevalence	
Country	**Author**	**Title (Publication year)**	**Type of vaccine**	**IPD**	**Pneumonia**
				70-74 years: 10% 75-79 years: 13% ≥80 years: 22% Non vaccine types 60-64 years: 12% 65-69 years: 22% 70-74 years: 22% 75-79 years: 13% ≥80 years: 19%	
	Zorginstituut (92)	Vaccination of pneumococci over 60s is financed outside the Health Insurance Act (2018)	PPV23	17% among ≥60 years	
				Serotype distribution details	
Austria	Walter et al. 2019 (107)	A public health and budget impact analysis (BIA) of vaccinating adults against pneumococcal diseases in Austria (2019)	PCV13 + PPV23	PCV13: 54% PPV23: 76.9%	
Belgium	Superior Health Council (65)	Report 9674 - Vaccination against pneumococcal disease (adults)- 2022	PPV23; PCV13; PCV15; PCV20	2021 PCV13: 16-49 years - 35.3% PCV13: 50-64 years - 39.1% PCV13: ≥65 years - 31.7% PCV13: ≥16 years - 34.4% PPV23: 16-49 years - 78.0% PPV23: 50-64 years - 73.4% PPV23: ≥65 years - 69.1% PPV23: ≥16 years - 72.1%	
	Willem et al. 2018 (117)	Economic evaluation of pneumococcal vaccines		PCV13: 25.3% PPV23: 66.2%	

				Outcome Type	
				Incidence/Prevalence	
Country	**Author**	**Title (Publication year)**	**Type of vaccine**	**IPD**	**Pneumonia**
		for adults aged over 50 years in Belgium (2018)			
	Marbaix et al. 2018 (108)	Cost-effectiveness of PCV13 vaccination in Belgian adults aged 65-84 years at elevated risk of pneumococcal infection (2018)	PCV13 and PPV23	PCV13: 65-84 years - 58% PPV23: 64-74 years - 10% PPV23: 75-84 years - 12.9%	
Denmark	Birck et al. 2021 (109)	Health economic evaluation of introducing a PPV23-based vaccination program to adults aged 65 and above, and an extension to the 60-64 age group in Denmark (2021)	PPV23	PCV13: 12.0% PPV23: 73.0%	
Finland	THL (KRAR) (73)	Pneumococcal vaccination strategy (2018)	PCV13 +PPV23	2016-2017: *18-49 years*: PCV13-PCV10 (3, 6A, 19A) - 3.18/100,000 PCV13: - 4.49/100,000 PPV23 - 1.54/100,000 50-64 years: PCV13-PCV10 (3, 6A, 19A) - 7.44/100,000 PCV13- - 10.1/100,000 PPV23 - 4.51/100,000 65-74 years: PCV13-PCV10 (3, 6A, 19A) - 12.9/100,000 PCV13- - 16.79/100,000 PPV23 - 6.56/100,000	

				Outcome Type	
				Incidence/Prevalence	
Country	**Author**	**Title (Publication year)**	**Type of vaccine**	**IPD**	**Pneumonia**
				75-84 years: PCV13-PCV10 (3, 6A, 19A) - 15.88/100,000 PCV13- - 19.99/100,000 PPV23 - 8.36/100,000 ≥65 years: PCV13-PCV10 (3, 6A, 19A) - 15.12/100,000 PCV13 - 19.51/100,000 PPV23 - 8/100,000 ≥85 years: PCV13-PCV10 (3, 6A, 19A) - 23.46/100,000 PCV13 - 30.81/100,000 PPV23 - 13.66/100,000	
France	HCSP (75)	Pneumococcal infections: vaccination recommendations for adults (2017)	PPV23 + PCV13	PPV23: expected in 2020: 18-64 years: 15% expected in 2020: >65 years: 13%	
Italy	Boccalini et al. 2017 (111)	Economic studies applied to vaccines against invasive diseases: An updated budget impact analysis of age-based pneumococcal vaccination strategies in the elderly in Italy (2017)	PCV13	PCV13 serotype coverage against IPD: 69.2%	PCV13 serotype coverage against pneumonia: 73.5%
Poland	Wróbel et al. 2017 (113)	Invasive pneumococcal disease among patients above 65 years old (2017)	PCV13 + PPV23	PCV13: 67.0% PPV23: 81.9%	

				Outcome Type	
				Incidence/Prevalence	
Country	**Author**	**Title (Publication year)**	**Type of vaccine**	**IPD**	**Pneumonia**
				% Attributable to *S. pneumoniae*	
Germany	Kuchenbecker et al. 2018 (79)	Estimating the cost-effectiveness of a sequential pneumococcal vaccination program for adults in Germany (2018)	PCV13 + PPV23		29.9% of all-cause nonbacteremic pneumonia in Germany are caused by *S. pneumoniae*
Italy	Sanduzzi et al. 2019 (112)	Impact of 13valent vaccine for prevention of pneumococcal diseases in children and adults at risk: Possible scenarios in Campania region (2019)	PCV13		40% of all CAP was caused by *S. pneumoniae*
Netherlands	Thorrington et al. 2018 (116)	Impact and cost-effectiveness of different vaccination strategies to reduce the burden of pneumococcal disease among elderly in the Netherlands (2018)	PCV13 or PPV23		30% of all cause CAP was caused by *S. pneumoniae*
Slovakia	Ministry of Health (101)	Pharmaco-economic analysis of the drug (for the purpose of drug categorization) 2017	PCV13		36% of all cause CAP was caused by *S. pneumoniae*

Key: HCSP=Haut Conseil de la santé publique; IPD=Invasive Pneumococcal Disease; PCV=Pneumococcal Conjugate Vaccine; PCV7=7-valent Pneumococcal Conjugate Vaccine; PCV13=13-valent Pneumococcal Conjugate Vaccine; PCV10=10-valent, PPV23= Pneumococcal Conjugate Vaccine; 23-valent Pneumococcal Polysaccharide Vaccine; RIVM=Rijksinstituut voor Volksgezondheid en Milieu; THL (KRAR)=Finnish institute for health and welfare (The National Advisory Committee on Vaccines)

Table S8: Summary of health economic evidence (n=22)

Country	Author - Title (publication year)	Summary
Austria	Walter et al. - A public health and budget impact analysis (BIA) of vaccinating adults against pneumococcal diseases in Austria (2019) (107)	**Type of analysis:** Budget impact analysis **Perspective:** Payer **Time horizon:** 5 years **Intervention:** PCV13 or PPV23 **Comparator:** No vaccination **Type of model:** Budget impact model **Model structure available:** Yes **Health states:** Hospitalized and outpatient pneumococcal-diseases, IPD, associated complications and mortality **Cycle length:** NR **Outcomes:** Direct cost, indirect cost, prevention of deaths, hospitalizations and IPD cases, direct costs **Findings:** In Austria, 1€ privately invested in pneumococcal vaccination has a 1.60€ return to society and saves the health-care-system 1.19€.
Belgium	Marbaix et al. - Cost-effectiveness of PCV13 vaccination in Belgian adults aged 65-84 years at elevated risk of pneumococcal infection (2018) (108)	**Type of analysis:** CUA **Perspective:** Belgian National Health Insurance perspective **Time horizon:** Lifetime **Intervention:** PCV13 **Comparator:** No vaccination **Type of model:** Markov **Model structure available:** Yes **Health states:** NR **Cycle length:** NR **Outcomes:** ICER, prevention of deaths, hospitalizations and IPD cases, direct costs **Findings:** Cost per QALY gained was €17,126. In probabilistic sensitivity analyses, use of PCV13 was cost-effective in 97% of 1,000 simulations. Use of PCV13 was cost-effective.
	Willem et al. - Economic evaluation of pneumococcal vaccines for adults aged over 50 years in Belgium (2018) (117)	**Type of analysis**: CUA **Perspective**: Health care payer's perspective **Time horizon**: Lifetime **Intervention**: PPV23 **Comparator**: PCV13 followed by PPV23 (sequential vaccination) **Type of model**: Static model **Model structure available**: Yes **Health states**: Model compartments and transitions regarding IPD and non-IPP (invasive pneumococcal pneumonia) incidence, mortality, and long-term effects.

		Cycle length: NR **Outcomes**: ICER, prevention of deaths, hospitalizations and IPD cases **Findings**: Pneumococcal vaccination would be most cost-effective in Belgium, when achieving high uptake with PPV23 in 75–84-year-old, as well as by negotiating a lower market-conform PPV23 price to improve uptake and cost-effectiveness.
Denmark	Sevilla et al. - Calculating the indirect costs of adult pneumococcal disease and the rate of return to the 13-valent pneumococcal conjugate vaccine (PCV13) in older adults, with an application to Denmark (2017) (118)	**Type of analysis**: Cost analysis **Perspective**: NR **Time horizon**: NR **Intervention**: PCV13 **Comparator**: NR **Type of model**: NR **Model structure available**: NR **Health states**: NR **Cycle length**: NR **Outcomes**: Indirect costs **Findings**: Indirect Costs (ICs) were largely driven by the value of foregone housework from death (e.g., for inpatient community-acquired pneumonia (ICAP), deaths among adults aged 50–85 y, lost housework costs €323,096.78, followed by lost earnings [€73,119.72], lost caregiving [€22,414.03], and lost volunteering [€8804.46]). Thus, ICs are high even among retirees.
	Birck et al. - Health economic evaluation of introducing a PPV23-based vaccination program to adults aged 65 and above, and an extension to the 60-64 age group in Denmark (2021) (109)	**Type of analysis**: CEA **Perspective**: Societal perspective **Time horizon**: 5 years **Intervention**: PPV23 **Comparator**: No vaccination **Type of model**: Markov **Model structure available**: Yes **Health states**: The model divides the population into five health states: (1) no pneumococcal disease (2) IPD (3) NBPP (4) post-meningitis sequelae (5) death **Cycle length**: 1 year **Outcomes**: Cost-saving, prevention of deaths, hospitalizations and IPD cases, direct costs, indirect costs **Findings**: The recent introduction of the age-based vaccination program offering PPV23 vaccination to all persons aged 65+ in Denmark is cost-effective. This is also the case if the program is extended to include persons aged 60–64.

European countries	Esposito et al. - The public health value of vaccination for seniors in Europe (2018) (71)	**Type of analysis**: Cost analysis **Perspective**: NR **Time horizon**: NR **Intervention**: NR **Comparator**: NR **Type of model**: NR **Model structure available**: NR **Health states**: NR **Cycle length**: NR **Outcomes**: Cost-saving **Findings**: Vaccines that can prevent diseases such as influenza, pneumococcal diseases and herpes zoster in the elderly are likely to reduce not only the direct costs associated with medication but also the indirect costs associated with their side effects.
Finland	THL (National Institute for Health and Welfare) - Pneumococcal vaccination strategy (2018) (73)	**Type of analysis**: CEA **Perspective**: NR **Time horizon**: NR **Intervention**: NR **Comparator**: NR **Type of model**: NR **Model structure available**: NR **Health states**: NR **Cycle length**: NR **Outcomes**: Direct costs for adults **Findings**: NR
France	HCSP - Pneumococcal infections: vaccination recommendations for adults (2017) (75)	**Type of analysis**: CUA **Perspective**: NR **Time horizon**: NR **Intervention**: PCV13 or PCV13 + PPV23 **Comparator**: PPV23 **Type of model**: NR **Model structure available**: NR **Health states**: NR **Cycle length**: NR **Outcomes**: ICER, prevention of deaths, hospitalizations and IPD cases **Findings**: The extension of the current recommendations by adding or substituting the PCV13 vaccine for the PPV23 vaccine for subjects belonging to the medium and high-risk groups proves to be cost effective with the assumptions made as to the effectiveness of the vaccines and for ratios C/E less than

		EUR 100,000 per QALY gained. The vaccination strategies for all subjects aged 65 to 84, regardless of the level of risk, do not appear to be usable based on the medico-economic assessment.
Germany	Kuchenbecker et al. - Estimating the cost-effectiveness of a sequential pneumococcal vaccination program for adults in Germany (2018) (79)	**Type of analysis**: CEA **Perspective**: NR **Time horizon**: Lifetime **Intervention**: Hypothetical strategies 1: sequential for all risk groups 2: Low-risk (LR) according to STIKO, sequential only for moderate-risk (MR) and high-risk (HR) 3: LR and MR initial vaccination with PCV13, HR sequential 4. 1 with immediate waning for PCV13 5. 1 with 64% NBP Effectiveness PPV23 6. 1 with 50% revaccination rate 7. 2 with 50% revaccination rate **Comparator**: Current recommendation: PPV23 for older, PCV13+PPV23 for risk groups **Type of model**: Markov **Model structure available**: Yes **Health states**: NR **Cycle length**: NR **Outcomes**: ICER, direct costs, indirect costs **Findings**: Additional costs per patient for the payer are €2.48 to €7.13 and for the society €2.20 to €6.85. The ICER per LYG ranged from €3,662 to €23,061 (payer) and €3,258 to €29,617 (societal). Compared to the vaccination strategy in place, the different hypothetical scenarios can be considered cost-effective and suitable as additional voluntary services.
	Kuhlmann & Graf Von Der Schulenburg - Serotype dynamics in pneumococcal diseases and the performance of vaccination strategies for older adults in Germany (2020) (119)	**Type of analysis**: CUA **Perspective**: NR **Time horizon**: NR **Intervention**: PCV13 **Comparator**: PCV13 + PPV23 (Sequential), or PPV23 **Type of model**: A dynamic transmission model **Model structure available**: Yes **Health states**: NR **Cycle length**: NR **Outcomes**: ICER **Findings**: Vaccination of older adults against PD is highly effective and very likely to be cost-effective in Germany. From an economic perspective, PPV23 or sequential vaccination would be preferred to PCV13 only.
	Storch et al. - The effect of influenza and pneumococcal	**Type of analysis**: Cost analysis **Perspective**: Health insurers' perspective

	vaccination in the elderly on health service utilization and costs: a claims data-based cohort study (2022) (110)	**Time horizon**: NR **Intervention**: Pneumococcal vaccinations **Comparator**: No vaccination **Type of model**: NR **Model structure available**: NR **Health states**: NR **Cycle length**: NR **Outcomes**: Cost-saving, direct costs **Findings**: Overall cost savings of pneumococcal vaccination were not statistically significant in both years, but disease-related outpatient care costs were lower in pneumococci-vaccinated individuals in 2015 [− €9.43; 95% CI − €17.56;− €1.30] and 2016 [− €12.93; 95% CI − €25.37;− €0.48].
Italy	Boccalini et al. - Economic studies applied to vaccines against invasive diseases: An updated budget impact analysis of age-based pneumococcal vaccination strategies in the elderly in Italy (2017) (111)	**Type of analysis**: Budget impact analysis **Perspective**: NR **Time horizon**: NR **Intervention**: PCV13 **Comparator**: No vaccination **Type of model**: Decision tree model **Model structure available**: NR **Health states**: NR **Cycle length**: NR **Outcomes**: ICER, prevention of deaths, hospitalizations and IPD cases, direct costs **Findings**: The new impact analysis highlights that the vaccination of one, two or three adult cohorts per year in Italy would lead to a considerable reduction in pneumococcal disease and its related costs over 5 years. The strategies proved cost-effective (ICERs ranging from €14,605 to €15,412/QALY), i.e. well below the threshold of €50,000/QALY. Vaccination of the elderly should therefore be strongly recommended nationwide in Italy.
	Sanduzzi et al. - Impact of 13valent vaccine for prevention of pneumococcal diseases in children and adults at risk: Possible scenarios in Campania region (2019) (112)	**Type of analysis**: Budget impact analysis **Perspective**: NR **Time horizon**: NR **Intervention**: PCV13 **Comparator**: No vaccination **Type of model**: NR **Model structure available**: NR **Health states**: NR **Cycle length**: NR **Outcomes**: Cost-saving, direct costs, prevention of pneumococcal disease cases **Findings**: Offering anti-pneumococcal vaccine to adults at risk would generate a return of around 29 million euros. Offering anti-pneumococcal 13-valent vaccine was proven to be a helpful political health

		strategy, not only in consideration of a reduction of cases but also in view of the favorable economic impacts.
Portugal	Gouveia et al. - Cost-effectiveness of the 13-valent pneumococcal conjugate vaccine in adults in Portugal versus "no vaccination" and versus vaccination with the 23-valent pneumococcal polysaccharide vaccine (2019) (114)	**Type of analysis**: CUA, CEA **Perspective**: Societal perspective **Time horizon**: Lifetime **Intervention**: PCV13 or PPV23 **Comparator**: No vaccination or PPV23 **Type of model**: Markov **Model structure available**: Yes **Health states**: NR **Cycle length**: 1 year **Outcomes**: ICER, Life-year gained, QALY, indirect costs, direct costs **Findings**: PCV13 showed ICERs of €17,746/QALY and €13,146/QALY versus “no vaccination” and vaccination with PPV23, respectively. It was found that PCV13 is a cost-effective strategy to prevent pneumococcal disease in adults in Portugal.
Spain	Gomez et al. - Economic evaluation of 60+ years adult vaccination strategy using pneumococcal polysaccharide vaccine in Spain (2018) (120)	**Type of analysis**: CUA **Perspective**: Spanish National Healthcare System **Time horizon**: Lifetime **Intervention**: PPV23 **Comparator**: PCV13 followed by PPV23 (sequential vaccination) **Type of model**: Markov **Model structure available**: NR **Health states**: NR **Cycle length**: NR **Outcomes**: ICER, prevention of deaths, and IPD cases **Findings**: The sequential strategy presented a larger number of quality-adjusted life-years (QALYs) compared to PPV23 alone but also increased the total costs by more than €218 million, resulting an ICER of €42,259 per QALY gained. A sequential vaccination strategy of immunocompetent adults aged 60+ with PCV13-PPV23 would result in an improvement in health outcomes, but at a cost exceeding typical cost-effective benchmarks for Spain, compared to PPV23 alone.
Sweden	Wolff et al. - Cost-effectiveness of pneumococcal vaccination for elderly in Sweden (2020) (115)	Type of analysis: CUA Perspective: Health-care perspective Time horizon: 5 years Intervention: PCV13 Comparator: PPV23 Type of model: Decision-tree model Model structure available: Yes

		Health states: The model considered the following disease categories; invasive pneumococcal disease (IPD), and community-acquired pneumonia (CAP). All individuals with IPD were assumed to be hospitalized, whereas individuals with CAP could either be hospitalized or cared for at home with additional visits to general practitioners (GP) at outpatient health care centers Cycle length: 1 year Outcomes: ICER, QALY, direct costs Findings: The cost per gained QALY was estimated to EUR 94,000 for vaccinating 65-year-olds and EUR 29,500 for 75-year-olds. With one dose PCV13 given instead of PPV23, the cost per gained QALY would increase by around 400% for both cohorts. Introducing a vaccination program against pneumococcal disease for 65-year-olds in Sweden is unlikely to be cost-effective, whereas it for 75-year-olds and using PPV23 can be considered good value for money. Our model indicates that vaccine price needs to be reduced by 55% for vaccination of 65-year-olds to be cost-effective, given a threshold of EUR 50,000.
The Netherlands	Zorginstituut - Vaccination of pneumococci over 60s is financed outside the Health Insurance Act (2018) (92)	Type of analysis: CEA Perspective: NR Time horizon: NR Intervention: PCV13 or PPV23 Comparator: none Type of model: NR Model structure available: NR Health states: NR Cycle length: NR Outcomes: ICER, prevention of deaths, hospitalizations and IPD cases Findings: Single vaccination of the elderly at age 65 with PCV13 (compared to existing vaccination of children with PCV10) leads on average to a reduction of 11 deaths, 41 cases of IPD, 45 hospitalizations for pneumococcal pneumonia. The ICER compared to the current situation, amounts to € 44,028 per QALY. Vaccinating the elderly against pneumococci with PPV23, PCV13 or vaccinating children with PCV13 instead of PCV10 for indirect protection of the elderly, results in a reduction of the disease burden. The benefit-risk ratio is favorable in all three strategies. The Committee finds the most effective approach to vaccination of elderly people with PPV23 at age 60 with recurrence at age 65, 70, and 75.
	Rozenbaum - Cost-effectiveness of sequential vaccination with the 13-valent pneumococcal conjugate vaccine (PCV13) followed by the 23 valent polysaccharide vaccine (PPV23) in the Netherlands (2018) (121)	**Type of analysis**: CUA **Perspective**: Societal perspective **Time horizon**: Lifetime **Intervention**: PCV13 followed by PPV23 (sequential vaccination) **Comparator**: PPV23 **Type of model**: Microsimulation model **Model structure available**: NR **Health states**: NR **Cycle length**: NR

		Outcomes: ICER, prevention of deaths, and IPD cases **Findings**: At list price (€68.56 for PCV13 and €19.99 for PPV23) the ICER of vaccinating all adults of ≥60 years of age resulted in an ICER of €8,936/QALY. Adding a single dose of PCV13 for those with chronic medical conditions (moderate risk) and immunocompromising conditions (high risk) was shown to be highly cost-effective compared to vaccination with PPV23 alone.
The Netherlands	de Vries et al. - Don't forget about the future: The impact of including future costs on the cost-effectiveness of adult pneumococcal conjugate vaccination with PCV13 in the Netherlands (2021) (122)	**Type of analysis**: CUA **Perspective**: NR **Time horizon**: NR **Intervention**: PCV13 **Comparator**: No vaccination **Type of model**: NR **Model structure available**: NR **Health states**: NR **Cycle length**: NR **Outcomes**: ICER, direct costs, indirect costs **Findings**: For the base-case strategy, the original incremental cost-effectiveness ratio (ICER) of PVC13 was €9,157 per quality adjusted life-year (QALY). Including all future medical costs increased the ICER to €28,540 per QALY. Also including future non-medical costs resulted in an ICER of €45,691 per QALY. This study showed a substantial effect of the inclusion of future costs on the ICER of vaccinating with PCV13. Especially when lives of people with underlying health conditions are extended, the impact of future medical costs is large. This inclusion may make vaccination a less attractive option, especially in relation to low thresholds as often applied for prevention. Although this raises important questions, ignoring these real future costs may lead to an inefficient use of healthcare resources. The study results may imply that prices for some vaccines need to be lowered to be cost-effective.
	Thorrington et al. - Impact and cost-effectiveness of different vaccination strategies to reduce the burden of pneumococcal disease among elderly in the Netherlands (2018) (116)	**Type of analysis**: CUA & budget impact **Perspective**: Health care provider's perspective **Time horizon**: 10 years **Intervention**: PCV13 **Comparator**: PPV23 **Type of model**: NR **Model structure available**: NR **Health states**: NR **Cycle length**: NR **Outcomes**: ICER, QALY, prevention of deaths, hospitalizations and IPD cases, direct costs, indirect costs **Findings**: The most cost-effective strategy was vaccinating with PPV23 at 70 years only with similar low ICERs at age 60 and 65. Vaccinating elderly with either PCV13 or PPV23 was dominated by PPV23 in all investigated scenarios, mainly due to the lower price of PPV23. The best value for money was the use of PPV23 for elderly, with a single dose or at five-year increment between age 60 to age 70.

	Zeevat et al. - Cost-effectiveness analysis on elderly pneumococcal vaccination in the Netherlands: challenging the Dutch health council's advice (2019) (123)	**Type of analysis**: CUA **Perspective**: Societal perspective **Time horizon**: 10 years **Intervention**: PCV13 **Comparator**: PPV23 **Type of model**: NR **Model structure available**: NR **Health states**: NR **Cycle length**: NR **Outcomes**: ICER **Findings**: best estimates of cost-effectiveness for PCV13 are consistently (well) below €20,000 per QALY, which reflects an often-used threshold for vaccines. Conjugated vaccine seems cost-effective. For one-off vaccination of 65-years old elderly, the use of PCV13 over PPV23 was estimated at €31,365 per QALY (UC: 26,012-46,340) at listed prices. However, when we applied a 50% reduction for both vaccines and PCV13 alone, incremental cost-effectiveness reduced to €13,364 (UC: 11,273-15,996) and €5,950 (UC: 3,232-5,960) per QALY, respectively. The PCV13 break-even prices were estimated at 61% (50-69) of the list price at a threshold of €20,000 and above list prices for thresholds of €40,000 per QALY and above. PCV13 and PPV23 are both potentially cost-effective options of elderly pneumococcal vaccination, when an adequate and consistent perspective is taken in the analyses of the Dutch Health Council.
	Rozenbaum - The cost-effectiveness of vaccinating adults at increased risk of pneumococcal disease against pneumococcal disease in the Netherlands (2018) (124)	**Type of analysis**: CUA **Perspective**: NR **Time horizon**: NR **Intervention**: PCV13 **Comparator**: PPV23 **Type of model**: Markov **Model structure available**: NR **Health states**: NR **Cycle length**: NR **Outcomes**: ICER, direct costs **Findings**: At list price (€68.56 for PCV13 and €19.99 for PPV23), vaccination of all adults at increased risk of pneumococcal disease resulted in an ICER of €20,186/QALY, while vaccinating those with chronic medical conditions (moderate risk) and immunocompromising conditions (high risk) resulted in an ICER of <€10,000/QALY. Large differences in ICERs between age-and risk-groups were observed. Vaccinating, high-risk individuals with PCV13 was cost-saving for those aged less than 65 years of age compared with PPV23 while vaccinating those aged 85 years and older with PCV13 was moderate cost-effective with an ICER of €60,900/QALY. Vaccinating moderate risk individuals was highly cost-effective (<€20,000/QALY), while vaccinating those with low risk of pneumococcal infection was cost-effective

		(<€50,000/QALY). However, within risk groups the ICER differed significantly between age groups. Vaccination all adults with PCV13 is cost effective compared with PPV23. There is a large variation in the cost-effectiveness between age and risk groups. Targeting individuals with underlying diseases aged less than 85 years would provide most value for money.
Key: BIA=Budget impact analysis; CAP=Community-acquired pneumonia; CE=Cost effectiveness; CEA=Cost-effectiveness analysis; CUA=Cost utility analysis; GP=General practitioner; IC=Indirect cost; ICAP=Inpatient community-acquired pneumonia; ICER=Incremental cost-effectiveness ratio; IPD=Invasive pneumococcal disease; IPP=Invasive pneumococcal pneumonia; LYG=Life year gained; NBPP=Notice of Benefit and Payment Parameters; NR=Not reported; PCV13=13-valent Pneumococcal Conjugate Vaccine; PPV23=23-valent Pneumococcal Polysaccharide Vaccine; QALY=Quality-adjusted life-year; STIKO=Ständige Impfkommission; UC=Uncertainty interval		

Table S9: Summary of VCR data (n=41)

Country	Title (publication year)	Description of population	Type of vaccine	VCR or serotype coverage rate?	Time period	Coverage rate (%)
Austria	A public health and budget impact analysis (BIA) of vaccinating adults against pneumococcal diseases in Austria (2019) (107)	>50 years and "at risk" (respiratory and CV diseases, diabetes, HIV, and immunocompromised patients	PPV23 ± PCV13	VCR	2018-2023	These are all estimates based on Austrian market research • Year 0 (2018): 15% • Year 1 (2019): 16% • Year 2 (2020): 17% • Year 3 (2021): 18% • Year 4 (2022): 19% • Year 5 (2023): 20%
	Towards understanding vaccine hesitancy and vaccination refusal in Austria (2021) (125)	Adults (16+)	NR	VCR	2016	5.1%
Belgium	Report 9674 Vaccination against pneumococcal disease (adults) (2022) (65)	Adult, elderly, and at-risk population	NR	VCR	2004-2018 2014-2018	• Elderly people > 65 years old: 8.5% • > 45 years old with an increased risk of pneumococcal infection: 12.6% (Finaba et al.,2018). At-risk Groups: 32% (Boey et al., 2020). Adult population: 18.7% ((de Burghgraeve et al., 2020).
	Economic evaluation of pneumococcal vaccines for adults aged over 50 years in Belgium (2018) (117)	Adults and elderly	PPV23, PPV23 ± PCV13	VCR	2015	Vaccination uptake by age in Belgium in 2015 (calculated as the yearly mean of the 2004, 2008 and 2013 five-year accumulated uptake and the uptake estimates for 2015 are based on the average seasonal influenzas uptake): Estimated (2015) situation with PPV23: • 50-64 years: 0.79% • 65-74 years: 2.46% • 75-84 years: 3.01% • 85-105 years: 2.48% Program with increased PPV23 and/or PCV13 uptake: • 50-64 years: 25% • 65-74 years: 50% • 75-84 years: 60% • 85-105 years: 40% Revaccination (PPV23, after 5 years):

Country	Title (publication year)	Description of population	Type of vaccine	VCR or serotype coverage rate?	Time period	Coverage rate (%)
						• 50-64 years: 15% • 65-74 years: 25% • 75-84 years: 25% • 85-105 years: 20%
	The incidence of lower respiratory tract infections and pneumococcal vaccination status in adults in Flemish primary care (2021) (66)	Adults at risk of PD	PPV23, PCV13	VCR	2015	• PPV23: 5.1% • PCV13: 0.6% • Targeted population (adults at high risk of pneumococcal infection): 18.7% • Non-target population (all patients aged 18–49 and low-risk patients aged 50–65): 0.9% Age group: 50–64 years • medium-risk group: 5.6% • high-risk group: 17.8% Age group: 65–84 years • medium-risk group: 26.5% • high-risk group: 34.0%
	Cost-effectiveness of PCV13 vaccination in Belgian adults aged 65-84 years at elevated risk of pneumococcal infection (2018) (108)	Elderly	PCV13	VCR	NR	58%
Croatia	Serotype distribution and antimicrobial resistance of invasive Streptococcus pneumoniae isolates among Croatian adults during a fifteen-year period (2005-2019) (2022) (126)	Adults	PPV23, PCV13	Serotype coverage	2005-2019	• PCV13: 80.2% • PPV23: 93.6% Elderly people (≥65 years): • PCV13: 79.2% • PPV23: 93.9%
Denmark	Health economic evaluation of introducing a PPV23-based vaccination program to adults	Elderly	PPV23	Serotype coverage	2017	PPV23: 73% (of IPD cases)

Country	Title (publication year)	Description of population	Type of vaccine	VCR or serotype coverage rate?	Time period	Coverage rate (%)
	aged 65 and above, and an extension to the 60-64 age group in Denmark (2021) (109)					
	The coverage of influenza and pneumococcal vaccination among HIV-infected patients in Denmark: A cross-sectional survey (2018) (127)	HIV	NR	VCR	2016-2017	4% (calculated from the 13 offered and then 9 accepted (out of 203 patients).
	The coverage of influenza and pneumococcal vaccination among kidney transplant recipients and waiting list patients: A cross-sectional survey in Denmark (2021) (128)	Kidney transplant recipients and kidney transplant waiting list patients	NR	VCR	2017-2019	4%
France	Pneumococcal infections: vaccination recommendations for adults (2017) (75)	Adults	PPV23, PCV13	VCR	NR	• PCV13: 20% • PPV23: 20%
	Pneumococcal vaccination coverage in France by general practitioners in adults with a high risk of pneumococcal disease (2021) (78)	Adults diagnosed with chronic disease (COPD, DM, CHF, and HIV)	PCV13 and PPV23, PPV23	VCR	Control period (March 2012–March 2013) Study period (April 2013–April 2017)	Overall VCR for patients diagnosed with one or more of chronic disease Control period: 6%) Study period: 4%) COPD: Study period: 5% Control period: 7% DM: Study period: 2% Control period: 2% CHF: Study period: 4% Control period: 7% HIV: Study period: 12% Control period: 16% • The majority of vaccinated COPD patients received the recommended vaccine (PPV23): 339 (57%) in the study and 152 (71%) in the control periods, respectively. • The majority of vaccinated patients with DM received the recommended vaccine (PPV23): 53

Country	Title (publication year)	Description of population	Type of vaccine	VCR or serotype coverage rate?	Time period	Coverage rate (%)
						(56%) in the study and 18 (64%) in the control periods, respectively. • The majority of vaccinated patients with CHF received the recommended vaccine (PPV23): 18 (64%) in the study and 8 (80%) in the control periods, respectively. • • Conversely, of the vaccinated HIV-infected patients, less than half, 16 (46%), received the recommended schedule (PCV13 and PPV23 8 weeks later) in the study period and only three (19%) received the recommended vaccine (PPV23) in the control period.
	Infectious disease consultation is effective in boosting vaccine coverage in patients awaiting kidney transplantation: A French prospective study (2021) (129)	Patients awaiting kidney transplantation	PCV13 and PPV23	VCR	2014-2018	Pneumococcal complete PCV 13 and PP23V: 6%
	Observational study of vaccination in cancer patients: How can vaccine coverage be improved? (2020) (130)	Cancer patients	NR	VCR	2016	7.3%
	Pneumococcal purpura fulminans in asplenic or hyposplenic patients: A French multicenter exposed-unexposed retrospective cohort study (2020) (131)	Asplenic or hyposplenic patients	NR	VCR	2000-2016	35%
	Pneumococcal and influenza vaccination coverage among at-risk adults: A 5-year French national observational study (2022) (77)	Adults at risk of pneumococcal diseases	NR	VCR	2014-2018	All patients at risk of pneumococcal diseases • 2014: 464,376 (12.7%) • 2015: 365,011 (9.8%) • 2016: 354,740 (9.3%) • 2017: 337,480 (8.6%) • 2018: 182,730 (4.5%)

Country	Title (publication year)	Description of population	Type of vaccine	VCR or serotype coverage rate?	Time period	Coverage rate (%)
						Immunocompromised patients: • 2014: 50,298 (10.3%) • 2015: 53,132 (10.4%) • 2016: 57,130 (10.7%) • 2017: 77,405 (13.8%) • 2018: 106,977 (18.8%)
	Effectiveness of a multifaceted informational-based and text message reminders on pneumococcal and influenza vaccinations in hospital emergency departments: A cluster-randomized controlled trial (2021) (132)	Elderly	NR	VCR	2015-2016	Self-reported 6-month pneumococcal vaccination: • Intervention arm - Three text message reminders sent to patients every two weeks (n = 780): 6.4% • Control - nonstructured information only (n = 695): 4.6%
Germany	Adherence to STIKO recommendations in patients with pulmonary disease in southeast Germany (2021) (81)	Pulmonary disease	PCV13 and PPV23, PPV23	VCR	2019-2020	• Any indication: 29.5 % • Occupational Vaccination - for increased occupational risk: 8.3 % • Indication Vaccination (I) - for increased risk (not occupational): • a) PCV13 followed by PPV23: 9.2 % • b) PPV23: 35.1 % • Standard Vaccination (S) - for universal application (also age-dependent recommendations): PPV23: 38.9 %
	Estimating the cost-effectiveness of a sequential pneumococcal vaccination program for adults in Germany (2018) (79)	Adults	PCV13 ± PPV23	VCR	2012	Assumption: 31.40% (information is taken from the Federal Health Monitoring with 2012 as reference year)
	Pneumococcal vaccination rates in immunocompromised patients—A cohort study based on claims data from more than 200,000 patients in Germany (2019) (133)	Immunocompromised patients	PCV13	VCR	2013-2014	• Overall: 4.4% (95%-CI: 4.3%-4.5%) • Eastern Germany: 6.5% (6.0%-6.9%) • Western Germany: 4.2% (4.1–4.3%) Patients starting immunosuppressants with underlying rheumatoid arthritis: 11.5% (10.1%-13.0%) • HIV patients: 9.9% (7.8%-12.4%)

Country	Title (publication year)	Description of population	Type of vaccine	VCR or serotype coverage rate?	Time period	Coverage rate (%)
	PROGNOSIS-the German bronchiectasis registry: First results (2017) (134)	Elderly people with bronchiectasis	PPV23, PCV13		2017	• PPV23: 50% • PCV13: 38%
	Vaccination management for elderly patients in primary care settings – Documentation and responsibilities during a vaccination campaign (2019) (135)	Elderly people	NR	VCR	2016-2017	30.30%
	The effect of influenza and pneumococcal vaccination in the elderly on health service utilization and costs: a claims data-based cohort study (2022) (110)	Elderly individuals over or equal to 60 years of age	NR	VCR	2014-2016	3.22% (4,469/138.877)
Greece	A clinical audit of pneumococcal vaccination among patients with autoimmune rheumatic diseases living in Greece: The power of awareness (2021) (136)	Autoimmune rheumatic diseases	PCV13 ± PPV23, PPV23, PCV13	VCR	2015-2016	Overall VCR: 49.37% (195 patients) Of these: - PCV13: 40.51% (79/195 patients) - PPV23: 59.49% (116/195 patients)
	Vaccination Coverage of the Elderly in Greece: A Cross-Sectional Nationwide Study (2020) (82)	elderly people ≥60 years old	PPV23, PCV13	VCR	2019	• PPV23: 23.2% (480/2072) • PCV13: 49.7% (1029/2072)
	The evolving epidemiology of serotype distribution and antimicrobial resistance of streptococcus pneumoniae strains isolated from adults in Crete, Greece, 2009–2016 (2018) (137)	Adults	PPV23, PCV13	VCR	2009–2016	Overall VCR: • PPV23: 73.3% • PCV13: 37.8% PCV13 • Elderly (> 65 years): 34% • High risk adults: 20% PPV23 • Elderly (> 65 years): ~30%

Country	Title (publication year)	Description of population	Type of vaccine	VCR or serotype coverage rate?	Time period	Coverage rate (%)
Ireland	A quality improvement initiative to improve influenza and pneumococcal vaccination rates in patients receiving biological DMARDs (bDMARDs) in the mid-west of Ireland (2020) (138)	Patients receiving biological DMARDs	NR	VCR	2018 - 2019	• First cycle: 33.7% • Second cycle (after implementation of a quality improvement intervention): 56.5%
	Colonization of Irish patients with chronic obstructive pulmonary disease by Streptococcus pneumoniae and analysis of the pneumococcal vaccine coverage: a non-interventional, observational, prospective cohort study (2017) (139)	Chronic obstructive pulmonary disease	PPV23	VCR	2014-2015	PPV23: • Colonized participants (n=11): 64% • Non-colonized participants (n=122): 61%
Italy	An Independent Study to Compare Compliance, Attitudes, Knowledge, and Sources of Knowledge about Pneumococcal Vaccinations among an Italian Sample of Older Adults (2022) (140)	Elderly people	PCV13 ± PPV23	VCR	NR	11.20%
	Calabria: a successful experience implementing Herpes Zoster vaccination strategies (2019) (141)	Elderly people	PCV13	VCR	2016-2017	VCR of PCV13 in elderly people vaccinated with Herpes Zoster (HZ) vaccine: • 65 years, those who also received HZ vaccine (n = 1693): 95.5% • 70 years, those who also received HZ vaccine (n = 1281): 94.4%
	Will vaccine hesitancy compromise our efforts to face the next SARS-CoV-2 epidemic wave? (2021) (142)	Elderly people with SARS-CoV-2	PPV23, PCV13, PPV23 and PCV13	VCR	2019-2020	PCV13: 11.3% PPV23: 3.4% PCV13 + PPV23: 5.1% Overall VCR: 19.8%
Poland	Invasive pneumococcal disease among patients above 65 years old (2017) (113)	Elderly people	PPV23, PCV13	Serotype coverage	2016	PCV13: 67.0% PPV23: 81.9%

Country	Title (publication year)	Description of population	Type of vaccine	VCR or serotype coverage rate?	Time period	Coverage rate (%)
	Rates of vaccination against streptococcus pneumoniae in cochlear implant patients (2017) (143)	Cochlear implant adult patients	NR	VCR	2014-2016	5.50%
Portugal	Chronic Obstructive Pulmonary Disease-Are We Vaccinating the Patients? (2017) (144)	Chronic Obstructive Pulmonary Disease	PPV23, PCV13	VCR	NR	PPV23: 22.4% PCV13: 11.5%
Slovenia	Audit of Post-Splenectomy Prophylaxis in a Single Tertiary Center in Slovenia: Where Are We and What Should Be Done? (2021) (145)	Post-Splenectomy Prophylaxis	PPV23 ± PCV13	VCR	2010-2018	Vaccination against pneumococcal disease (PPV23 ± PCV13): 77.5% Patients after elective splenectomy: 89.0% Non-elective splenectomy: 61.5%
Spain	Pneumococcal vaccination coverages by age, sex and specific underlying risk conditions among middle-aged and older adults in Catalonia, Spain, 2017 (2019) (146)	Adult and at-risk population	PPV23, PCV13, PPV23 and PVC13 PCV13 ± PPV23	VCR	Up to 1 Jan 2017	PPV23: • Aged 50–64 years: 9.2% • Aged 65–79 years: 63.1% • Aged ≥ 80 years: 81.2% • All-age groups: 38.7% PCV13: • Aged 50–64 years: 0.4% • Aged 65–79 years: 0.9% • Aged ≥ 80 years: 1.0% • All-age groups: 0.7% PCV13 + PPV23: • Aged 50–64 years: 0.3% • Aged ≥ 65 years: 0.8% • Overall (≥ 50 years): 0.5% PCV13 or PPV23: • Aged 50–64 years: 9.3% • Aged ≥ 65 years: 69.0% • Overall (≥ 50 years): 38.9%
Sweden	Cost-effectiveness of pneumococcal vaccination for elderly in Sweden (2020) (115)	Elderly	PCV13 ± PPV23	Serotype coverage	NR	Assumed 75%

Country	Title (publication year)	Description of population	Type of vaccine	VCR or serotype coverage rate?	Time period	Coverage rate (%)
The Netherlands	Monitor Vaccinatiegraad Nationaal Programma Pneumokokkenvaccinatie Volwassenen (NPPV) 2020 (95)	PD	PPV23	VCR	2020	73% (Note: that it is 73% out of the 6.1% of the Dutch population that were invited by their GP for vaccination)
	Impact and cost-effectiveness of different vaccination strategies to reduce the burden of pneumococcal disease among elderly in the Netherlands (2018) (116)	PD	PCV13 ± PPV23	VCR	2004-2014	Assumed 50% (This is an estimation applied to generate results for vaccination of elderly based on the uptake of influenza vaccine)
	Incidence and risk factors for invasive pneumococcal disease and community-acquired pneumonia in human immunodeficiency virus-infected individuals in a high-income setting (2020) (147)	HIV - infected individuals in a high-income setting with PD	NR	VCR	2008 -2017	Case (Community-acquired Pneumonia): 7.4% Control: 3.7%
United Kingdom	Pneumococcal vaccine coverage among individuals aged 18 to 64 years old with underlying medical conditions in the UK: a retrospective database analysis (2020) (148)	Adults and at-risk population	NR	VCR	2011-2015	Within 1 year of follow-up: Overall VCR: 13.6% • chronic respiratory disease: 13.9% • immunosuppression: 13.2% • diabetes mellitus: 14.4% • Individuals with cerebrospinal fluid leaks: 7.2% Within 4 years of follow-up: • chronic respiratory disease: 32.9% • immunosuppression: 32.7% • diabetes mellitus: 31.8% • Individuals with cerebrospinal fluid leaks: 21.2%

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