



BACKGROUND DOCUMENT

AIB Technical Meeting

Assessing the health burden of vaccine-preventable infections in European Adults: challenges and opportunities

Antwerp, Belgium
20 - 21 April 2023



Prepared by: Jade Pattyn, Marco Del Riccio and Greet Hendrickx
Adult Immunization Board (AIB) Secretariat

University of Antwerp, Centre for the Evaluation of Vaccination (CEV), Faculty of Medicine and Health Sciences, Drie Eikenstraat 663 – 2650 Antwerp (Belgium)
Università degli Studi di Firenze Dipartimento di Scienze della Salute Viale G.B. Morgagni, 48 50134 Firenze (Italy) adultimmunizationboard@uantwerpen.com

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Purpose of the background document

This pre-meeting background document contains a list of, AIB secretariat selected, abstracts/ references from a Pubmed Medline and grey literature search on the topic(s) of the technical meeting. In addition, speakers from the different meeting sessions were asked to provide additional relevant and interesting references. The references are ranged by publication year (*most recent first, search from earliest dates available to March 2023*) and for each year in alphabetical order of the first author's name.

This document should guide you in the preparation of the meeting, it should not be considered as a complete literature review, but hopefully it will give an overview of what has been published on the topic of the AIB technical meeting.

Inclusion of references in this document does not indicate that the AIB secretariat agrees with the content or correctness of the content.

Introduction

Accurate information on the health burden of vaccine-preventable infections (VPIs) in adults is needed for several reasons:

- To understand the need and justification for consolidating existing and proposing new adult vaccination programs
- To measure the impact of adult vaccination programs on individual and population health, health systems, economic and social factors
- To collate the rationale to improve prevention / vaccination strategies for adult diseases (e.g., update or revise immunization schedules, implement targeted delivery strategies, etc.)
- To support health policy recommendations and priorities

The purpose of the first AIB technical meeting is to identify and discuss the challenges and opportunities when assessing the health burden of VPIs in European adults.

Meeting objectives

- To provide an overview of current vaccine-preventable infections (VPIs) in the adult population (≥ 18 years of age)
- To discuss the methodology and challenges in calculating the health burden of adult VPIs (focus on Europe)
- To understand how health burden estimates of adult VPIs shape national vaccination policies and practices and inform public health priorities
- To evaluate current VPIs health burden evidence to provide a convincing case for strengthening adult vaccination in Europe

Target audience

- Public health experts, policy makers, healthcare professionals, academics with expertise/ interest in the health burden of vaccine-preventable infections in adults
- AIB advisors and observers

Part 1 Short agenda: AIB Technical Meeting

Sessions	Topics	Speaker(s)
Session 1: Introduction / Meeting definition setting	1.1 Short intro on what is health burden of disease (focus on VPIs)	Brecht Devleesschauwer
	1.2 Adult vaccine space: current VPIs in the adult population ($\geq 18y$)	Joe Schmitt
Session 2: The methodology and challenges of computing the health burden of adult VPIs	2.1 Burden of (vaccine-preventable) infectious disease studies	Mirjam Kretzschmar Periklis Charalampous, Tracy Dixon Jeffrey C Kwong
	2.2 Health information systems and data sources	Anindya Bose Javier Díez-Domingo Mark R O'Donovan Dipak Kalra
	2.3 What can we learn from the GBD study?	Tomislav Mestrovic
Session 3: The Epidemiology and health burden of selected adult VPIs	3.1 Health Burden of VPIs in pandemic situation: COVID-19 example	Sara Monteiro Pires
	3.2 Health Burden of VPIs in older adults: HZ, RSV and Influenza example	Angela Bechini Hester E de Melker Xiao Li Stefania Maggi
	3.3 Health Burden of VPIs in young adults: HPV example	Paolo Bonanni
	3.4 Health Burden of VPIs in travelers	Robert Steffen
	3.5 Health Burden of VPIs in immunocompromised adults	Per Lungman
Session 4: From theory to practice	4.1 How are health burden estimates used to recommend adult vaccines in national immunization programs in Europe	Ziad El-Khatib Lois Privor-Dumm Chiara Cadeddu Heini Salo Roman Chlibek Thomas Weinke Sotirios Tsiodras

Part 2 Article References by session

Session 1: Introduction / Meeting definition setting

Session 1: Introduction / Meeting definition setting	1.1 Short intro on what is health burden of disease (focus on VPIs)	Brecht Devleesschauwer
	1.2 Adult vaccine space: current VPIs in the adult population (≥18y)	Joe Schmitt

Meeting title definitions:

Health burden of disease	Impact of infections/ diseases on physical and psychosocial health measured in a comprehensive and comparable way by mortality and morbidity, or other indicators. <i>Source: Sciensano/burden-disease</i>
Vaccine-preventable infections	<u>An infection</u> : The invasion and multiplication of microorganisms such as bacteria, viruses, and parasites that are not normally present within the body. An infection may cause no symptoms and be subclinical, or it may cause symptoms and be clinically apparent. <u>An infectious disease</u> : also known as a transmissible disease or communicable disease, is an illness resulting from an infection. <u>A vaccine-preventable infection/ disease</u> is an infection/ disease for which an effective preventive vaccine exists. <i>Source: Medical Editor: Charles Patrick Davis, MD, PhD</i>
Adult immunization	Adult immunization refers to the administration of vaccines to individuals who are <u>18 years of age or older</u> in order to protect them against various infectious diseases. <i>Source: AIB secretariat</i>

1.1 Brief introduction on what is 'health burden of disease' (focus on vaccine-preventable infections (VPIs))

Potential questions/outcomes: (i) Explanation of BoD analysis (e.g. DALYs) – Is there a 'golden standard' to calculate BoD? (ii) Explanation of common methodological approaches (**Incidence based approach** (Compared to a prevalence-based approach, in the incidence-based DALYs, the potential future burden avoided, for example, by vaccination as a possible intervention measure, is included **vs Pathogen based approach**) (iii) **Pros and cons of # data sources**: Study collected data / sec data / modelling - Which organizations are mostly involved in calculating the BoD? (iv) **Specific approaches / issues for infectious diseases / VPIs**: e.g. *adjustment of observed case counts for both under-ascertainment and underreporting* (v) **Specific approaches / issues for (older) adults**: *heterogeneity between targeted individuals*

(large variation in age / heterogeneous risk profile within single age group: greater time over which to accumulate differences in relevant underlying conditions and exposures) in terms of risk of infection, severity of disease and response to vaccination

Related articles:

Source: Pubmed search and/or proposed by speaker B. Devleesschauwer

1.1.1 Charalampous P, Haagsma JA, ..., Devleesschauwer B, Pires SM. [Burden of infectious disease studies in Europe and the United Kingdom: a review of methodological design choices](#). *Epidemiol Infect.* 2023 Jan 9:1-32.

Abstract: This systematic literature review aimed to provide an overview of the characteristics and methods used in studies applying the Disability-Adjusted Life Years (DALY) concept for infectious diseases within European Union (EU)/European Economic Area (EEA)/European Free Trade Association (EFTA) countries and the United Kingdom. Electronic databases and grey literature were searched for articles, reporting the assessment of DALY and its components. We considered studies in which researchers performed DALY calculations using primary epidemiological data input sources. We screened 3,053 studies of which 2,948 were excluded and 105 studies met our inclusion criteria. Of these studies, 22 were multi-country and 83 were single-country studies, of which 46 were from the Netherlands. Food and water-borne diseases were the most frequently studied infectious diseases. Between 2015 and 2022, the number of burden of infectious disease studies was 1.6 times higher compared to that published between 2000 and 2014. Almost all studies (97%) estimated DALYs based on the incidence and pathogen-based approach and without social weighting functions; however, there was less methodological consensus with regards to the disability weights and life tables that were applied. The number of burden of infectious disease studies undertaken across Europe has increased over time. Development and use of guidelines will promote performing burden of infectious disease studies and facilitate comparability of the results.

1.1.2 Charalampous P, et al. [A systematic literature review of disability weights measurement studies: evolution of methodological choices](#). *Archives of Public Health.* 2022;80:91

Abstract Background: The disability weight is an essential factor to estimate the healthy time that is lost due to living with a certain state of illness. A 2014 review showed a considerable variation in methods used to derive disability weights. Since then, several sets of disability weights have been developed. This systematic review aimed to provide an updated and comparative overview of the methodological design choices and surveying techniques that have been used in disability weights measurement studies and how they evolved over time. **Methods:** A literature search was conducted in multiple international databases (early-1990 to mid-2021). Records were screened according to pre-defined eligibility criteria. The quality of the included disability weights measurement studies was assessed using the Checklist for Reporting Valuation Studies (CREATE) instrument. Studies were collated by characteristics and methodological design approaches. Data extraction was performed by one reviewer and discussed with a second. **Results:** Forty-six unique disability weights measurement studies met our eligibility criteria. More than half (n = 27; 59%) of the identified studies assessed disability weights for multiple ill-health outcomes. Thirty studies (65%) described the health states using disease-specific descriptions or a combination of a disease-specific descriptions and generic-preference instruments. The percentage of studies obtaining health preferences from a population-based panel increased from 14% (2004–2011) to 32% (2012–2021). None of the disability weight studies published in the past 10 years used

the annual profile approach. Most studies performed panel-meetings to obtain disability weights data. Conclusions Our review reveals that a methodological uniformity between national and GBD disability weights studies increased, especially from 2010 onwards. Over years, more studies used disease-specific health state descriptions in line with those of the GBD study, panel from general populations, and data from web-based surveys and/or household surveys. There is, however, a wide variation in valuation techniques that were used to derive disability weights at national-level and that persisted over time.

1.1.3 Kim YE, et al. [DALY Estimation Approaches: Understanding and Using the Incidence-based Approach and the Prevalence-based Approach](#). Journal of Preventive Medicine and Public Health. 2022;55(1):10-8.

Abstract: Disability-adjusted life-year (DALY) estimates may vary according to factors such as the standard life expectancy, age weighting, time preference and discount rate, calculation of disability weights, and selection of the estimation method. DALY estimation methods are divided into the following 3 approaches: the incidence-based approach, the pure prevalence-based approach, and the hybrid approach. These 3 DALY estimation approaches each reflect different perspectives on the burden of disease using unique characteristics, based on which the selection of a suitable approach may vary by the purpose of the study. The Global Burden of Disease studies, which previously estimated DALYs using the incidence-based approach, switched to using the hybrid approach in 2010, while the National Burden of Disease studies in Korea still mainly apply the incidence-based approach. In order to increase comparability with other international burden of disease studies, more DALY studies using the prevalence-based approach need to be conducted in Korea. However, with the limitations of the hybrid approach in mind, it is necessary to conduct more research using a disease classification system suitable for Korea. Furthermore, more detailed and valid data sources should be established before conducting studies using a broader variety of DALY estimation approaches. This review study will help researchers on burden of disease use an appropriate DALY estimation approach and will contribute to enhancing researchers' ability to critically interpret burden of disease studies.

1.1.4 Wyper GMA, Assuncao R, Fletcher E, Gourley M, Grant I, Haagsma JA, Hilderink H, Idavain J, Lesnik T, von der Lippe E, Majdan M, Mccartney G, Santric-Milicevic M, Pallari E, Pires SM, Plass D, Porst M, Santos JV, de Haro Moro MT, Stockton DL, Devleeschauwer B. [The increasing significance of disease severity in a burden of disease framework](#). Scand J Public Health. 2021 Jul 2

Abstract - Recent estimates have reiterated that non-fatal causes of disease, such as low back pain, headaches and depressive disorders, are amongst the leading causes of disability-adjusted life years (DALYs). For these causes, the contribution of years lived with disability (YLD) - put simply, ill-health - is what drives DALYs, not mortality. Being able to monitor trends in YLD closely is particularly relevant for countries that sit high on the socio-demographic spectrum of development, as it contributes more than half of all DALYs. There is a paucity of data on how the population-level occurrence of disease is distributed according to severity, and as such, the majority of global and national efforts in monitoring YLD lack the ability to differentiate changes in severity across time and location. This raises uncertainties in interpreting these findings without triangulation with other relevant data sources. Our commentary aims to bring this issue to the forefront for users of burden of disease estimates, as its impact is often easily overlooked as part of the fundamental process of generating DALY estimates. Moreover, the wider health harms of the COVID-19 pandemic have underlined the likelihood of latent and delayed demand in accessing vital health and care services that will ultimately lead to exacerbated disease severity and health outcomes. This places increased

importance on attempts to be able to differentiate by both the occurrence and severity of disease.

1.1.5 Maertens de Noordhout C, Devleeschauwer B, Salomon JA, Turner H, Cassini A, Colzani E, Speybroeck N, Polinder S, Kretzschmar ME, Havelaar AH, Haagsma JA. [Disability weights for infectious diseases in four European countries: comparison between countries and across respondent characteristics](#). Eur J Public Health. 2018 Feb 1;28(1):124-133.

Abstract Background: In 2015, new disability weights (DWs) for infectious diseases were constructed based on data from four European countries. In this paper, we evaluated if country, age, sex, disease experience status, income and educational levels have an impact on these DWs. Methods: We analyzed paired comparison responses of the European DW study by participants' characteristics with separate probit regression models. To evaluate the effect of participants' characteristics, we performed correlation analyses between countries and within country by respondent characteristics and constructed seven probit regression models, including a null model and six models containing participants' characteristics. We compared these seven models using Akaike Information Criterion (AIC). Results: According to AIC, the probit model including country as covariate was the best model. We found a lower correlation of the probit coefficients between countries and income levels (range rs: 0.97-0.99, $P < 0.01$) than between age groups (range rs: 0.98-0.99, $P < 0.01$), educational level (range rs: 0.98-0.99, $P < 0.01$), sex (rs = 0.99, $P < 0.01$) and disease status (rs = 0.99, $P < 0.01$). Within country the lowest correlations of the probit coefficients were between low and high income level (range rs = 0.89-0.94, $P < 0.01$). Conclusions: We observed variations in health valuation across countries and within country between income levels. These observations should be further explored in a systematic way, also in non-European countries. We recommend future researches studying the effect of other characteristics of respondents on health assessment.

1.1.6 Hilderink HB, Plasmans MH, Snijders BE, Boshuizen HC, Poos MJ, van Gool CH. [Accounting for multimorbidity can affect the estimation of the Burden of Disease: a comparison of approaches](#). Arch Public Health. 2016 Aug 22;74:37.

Abstract Background: Various Burden of Disease (BoD) studies do not account for multimorbidity in their BoD estimates. Ignoring multimorbidity can lead to inaccuracies in BoD estimations, particularly in ageing populations that include large proportions of persons with two or more health conditions. The objective of this study is to improve BoD estimates for the Netherlands by accounting for multimorbidity. For this purpose, we analyzed different methods for 1) estimating the prevalence of multimorbidity and 2) deriving Disability Weights (DWs) for multimorbidity by using existing data on single health conditions. Methods: We included 25 health conditions from the Dutch Burden of Disease study that have a high rate of prevalence and that make a large contribution to the total number of Years Lived with a Disability (YLD). First, we analyzed four methods for estimating the prevalence of multimorbid conditions (i.e. independent, independent age- and sex-specific, dependent, and dependent sex- and age-specific). Secondly, we analyzed three methods for calculating the Combined Disability Weights (CDWs) associated with multimorbid conditions (i.e. additive, multiplicative and maximum limit). A combination of these two approaches was used to recalculate the number of YLDs, which is a component of the Disability-Adjusted Life Years (DALY). Results: This study shows that the YLD estimates for 25 health conditions calculated using the multiplicative method for Combined Disability Weights are 5 % lower, and 14 % lower when using the maximum limit method, than when calculated using the additive method. Adjusting for sex- and age-specific dependent co-occurrence of

health conditions reduces the number of YLDs by 10 % for the multiplicative method and by 26 % for the maximum limit method. The adjustment is higher for health conditions with a higher prevalence in old age, like heart failure (up to 43 %) and coronary heart diseases (up to 33 %). Health conditions with a high prevalence in middle age, such as anxiety disorders, have a moderate adjustment (up to 13 %). Conclusions: We conclude that BoD calculations that do not account for multimorbidity can result in an overestimation of the actual BoD. This may affect public health policy strategies that focus on single health conditions if the underlying cost-effectiveness analysis overestimates the intended effects. The methodology used in this study could be further refined to provide greater insight into co-occurrence and the possible consequences of multimorbid conditions in terms of disability for particular combinations of health conditions.

1.1.7 Devleesschauwer B, Havelaar AH, Maertens de Noordhout C, Haagsma JA, Praet N, Dorny P, Duchateau L, Torgerson PR, Van Oyen H, Speybroeck N. [DALY calculation in practice: a stepwise approach](#). Int J Public Health. 2014 Jun;59(3):571-4.

This Hints and Kinks paper tries to address the steps preceding the actual DALY calculation in practice by presenting a stepwise approach.

1.1.8 Devleesschauwer B, Havelaar AH, Maertens de Noordhout C, Haagsma JA, Praet N, Dorny P, Duchateau L, Torgerson PR, Van Oyen H, Speybroeck N (2014) [Calculating disability-adjusted life years to quantify burden of disease](#). Int J Public Health.

In this Hints and Kinks paper, the authors summarize the DALY's basic features and present a description of its calculation.

1.1.9 Mangen MJ, Plass D, Havelaar AH, Gibbons CL, Cassini A, Mühlberger N, van Lier A, Haagsma JA, Brooke RJ, Lai T, de Waure C, Kramarz P, Kretzschmar ME; BCoDE consortium. [The pathogen- and incidence-based DALY approach: an appropriate methodology for estimating the burden of infectious diseases](#). PLoS One. 2013 Nov 20;8(11):e79740.

Abstract: In 2009, the European Centre for Disease Prevention and Control initiated the 'Burden of Communicable Diseases in Europe (BCoDE)' project to generate evidence-based and comparable burden-of-disease estimates of infectious diseases in Europe. The burden-of-disease metric used was the Disability-Adjusted Life Year (DALY), composed of years of life lost due to premature death (YLL) and due to disability (YLD). To better represent infectious diseases, a pathogen-based approach was used linking incident cases to sequelae through outcome trees. Health outcomes were included if an evidence-based causal relationship between infection and outcome was established. Life expectancy and disability weights were taken from the Global Burden of Disease Study and alternative studies. Disease progression parameters were based on literature. Country-specific incidence was based on surveillance data corrected for underestimation. Non-typhoidal *Salmonella* spp. and *Campylobacter* spp. were used for illustration. Using the incidence- and pathogen-based DALY approach the total burden for *Salmonella* spp. and *Campylobacter* spp. was estimated at 730 DALYs and at 1,780 DALYs per year in the Netherlands (average of 2005-2007). Sequelae accounted for 56% and 82% of the total burden of *Salmonella* spp. and *Campylobacter* spp., respectively. The incidence- and pathogen-based DALY methodology allows in the case of infectious diseases a more comprehensive calculation of the disease burden as subsequent sequelae are fully taken into account. Not considering subsequent sequelae would strongly underestimate the burden of infectious diseases. Estimates can be used to support prioritisation and

comparison of infectious diseases and other health conditions, both within a country and between countries.

1.1.10 Murray CJ. [Quantifying the burden of disease: the technical basis for disability-adjusted life years](#). Bulletin of the World Health Organization. 1994;72(3):429-45.

Abstract: Detailed assumptions used in constructing a new indicator of the burden of disease, the disability-adjusted life year (DALY), are presented. Four key social choices in any indicator of the burden of disease are carefully reviewed. First, the advantages and disadvantages of various methods of calculating the duration of life lost due to a death at each age are discussed. DALYs use a standard expected-life lost based on model life-table West Level 26. Second, the value of time lived at different ages is captured in DALYs using an exponential function which reflects the dependence of the young and the elderly on adults. Third, the time lived with a disability is made comparable with the time lost due to premature mortality by defining six classes of disability severity. Assigned to each class is a severity weight between 0 and 1. Finally, a three percent discount rate is used in the calculation of DALYs. The formula for calculating DALYs based on these assumptions is provided.

1.2 The adult vaccine space: current VPIs in the adult population (≥18y).

Potential questions/outcomes: What are the current adult vaccine preventable infections? What are the past, current and possible future trends? Do we have vaccines for the infectious diseases with the highest burden in adults?

Input from European Medicines Agency (EMA) (last updated 30 March 2023)

All 55 human vaccines with a valid EMA marketing authorization on the first of April, 2023 were investigated if indicated for over 18 years of age. Indication(s) were checked to determine if vaccines are indicated for over 18 years of age and the relevant products' EPAR were checked on the EMA web page (<https://www.ema.europa.eu/en/medicines>) to see exactly for which age groups the vaccines are authorized.

! Note that not all adult vaccines currently used in the EU are authorized by EMA. Some vaccines (e.g. "old" vaccines) are authorized at national level. Vaccines Europe is currently completing this list with its members.

An overview of the vaccines / indication(s) authorized By EMA for over 18 years of age are given below:

Vaccines by indication <i>Indication (Number of vaccines)</i>	Vaccines authorized <i>EU trade name (Manufacture)</i>
Pneumococcal polysaccharide conjugate vaccines (2)	Apexxnar (Pfizer) Prevenar 13 (Pfizer)
Meningococcal group B vaccines (2)	Bexsero (GSK) Trumenba (Pfizer)
Meningococcal group A, C, W-135 and Y conjugate vaccines (3)	MenQuadfi (Sanofi) Menveo (GSK) Nimenrix (Pfizer)
HPV vaccines (3)	Cervarix (GSK) Gardasil (MSD) Gardasil9 (MSD)

Vaccines by indication <i>Indication (Number of vaccines)</i>	Vaccines authorized <i>EU trade name (Manufacture)</i>
COVID-19 vaccines (8)	Bimervax (HIPRA Human Health) Comirnaty (BioNTech/Pfizer) COVID-19 vaccine (Valneva) Spikevax (Moderna) Jcovden (Janssen) Nuvaxovid (Novavax) Vaxzevria (AstraZeneca) VidPrevtyn Beta (Sanofi Pasteur)
Dengue vaccines (2)	Dengvaxia (Sanofi) Qdenga (Takeda)
Cholera vaccines (2)	Dukoral (Valneva) Vaxchora (IL-CSM GmbH)
Ebola Zaire-vaccines (2)	Ervebo (Burgwedel Biotech GmbH) Mvabea / Zabdeno (Janssen)
Hepatitis B vaccines (3)	Fendrix (GSK) Hepelisav B (Dynavax) PreHevri (MIAS Pharma Limited)
Hepatitis A / B vaccine (1)	Twinrix Adult (GSK)
Smallpox/ Mpox vaccine (1)	Imvanex (Bavarian Nordic)
Japanese encephalitis vaccine (1)	Ixiaro (Valneva)
Measles mumps rubella vaccine (1)	M-M-RvaxPro (MSD)
Measles, mumps, rubella, varicella vaccine (1)	ProQuad (MSD)
Herpes zoster vaccines (2)	Shingrix (GSK) Zostavax (MSD)
Influenza vaccines (3)	Fluad Tetra (CSL Seqirus) Flucelvax Tetra (CSL Seqirus) Supemtek (Sanofi)
Pandemic Influenza vaccines (H5N1) (4)	Adjupanrix (GSK) Aflunov (CSL Seqirus) Foclivia (CSL Seqirus) Pandemic Influenza Vaccine (Baxter AG)

Related articles:

Pubmed search and/or proposed by speaker J. Schmitt

1.2.1 Kingsley T, Phelan D, Poland GA. [A review of 2023 adult immunization schedule updates](#). Vaccine. 2023 Apr 17;41(16):2631-2633. doi: 10.1016/j.vaccine.2023.03.019. Epub 2023 Mar 23. PMID: 36966076.

Adult Immunization Schedule - **Recommendations for Ages 19 Years or Older, United States, 2023**

<https://www.cdc.gov/vaccines/schedules/hcp/imz/adult.html>

Table 1 Recommended Adult Immunization Schedule by Age Group, United States, 2023

Vaccine	19–26 years	27–49 years	50–64 years	≥65 years
COVID-19	2- or 3- dose primary series and booster (See Notes)			
Influenza inactivated (IIV4) or Influenza recombinant (RIV4)	1 dose annually			
Influenza live, attenuated (LAIV4)	1 dose annually			
Tetanus, diphtheria, pertussis (Tdap or Td)	1 dose Tdap each pregnancy; 1 dose Td/Tdap for wound management (see notes)			
Measles, mumps, rubella (MMR)	1 dose Tdap, then Td or Tdap booster every 10 years			
Measles, mumps, rubella (MMR)	1 or 2 doses depending on indication (if born in 1957 or later)			For healthcare personnel, see notes
Varicella (VAR)	2 doses (if born in 1980 or later)		2 doses	
Zoster recombinant (RZV)	2 doses for immunocompromising conditions (see notes)		2 doses	
Human papillomavirus (HPV)	2 or 3 doses depending on age at initial vaccination or condition	27 through 45 years		
Pneumococcal (PCV15, PCV20, PPSV23)	1 dose PCV15 followed by PPSV23 OR 1 dose PCV20 (see notes)			See Notes
Hepatitis A (HepA)	2, 3, or 4 doses depending on vaccine			
Hepatitis B (HepB)	2, 3, or 4 doses depending on vaccine or condition			
Meningococcal A, C, W, Y (MenACWY)	1 or 2 doses depending on indication, see notes for booster recommendations			
Meningococcal B (MenB)	19 through 23 years	2 or 3 doses depending on vaccine and indication, see notes for booster recommendations		
Haemophilus influenzae type b (Hib)	1 or 3 doses depending on indication			

 Recommended vaccination for adults who meet age requirement, lack documentation of vaccination, or lack evidence of past infection
 Recommended vaccination for adults with an additional risk factor or another indication
 Recommended vaccination based on shared clinical decision-making
 No recommendation/ Not applicable

Table 2 Recommended Adult Immunization Schedule by Medical Condition or Other Indication, United States, 2023

Vaccine	Pregnancy	Immuno-compromised (excluding HIV infection)	HIV infection CD4 percentage and count	Asplenia, complement deficiencies	End-stage renal disease, or on hemodialysis	Heart or lung disease; alcoholism ^a	Chronic liver disease	Diabetes	Health care personnel ^b	Men who have sex with men
COVID-19		See Notes								
IIV4 or RIV4		1 dose annually								
OR		Contraindicated			Precaution			1 dose annually		
LAIV4										
Tdap or Td	1 dose Tdap each pregnancy	1 dose Tdap, then Td or Tdap booster every 10 years								
MMR	Contraindicated ^a	Contraindicated		1 or 2 doses depending on indication						
VAR	Contraindicated ^a	Contraindicated			2 doses					
RZV		2 doses at age ≥19 years			2 doses at age ≥50 years					
HPV	Not Recommended ^a	3 doses through age 26 years			2 or 3 doses through age 26 years depending on age at initial vaccination or condition					
Pneumococcal (PCV15, PCV20, PPSV23)		1 dose PCV15 followed by PPSV23 OR 1 dose PCV20 (see notes)								
HepA		2, 3, or 4 doses depending on vaccine								
HepB	3 doses (see notes)	2, 3, or 4 doses depending on vaccine or condition								
MenACWY		1 or 2 doses depending on indication, see notes for booster recommendations								
MenB	Precaution	2 or 3 doses depending on vaccine and indication, see notes for booster recommendations								
Hib		3 doses HSCT ^c recipients only		1 dose						

 Recommended vaccination for adults who meet age requirement, lack documentation of vaccination, or lack evidence of past infection
 Recommended vaccination for adults with an additional risk factor or another indication
 Recommended vaccination based on shared clinical decision-making
 Precaution—vaccination might be indicated if benefit of protection outweighs risk of adverse reaction
 Contraindicated or not recommended—vaccine should not be administered.
 No recommendation/ Not applicable

^a Precaution for LAIV4 does not apply to alcoholism. ^b See notes for influenza; hepatitis B; measles, mumps, and rubella; and varicella vaccinations. ^c Hematopoietic stem cell transplant.

1.2.2 Wallace AS, Ryman TK, Privor-Dumm L, Morgan C, Fields R, Garcia C, Sodha SV, Lindstrand A, Nic Lochlainn LM. [Leaving no one behind: Defining and implementing an integrated life course approach to vaccination across the next decade as part of the immunization Agenda 2030](#). Vaccine. 2022 Dec 8:S0264

Abstract: Strategic Priority 4 (SP4) of the Immunization Agenda 2030 aims to ensure that all people benefit from recommended immunizations throughout the life-course, integrated with essential health services. Therefore, it is necessary for immunization programs to have coordination and collaboration across all health programs. Although there has been progress, immunization platforms in the second year of life and beyond need continued strengthening, including booster doses and catch-up vaccination, for all ages, and recommended vaccines for older age groups. We note gaps in current vaccination programs policies and achieved coverage, in the second year of life and beyond. In 2021, the second dose of measles-containing vaccine (MCV2), given in the second year of life, achieved 71% global coverage vs 81% for MCV1. For adolescents, 60% of all countries have adopted human papillomavirus vaccines in their vaccination schedule with a global coverage rate of only 12 percent in 2021. Approximately 65% of the countries recommend influenza vaccines for older adults, high-risk adults and pregnant women, and only 25% recommended pneumococcal vaccines for older adults. To achieve an integrated life course approach to vaccination, we reviewed the evidence, gaps, and strategies in four focus areas: generating evidence for disease burden and potential vaccine impact in older age groups; building awareness and shifting policy beyond early childhood; building integrated delivery approaches throughout the life course; and identifying missed opportunities for vaccination, implementing catch-up strategies, and monitoring vaccination throughout the life course. We identified needs, such as tailoring strategies to the local context, conducting research and advocacy to mobilize resources and build political will. Mustering sufficient financial support and demand for an integrated life course approach to vaccination, particularly in times of COVID-19, is both a challenge and an opportunity.

	Pregnant Women	Newborn <28 days	Infant 1 month - <1 year	Second Year of Life 12-23 months	Child (2-8 years)	Adolescent (9-19 years)	Adult (20-64 years)	Older Persons >65 years
WHO recommended vaccines	Tetanus Toxoid Containing Vaccines (TTCV) Seasonal Influenza*	BCG HepB - BD	DTP CV HepB Hib Measles PCV Rubella Rotavirus Japanese Encephalitis* Meningococcal* Rabies* Seasonal Influenza* Typhoid* Yellow fever*	DTP CV Booster Measles PCV3 (if 2+1 schedule) Cholera* Hepatitis A* Meningococcal* Mumps* Rabies* Seasonal Influenza* Typhoid* Varicella*	Diphtheria Booster Tetanus Booster Cholera* Rabies* Seasonal Influenza* Typhoid*	Diphtheria Booster HPV Tetanus Booster Cholera* Dengue* Rabies* Seasonal Influenza* Typhoid*	Cholera* Dengue* Rabies* Seasonal Influenza*	Cholera* Rabies* Seasonal Influenza*

Fig. 4. in paper: * Vaccines recommended by WHO for certain regions/high risk populations/immunization programs with certain characteristics.

1.2.3 Schmitt J. Global Health Cast – Edition 14 - **Current vaccines and vaccine development** - 2022 Sept 2022. <https://id-ea.org/global-health-cast-edition-14/>

Global Health Cast Edition 1.4
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Current Vaccines

Maternal Immunization (5)	Infant, toddlers (≥11+4)	School Entry/ Adolescents (6)	Adults (>3)	≥65 yrs (9)
<ul style="list-style-type: none"> - Tdap - Influenza - COVID19 (Recommended, not licensed)	<ul style="list-style-type: none"> - DTaP-Hib-IPV-HBV - PCV - Rotavirus - Influenza - MenACWY - Men B - (TBE >1 yr) - MMR-V 	<ul style="list-style-type: none"> - Boosters Tdap - Influenza - COVID19 - Men ACWY - MenB - HPV - (TBE) 	<ul style="list-style-type: none"> - Boosters - Tdap-IPV - Influenza - HPV - (TBE) - „Workplace Vx“ 	<ul style="list-style-type: none"> - Boosters - Tdap - (TBE) - COVID19 - Influenza - PCV - Zoster - MenACWY - MenB

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Medical Need Based on special host/exposure

Traveller	Underlying diseases	B-&T-cell Defect/ Cancer*	Emerging infections	Lack of health care resources
<ul style="list-style-type: none"> - Boosters - TBE (FSME) - HAV - HBV - Influenza - MenACWY - MenB - JE - Typhoid - Rabies - Yellow fever - Cholera - Dengue 	<ul style="list-style-type: none"> - Influenza - Boosters - (risk-based Vx) 	<ul style="list-style-type: none"> - Influenza - PCV - MenACWY - MenB - H. influenzae b - HBV - Boosters 	<ul style="list-style-type: none"> - COVID19 VOCs - Avian influenza - Cholera - Smallpox - Monkeypox 	<ul style="list-style-type: none"> - Monkeypox - Ebola

1.2.4 Cassimos DC, Efraimidou E, Medic S, Konstantinidis T, Theodoridou M, Maltezos HC. [Vaccination Programs for Adults in Europe, 2019](#). Vaccines (Basel). 2020 Jan 20;8(1):34.

Abstract - Background: While all European countries implement vaccination programs for children, there are gaps in terms of vaccination programs for adults. Methods: We studied the 2019 vaccination policies for adults in 42 European countries. Results: Vaccination programs for adults were in place in all countries. However, there were considerable differences between countries in terms of number of vaccinations, target populations and frame of implementation (recommended or mandatory vaccinations). In particular the following vaccination policies were in place: influenza (42 countries), tetanus (31), diphtheria (30), pneumococcus (29), hepatitis B (20), pertussis (18), measles (14), human papilloma virus (14), meningococcus tetravalent A,C,W,Y (14), rubella (13), hepatitis A (11), mumps (11), poliomyelitis (10), herpes zoster (9), varicella (8), tick-borne encephalitis (8), meningococcus B (6), rabies (6), Haemophilus influenzae

type b (5), tuberculosis (3), typhoid fever (3), meningococcus C (2), and yellow fever (1). Seventeen countries implement mandatory vaccinations, mainly against diphtheria, tetanus and hepatitis B. Conclusions: There are significant differences in vaccination programs for adults in Europe. Routine vaccination programs for adults need to be strengthened. A consensus-based vaccination program is needed.

Table 2. National vaccination policies for adults in Europe by vaccine and by country, 2019.

Country	D	T	P	Polio	Hib	HepB	HepA	Me	Mu	R	VZV	HZ	BCG	HPV	Flu	MenB	MenC	MCV4	PPV	PCV	TBE	TF	Rabies	YF
Albania	R	R	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Austria	R	R	R	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	R	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Belarus	M	M	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	R	R	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Belgium	RspR	RspR	RspR	spR	spM	nMnR	spR	spR	R	R	R	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Bosnia	M	M	nMnR	nMnR	nMnR	spM	spR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Herzegovina	M	M	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Bulgaria	R	MR	R	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Croatia	R	MR	R	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Cyprus	R	R	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Czech Republic	RspR	MRspR	RspR	nMnR	spR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Denmark	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Estonia	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Finland	R	R	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
France	RspR	RspR	R	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Germany	R	R	R	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Greece	RspR	RspR	RspR	R	spR	spR	RspR	RspR	RspR	RspR	R	nMnR	spR	RspR	spR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Hungary	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Iceland	spR	spR	spR	spR	nMnR	spR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Ireland	spR	spR	spR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Italy	MRspR	MRspR	MRspR	MRspR	MRspR	MRspR	MRspR	MRspR	MRspR	MRspR	MRspR	MRspR	MRspR	MRspR	R	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Latvia	RspR	RspR	R	nMnR	nMnR	spR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Liechtenstein	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Lithuania	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Luxembourg	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Malta	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Moldova	M	M	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Monaco	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Montenegro	M	M	nMnR	nMnR	spM	spM	spR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Netherlands	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
North Macedonia	nMnR	M	nMnR	nMnR	nMnR	spM	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Norway	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Poland	M	M	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Portugal	RspR	RspR	RspR	nMnR	nMnR	spR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Romania	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Russia	M	M	nMnR	nMnR	nMnR	M	nMnR	spMspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	R	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Serbia	spR	spR	spR	nMnR	spM	spMspR	spMspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Slovakia	R	M	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Slovenia	M	M	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Spain	R	R	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Sweden	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Switzerland	R	R	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
Ukraine	M	M	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR
United Kingdom	spR	spR	spR	spR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	RspR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR	nMnR

D: diphtheria; T: tetanus; P: pertussis; Polio: poliomyelitis; Hib: *Haemophilus influenzae*; Hep B: hepatitis B; Hep A: hepatitis A; Me: measles; Mu: mumps; R: rubella; VZV: varicella-zoster virus; HZ: herpes zoster; BCG: bacillus Calmette-Guérin vaccine; HPV: human papilloma virus; Flu: influenza; MenB: meningococcus B; MenC: meningococcus C; MCV4: meningococci A,C,W,Y; PPV: pneumococcal polysaccharide vaccine; PCV: pneumococcal conjugate vaccine; TBE: tick-borne encephalitis; TF: typhoid fever; YF: yellow fever; R: recommended for all adults; spR: recommended for specific groups; M: mandatory for all adults; spM: mandatory for specific groups; nMnR: not mandatory-not recommended.

Table 2: National vaccination policies for adults in Europe by vaccine and by country, 2019.

1.2.5 Doherty TM, Del Giudice G, Maggi S. **Adult vaccination as part of a healthy lifestyle: moving from medical intervention to health promotion.** Ann Med. 2019 Mar;51(2):128-140.

Abstract As the global population ages, there is concern about the effect of an increased proportion of older individuals on the economic sustainability of healthcare systems and the social effects of an older society. Health authorities and advocacy groups in countries at the forefront of this trend are now developing strategies to ameliorate the social and financial effects of an ageing population. There is broad agreement that for both society and for the individuals, it is important to ensure that increasing lifespans are matched with increased "healthspans" - the number of years spent in good health. There is also growing consensus that vaccination is one of the tools that can play an important role in improving adult health - though currently vaccination coverage is often poor. This review focuses on two issues that consistently appear to be associated with under-vaccination: the low awareness of risk (and potential consequences) for vaccine-preventable diseases and a poor understanding of the value of improved vaccination coverage for adults. We suggest that understanding of vaccination as a health-promoting activity, rather than a medical intervention designed to prevent the spread of a specific pathogen - is a crucial step to improve vaccination uptake among adults (see Supplementary video abstract). Key messages As populations age globally, we are seeing an increasing burden of vaccine-preventable disease in adults. Adult vaccination against some common diseases has been shown to dramatically improve health and quality of life for older people. Despite the attested benefits, vaccination coverage is almost always poor in adults, even in countries where access is free at point of care. In this article, we discuss what appears to a



neglected issue in adult vaccination, that of personal autonomy. We argue that adult vaccination will only be successful if it respects individual autonomy and that this requires treating the choice to vaccinate as a public health issue akin to smoking cessation, exercise and healthy diet.

Table 1. Human vaccine preventable diseases [3–5]^a.

Infection	EPI ^b recommendation	Infection	EPI ^b recommendation
Anthrax		Pertussis	✓
Cholera		Pneumococcal disease	✓
Dengue		Poliomyelitis	✓
Diphtheria	✓	Q fever	
Hepatitis A		Rabies	
Hepatitis B	✓	Rotavirus	✓
Hepatitis E		Rubella	
<i>Haemophilus influenzae</i> type b (Hib)	✓	Smallpox	✓
Human papillomavirus (HPV)		Tetanus	
Influenza		Tick-borne encephalitis	
Japanese encephalitis		Tuberculosis	✓
Malaria		Typhoid	
Measles	✓	Varicella (Chickenpox and Zoster)	
Meningococcal meningitis		Yellow Fever	
Mumps			

^aVaccines listed are not all recommended or relevant in all countries. This list covers licensed vaccines which have been and widely used in humans, but does not include those which are no longer readily available such as the killed *Yersinia pestis* vaccine, or which have been used, but are not yet licensed, such as the Ebola vaccines.

^bThe EPI is the Expanded Programme on Immunisation – a WHO programme established in 1974 to develop and expand immunisation programmes throughout the world. The vaccines listed are current as of 2018 (http://www.who.int/immunization/programmes_systems/supply_chain/benefits_of_immunization/en/).

Table 1. Human vaccine preventable diseases

Session 2: The methodology and challenges of computing the health burden of adult VPIs (focus on Europe)

Session 2: The methodology and challenges of computing the health burden of adult VPIs	2.1 Burden of (vaccine-preventable) infectious disease studies	Mirjam Kretzschmar Periklis Charalampous, Tracy Dixon Jeffrey C Kwong
	2.2 Health information systems and data sources	Anindya Bose Javier Díez-Domingo Mark R O'Donovan Dipak Kalra
	2.3 What can we learn from the GBD study?	Tomislav Mestrovic

2.1 Burden of (vaccine-preventable) infectious disease studies

Potential questions/outcomes: What are the current methods used to compute individual and population health burden of infections? What are the most successful experiences in assessing the health burden of adult VPIs and what challenges are faced? Who's responsibility is it to conduct VPI burden studies? (Governments, academics, manufactures?) Do all countries need to conduct separate burden of disease studies or is a study in some 'EU-countries enough'?

Related articles: Source: Pubmed search and/or proposed by speakers: Mirjam Kretzschmar, P. Charalampous, T. Dixon, J.C Kwong

2.1.1 Charalampous P, Haagsma JA, ..., Devleeschauwer B, Pires SM. [Burden of infectious disease studies in Europe and the United Kingdom: a review of methodological design choices](#). *Epidemiol Infect.* 2023 Jan 9:1-32.

Abstract: See page 6 (Reference already mentioned in Session 1 – article 1.1.1)

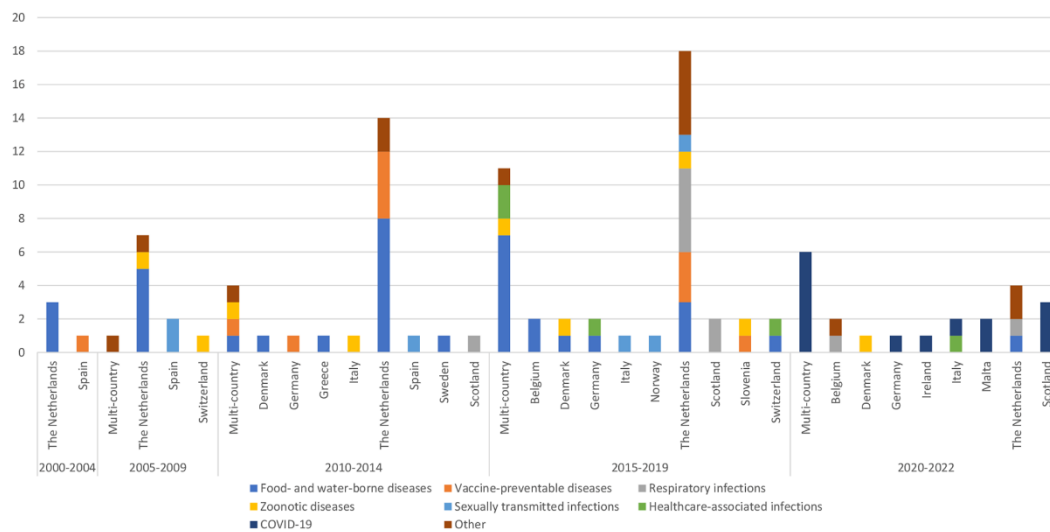


Fig. 2. Number of single-country and multi-country independent burden of infectious disease studies per year of publication, geographic coverage and infectious cause category studied.

2.1.2 von der Lippe E, Devleeschauwer B, Gourley M, Haagsma J, Hilderink H, Porst M, Wengler A, Wyper G, Grant I. [Reflections on key methodological decisions in national burden of disease assessments](#). Arch Public Health. 2020 Dec 31;78(1):137. doi: 10.1186/s13690-020-00519-7. PMID: 33384020; PMCID: PMC7774238.

Abstract Background: Summary measures of population health are increasingly used in different public health reporting systems for setting priorities for health care and social service delivery and planning. Disability-adjusted life years (DALYs) are one of the most commonly used health gap summary measures in the field of public health and have become the key metric for quantifying burden of disease (BoD). BoD methodology is, however, complex and highly data demanding, requiring a substantial capacity to apply, which has led to major disparities across researchers and nations in their resources to perform themselves BoD studies and interpret the soundness of available estimates produced by the Global Burden of Disease Study. **Methods:** BoD researchers from the COST Action European Burden of Disease network reflect on the most important methodological choices to be made when estimating DALYs. The paper provides an overview of eleven methodological decisions and challenges drawing on the experiences of countries working with BoD methodology in their own national studies. Each of these steps are briefly described and, where appropriate, some examples are provided from different BoD studies across the world. **Results:** In this review article we have identified some of the key methodological choices and challenges that are important to understand when calculating BoD metrics. We have provided examples from different BoD studies that have developed their own strategies in data usage and implementation of statistical methods in the production of BoD estimates. **Conclusions:** With the increase in national BoD studies developing their own strategies in data usage and implementation of statistical methods in the production of BoD estimates, there is a pressing need for equitable capacity building on the one hand, and harmonization of methods on the other hand. In response to these issues, several BoD networks have emerged in the European region that bring together expertise across different domains and professional backgrounds. An intensive exchange in the experience of

the researchers in the different countries will enable the understanding of the methods and the interpretation of the results from the local authorities who can effectively integrate the BoD estimates in public health policies, intervention and prevention programs.

2.1.3 Australian Institute of Health and Welfare 2019. [The burden of vaccine preventable diseases in Australia](#). Cat. no. PHE 263. Canberra: AIHW.

Abstract: This report presents results from the Burden of Vaccine Preventable Diseases in Australia study (BVPD study). The BVPD study used incidence-based modelling to estimate burden. This approach reflects the burden of all new cases of disease that occur in the reference year and their immediate and future consequences (including death). Due to differences in methods, results from this report should not be directly compared with those from the Australian Burden of Disease Study or the Global Burden of Disease study.

The Australian Government provides free vaccines to eligible people, including young children, older Australians, Aboriginal and Torres Strait Islander Australians, and others who are at greater risk of serious harm from vaccine preventable diseases (VPD), such as pregnant women. In 2018, the Australian National Immunisation Program (NIP) provided vaccines against 17 diseases.

Results of the BVPD study show a reduction in the burden for a number of diseases for which vaccines have been added to, or vaccine eligibility extended on, the NIP schedule during the past 20 years. These include human papillomavirus (HPV), chickenpox, hepatitis A, hepatitis B, meningococcal disease, pneumococcal disease and rotavirus.

In 2015:

- 5 diseases accounted for almost 95% of the VPD burden: influenza (36%), pneumococcal disease (24%), HPV (24%), shingles (7%) and meningococcal disease (4%)
- over three-quarters (80%) of the VPD burden was due to premature death
- the rate of VPD burden was highest in infants and older Australians (85 years and over). Among those aged 1–74, young adults aged 25–29 had the highest rate of burden. The majority of the burden in this age group is due to the potential long-term outcome of developing cervical cancer following HPV infection.

Between 2005 and 2015:

- there was a 31% decrease in the overall age-standardised rate of burden due to the 17 VPD included on the NIP schedule
- the VPD burden rate decreased among infants, young children and young adults, and increased among those aged 65 and over
- decreased burden in young children was mostly driven by declines in the incidence of rotavirus, pneumococcal and meningococcal diseases, while the sharp decreases for young adults were driven by declines in HPV infection
- the increased burden in older adults (65 years and over) was mainly due to the increased incidence of influenza and shingles, along with greater numbers of deaths from these 2 diseases.

Estimates of the burden among Indigenous Australians were calculated for 13 VPD: chickenpox, Haemophilus influenzae type b (Hib), hepatitis A, hepatitis B, HPV, influenza, measles, meningococcal disease, mumps, pneumococcal disease, rotavirus, shingles and whooping cough.

- In 2015, 10% of the burden due to these 13 VPD was among Indigenous Australians. The Indigenous VPD burden rate was 4.1 times the rate for non-Indigenous Australians.
- Between 2005 and 2015, the age-standardised rate of burden among Indigenous Australians due to the 13 specified VPD decreased by almost 41%.

2.1.4 Cassini A, Colzani E, ..., Kretzschmar ME; BCoDE consortium. [Impact of infectious diseases on population health using incidence-based disability-adjusted life years \(DALYs\): results from the Burden of Communicable Diseases in Europe study, European Union and European Economic Area countries, 2009 to 2013](#). Euro Surveill. 2018 Apr;23(16):17-00454.

Abstract: Background and aims The Burden of Communicable Diseases in Europe (BCoDE) study aimed to calculate disability-adjusted life years (DALYs) for 31 selected diseases in the European Union (EU) and European Economic Area (EEA). Methods: DALYs were estimated using an incidence-based and pathogen-based approach. Incidence was estimated through assessment of data availability and quality, and a correction was applied for under-estimation. Calculation of DALYs was performed with the BCoDE software toolkit without applying time discounting and age-weighting. Results: We estimated that one in 14 inhabitants experienced an infectious disease episode for a total burden of 1.38 million DALYs (95% uncertainty interval (UI): 1.25-1.5) between 2009 and 2013; 76% of which was related to the acute phase of the infection and its short-term complications. Influenza had the highest burden (30% of the total burden), followed by tuberculosis, human immunodeficiency virus (HIV) infection/AIDS and invasive pneumococcal disease (IPD). Men had the highest burden measured in DALYs (60% of the total), adults 65 years of age and over had 24% and children less than 5 years of age had 11%. Age group-specific burden showed that infants (less than 1 year of age) and elderly people (80 years of age and over) experienced the highest burden. Conclusions: These results provide baseline estimates for evaluating infectious disease prevention and control strategies. The study promotes an evidence-based approach to describing population health and assessing surveillance data availability and quality, and provides information for the planning and prioritisation of limited resources in infectious disease prevention and control.

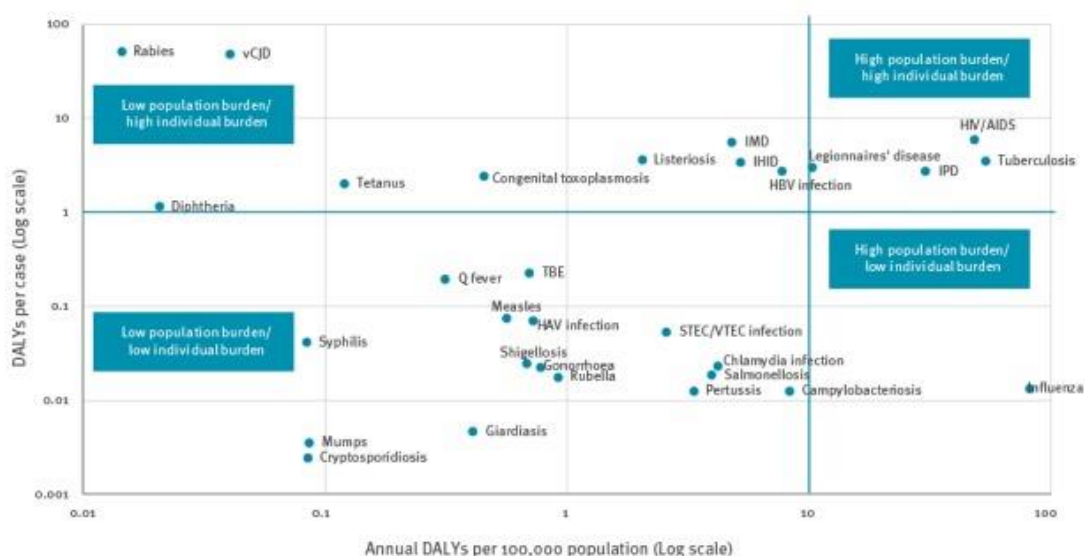


Figure 4 Scatterplot of the burden of selected infectious diseases in DALYs per case and DALYs per 100,000 population per year, EU/EEA countries, 2009–2013

2.1.5 Colzani E, Cassini A, Lewandowski D, Mangen MJ, Plass D, McDonald SA, van Lier A, Haagsma JA, Maringhini G, Pini A, Kramarz P, Kretzschmar ME. [A Software Tool for Estimation of Burden of Infectious Diseases in Europe Using Incidence-Based Disability Adjusted Life Years](#). PLoS One. 2017 Jan 20;12(1):e0170662.

Abstract - The burden of disease framework facilitates the assessment of the health impact of diseases through the use of summary measures of population health such as Disability-Adjusted Life Years (DALYs). However, calculating, interpreting and communicating the results of studies using this methodology poses a challenge. The aim of the Burden of Communicable Disease in Europe (BCoDE) project is to summarize the impact of communicable disease in the European Union and European Economic Area Member States (EU/EEA MS). To meet this goal, a user-friendly software tool (BCoDE toolkit), was developed. This stand-alone application, written in C++, is open-access and freely available for download from the website of the European Centre for Disease Prevention and Control (ECDC). With the BCoDE toolkit, one can calculate DALYs by simply entering the age group- and sex-specific number of cases for one or more of selected sets of 32 communicable diseases (CDs) and 6 healthcare associated infections (HAIs). Disease progression models (i.e., outcome trees) for these communicable diseases were created following a thorough literature review of their disease progression pathway. The BCoDE toolkit runs Monte Carlo simulations of the input parameters and provides disease-specific results, including 95% uncertainty intervals, and permits comparisons between the different disease models entered. Results can be displayed as mean and median overall DALYs, DALYs per 100,000 population, and DALYs related to mortality vs. disability. Visualization options summarize complex epidemiological data, with the goal of improving communication and knowledge transfer for decision-making.

2.1.6 Kwong JC, Ratnasingham S, ..., Zagorski B, Crowcroft NS. [The impact of infection on population health: results of the Ontario burden of infectious diseases study](#). PLoS One. 2012;7(9):e44103.

Abstract Background: Evidence-based priority setting is increasingly important for rationally distributing scarce health resources and for guiding future health research. We sought to quantify the contribution of a wide range of infectious diseases to the overall infectious disease burden in a high-income setting. Methodology/principal findings: We used health-adjusted life years (HALYs), a composite measure comprising premature mortality and reduced functioning due to disease, to estimate the burden of 51 infectious diseases and associated syndromes in Ontario using 2005-2007 data. Deaths were estimated from vital statistics data and disease incidence was estimated from reportable disease, healthcare utilization, and cancer registry data, supplemented by local modelling studies and national and international epidemiologic studies. The 51 infectious agents and associated syndromes accounted for 729 lost HALYs, 44.2 deaths, and 58,987 incident cases per 100,000 population annually. The most burdensome infectious agents were: hepatitis C virus, Streptococcus pneumoniae, Escherichia coli, human papillomavirus, hepatitis B virus, human immunodeficiency virus, Staphylococcus aureus, influenza virus, Clostridium difficile, and rhinovirus. The top five, ten, and 20 pathogens accounted for 46%, 67%, and 75% of the total infectious disease burden, respectively. Marked sex-specific differences in disease burden were observed for some pathogens. The main limitations of this study were the exclusion of certain infectious diseases due to data availability issues, not considering the impact of co-infections and co-morbidity, and the inability to assess the burden of milder infections that do not result in healthcare utilization. Conclusions/significance: Infectious diseases continue to cause a substantial health

burden in high-income settings such as Ontario. Most of this burden is attributable to a relatively small number of infectious agents, for which many effective interventions have been previously identified. Therefore, these findings should be used to guide public health policy, planning, and research.

2.2 Health information systems and data sources

Potential questions/outcomes: Are the available European data sources suitable for calculating the Burden of VPI? Do we have a surveillance strategy in place in Europe? What can we learn from 'non-infectious disease' Burden of disease studies in Europe? How can the EU disease burden network improve VPI studies in the future? How can the EHDS improve burden of VPI studies in the future?

Related articles: Source: Pubmed search and/or proposed by speakers: Anindya Bose, J. Díez-Domingo, M. R. O'Donovan, D. Kalra

2.2.1 ECDC [Long-term surveillance framework 2021–2027](#). 4 April 2023

Abstract - This long-term surveillance framework ties in with the overall ECDC strategy 2021–2027. Aspirations for the coming seven years relevant to surveillance are to promote standards, help bridge the gap between science, policy and practice, provide tailored support to Member States, harness technological innovation, and collaborate with EU enlargement and other neighbourhood countries as well as EU sister agencies, WHO, global centres for disease prevention and control (CDCs) and other relevant players.

Vision: EU/EEA infectious disease surveillance is founded on strong harmonized national surveillance systems, an optimal mixture of data sources, and state-of-the-art technology to generate a continuous, automated, integrated and, where required, real-time digital data stream that provides the right information where and when it is needed to most timely and effectively fight cross-border threats to public health from infectious diseases.

2.2.2 Patel M. K., Scobie H. M., Serhan F., Dahl B., Murrill C. S., Nakamura T., Pallas S. W., Cohen A. L., [A global comprehensive vaccine-preventable disease surveillance strategy for the immunization Agenda 2030](#), Vaccine, 2022, available online 21 October 2022 - ISSN 0264-410X.

Abstract - As part of the Immunization Agenda 2030, a global strategy for comprehensive vaccine-preventable disease (VPD) surveillance was developed. The strategy provides guidance on the establishment of high-quality surveillance systems that are 1) comprehensive, encompassing all VPD threats faced by a country, in all geographic areas and populations, using all laboratory and other methodologies required for timely and reliable disease detection; 2) integrated, wherever possible, taking advantage of shared infrastructure for specific components of surveillance such as data management and laboratory systems; 3) inclusive of all relevant data needed to guide immunization program management actions. Such surveillance systems should generate data useful to strengthen national immunization programs, inform vaccine introduction decision-making, and reinforce timely and effective detection and response. All stakeholders in countries and globally should work to achieve this vision.

2.2.3 Méroc E, Fröberg J, Almasi T, Winje BA, Orrico-Sánchez A, Steens A, McDonald SA, Bollaerts K, Knol MJ. [European data sources for computing](#)

[burden of \(potential\) vaccine-preventable diseases in ageing adults](#). BMC Infect Dis. 2021 Apr 13;21(1):345.

Abstract - Background: To guide decision-making on immunisation programmes for ageing adults in Europe, one of the aims of the Vaccines and Infectious diseases in the Ageing population (IMI2-VITAL) project is to assess the burden of disease (BoD) of (potentially) vaccine-preventable diseases ((P)VPD). We aimed to identify the available data sources to calculate the BoD of (P)VPD in participating VITAL countries and to pinpoint data gaps. Based on epidemiological criteria and vaccine availability, we prioritized (P) VPD caused by Extra-intestinal pathogenic *Escherichia coli* (ExPEC), norovirus, respiratory syncytial virus, *Staphylococcus aureus*, and pneumococcal pneumonia. **Methods:** We conducted a survey on available data (e.g. incidence, mortality, disability-adjusted life years (DALY), quality-adjusted life years (QALY), sequelae, antimicrobial resistance (AMR), etc.) among national experts from European countries, and carried out five pathogen-specific literature reviews by searching MEDLINE for peer-reviewed publications published between 2009 and 2019. **Results:** Morbidity and mortality data were generally available for all five diseases, while summary BoD estimates were mostly lacking. Available data were not always stratified by age and risk group, which is especially important when calculating BoD for ageing adults. AMR data were available in several countries for *S. aureus* and ExPEC. **Conclusion:** This study provides an exhaustive overview of the available data sources and data gaps for the estimation of BoD of five (P) VPD in ageing adults in the EU/EAA, which is useful to guide pathogen-specific BoD studies and contribute to calculation of (P)VPDs BoD.

2.2.4 Cuschieri S, Pallari E, Terzic N, Alkerwi A, Sigurvinsdottir R, Sigfusdottir ID, Devleeschauwer B. [Conducting national burden of disease studies in small countries in Europe- a feasible challenge?](#) Arch Public Health. 2021 May 11;79(1):73.

Abstract Background: Burden of Disease (BoD) studies use disability-adjusted life years (DALYs) as a population health metric to quantify the years of life lost due to morbidity and premature mortality for diseases, injuries and risk factors occurring in a region or a country. Small countries usually face a number of challenges to conduct epidemiological studies, such as national BoD studies, due to the lack of specific expertise and resources or absence of adequate data. Considering Europe's small countries of Cyprus, Iceland, Luxembourg, Malta and Montenegro, the aim was to assess whether the various national data sources identified are appropriate to perform national BoD studies. **Main body:** The five small countries have a well-established mortality registers following the ICD10 classification, which makes calculation of years of life lost (YLL) feasible. A number of health information data sources were identified in each country, which can provide prevalence data for the calculation of years lived with disability (YLD) for various conditions. These sources include disease-specific registers, hospital discharge data, primary health care data and epidemiological studies, provided by different organisations such as health directorates, institutes of public health, statistical offices and other bodies. Hence, DALYs can be estimated at a national level through the combination of the YLL and YLD information. On the other hand, small countries face unique challenges such as difficulty to ensure sample representativeness, variations in prevalence estimates especially for rarer diseases, existence of a substantial proportion of non-residents affiliated to healthcare systems and potential exclusion from some European or international initiatives. Recently established BoD networks may provide a platform for small countries to share experiences, expertise, and engage with countries and institutions that have long-standing experience with BoD assessment. **Conclusion:** Apart from mortality registries, adequate health data sources, notably for cancer, are potentially available at the small states to perform

national BoD studies. Investing in sharing expert knowledge through engagement of researchers in BoD networks can enable the conduct of country specific BoD studies and the establishment of more accurate DALYs estimates. Such estimates can enable local policymakers to reflect on the relative burden of the different conditions that are contributing to morbidity and mortality at a country level.

2.2.5 Devleesschauwer B. [European burden of disease network: strengthening the collaboration](#). Eur J Public Health. 2020 Feb 1;30(1):2-3.

Article on the European burden of disease network: a technical platform to integrate and strengthen capacity in burden of disease assessment across Europe and beyond. The project was launched in 2019 and includes epidemiologists and public-health researchers from 53 countries worldwide.

Website: <https://www.burden-eu.net/>

2.2.6 O'Donovan MR, Gapp C, Stein C. [Burden of disease studies in the WHO European Region-a mapping exercise](#). Eur J Public Health. 2018 Aug 1;28(4):773-778.

Abstract Background: The World Health Organization (WHO) and the Institute for Health Metrics and Evaluation (IHME) have produced numerous global burden of disease (GBD) estimates since the 1990s, using disability-adjusted life-years (DALYs). Here we attempt to identify studies that have either independent DALY estimates or build on the work of WHO and IHME, for the WHO European Region, categorize them by scope of disease analysis and geographic coverage, and briefly compare their methodology (age weighting, discounting and disability weights). Methods: Google and Google Scholar were used with the search terms 'DALY', 'national burden of disease', Member State names and researcher's names, covering all years. Studies were categorized as: 'specific' (fewer than five disease categories or just risk factors for a single country), 'specific, multicountry' (fewer than five disease categories or just risk factors for more than one country), 'extensive' (covering five or more but not all disease categories for one country), 'full, sub country' (covering all relevant disease categories for part of one country) and 'full, country' (covering all relevant disease categories for one country). Results: A total of 198 studies were identified: 143 'specific', 26 'specific, multicountry', 7 'extensive', 10 'full, sub country' and 12 'full, country' [England (1), Estonia (2), France (1), Romania (1), Serbia (1), Spain (3), Sweden (2) and Turkey (1)]. About 5 (20%) of the 25 examinable 'extensive', 'full, sub country' and 'full, country' studies calculated DALYs using GBD 2010 methodology. Conclusions: Independent burden of diseases studies in Europe have been located, and categorized by scope of disease analysis and geographic coverage. Methodological choices varied between independent 'full, country' studies.

2.2.7 Communication from the European Commission - [A European Health Data Space \(EHDS\): harnessing the power of health data for people, patients and innovation](#); Publication date: 3 May 2022; Author: Directorate-General for Health and Food Safety

Abstract: Communication published by the European Commission on 3 May 2022, providing the reasoning behind the introduction of a European Health Data Space (EHDS). Further information: A vast amount of health data is currently generated every second, providing healthcare services and researchers with potential valuable insights. However, the complexity and divergence of rules, structures and processes within and across Member States of the European Union (EU) makes it difficult to easily access and share health data. This is seen as creating barriers to healthcare delivery and innovation, leaving patients unable to benefit from its

potential. Moreover, health systems are becoming the target of cyberattacks. Cybersecurity must be considered as a key factor for ensuring the resilience and availability of key healthcare services. Harnessing the power of health data through the digital transformation is particularly relevant when patients move within or to other EU countries; and when researchers, innovators, policy-makers or regulators need critical data that can enable the power of science to help patients. Similarly, sharing health data in border regions where individuals access healthcare services across the border much more frequently can become an easier task. This Communication was published on 3 May 2022 to support the adoption of a legislative initiative setting up a European Health Data Space (EHDS), which aims at unleashing the potential of health data in the EU.

2.2.8 Hyde TB, Andrus JK, Dietz VJ; [Integrated All-VPD Surveillance Working Group: Critical issues in implementing a national integrated all-vaccine preventable disease surveillance system](#). Vaccine. 2013 Jul 2;31 Suppl 3(03):C94-8

Abstract In 2007, the World Health Organization published the Global Framework for Immunization Monitoring and Surveillance (GFIMS) outlining measures to enhance national surveillance for vaccine preventable diseases (VPDs). The GFIMS emphasized that VPD surveillance should be integrated and placed in a 'unified framework' building upon the strengths of existing surveillance systems to prevent duplication of activities common to all surveillance systems and to minimize human resource and supply expenditures. Unfortunately, there was little experience in actually developing integrated VPD surveillance. We describe the process of developing operational guidance for ministries of health to implement such an integrated surveillance system for multiple VPDs.

2.3 What can we learn from the GBD study?

Potential questions/outcomes: What can VPI studies learn from the global GBD? What are the Major limitations of the GBD and how are they addressed? How does GBD handle data lacunae? What did GBD learned on communicating uncertainty to policy makers etc?

Related articles: Source: Pubmed search and/or proposed by speaker: Tomislav Mestrovic

2.3.1 GBD 2019 Antimicrobial Resistance Collaborators. [Global mortality associated with 33 bacterial pathogens in 2019: a systematic analysis for the Global Burden of Disease Study 2019](#). Lancet. 2022 Dec 17;400(10369):2221-2248.

Abstract Background: Reducing the burden of death due to infection is an urgent global public health priority. Previous studies have estimated the number of deaths associated with drug-resistant infections and sepsis and found that infections remain a leading cause of death globally. Understanding the global burden of common bacterial pathogens (both susceptible and resistant to antimicrobials) is essential to identify the greatest threats to public health. To our knowledge, this is the first study to present global comprehensive estimates of deaths associated with 33 bacterial pathogens across 11 major infectious syndromes. Methods: We estimated deaths associated with 33 bacterial genera or species across 11 infectious syndromes in 2019 using methods from the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019, in addition to a subset of the input data described in the Global Burden of Antimicrobial Resistance 2019 study. This study included 343 million individual records or isolates covering 11 361 study-

location-years. We used three modelling steps to estimate the number of deaths associated with each pathogen: deaths in which infection had a role, the fraction of deaths due to infection that are attributable to a given infectious syndrome, and the fraction of deaths due to an infectious syndrome that are attributable to a given pathogen. Estimates were produced for all ages and for males and females across 204 countries and territories in 2019. 95% uncertainty intervals (UIs) were calculated for final estimates of deaths and infections associated with the 33 bacterial pathogens following standard GBD methods by taking the 2.5th and 97.5th percentiles across 1000 posterior draws for each quantity of interest. **Findings:** From an estimated 13.7 million (95% UI 10.9-17.1) infection-related deaths in 2019, there were 7.7 million deaths (5.7-10.2) associated with the 33 bacterial pathogens (both resistant and susceptible to antimicrobials) across the 11 infectious syndromes estimated in this study. We estimated deaths associated with the 33 bacterial pathogens to comprise 13.6% (10.2-18.1) of all global deaths and 56.2% (52.1-60.1) of all sepsis-related deaths in 2019. Five leading pathogens—*Staphylococcus aureus*, *Escherichia coli*, *Streptococcus pneumoniae*, *Klebsiella pneumoniae*, and *Pseudomonas aeruginosa*—were responsible for 54.9% (52.9-56.9) of deaths among the investigated bacteria. The deadliest infectious syndromes and pathogens varied by location and age. The age-standardised mortality rate associated with these bacterial pathogens was highest in the sub-Saharan Africa super-region, with 230 deaths (185-285) per 100 000 population, and lowest in the high-income super-region, with 52.2 deaths (37.4-71.5) per 100 000 population. *S aureus* was the leading bacterial cause of death in 135 countries and was also associated with the most deaths in individuals older than 15 years, globally. Among children younger than 5 years, *S pneumoniae* was the pathogen associated with the most deaths. In 2019, more than 6 million deaths occurred as a result of three bacterial infectious syndromes, with lower respiratory infections and bloodstream infections each causing more than 2 million deaths and peritoneal and intra-abdominal infections causing more than 1 million deaths. **Interpretation:** The 33 bacterial pathogens that we investigated in this study are a substantial source of health loss globally, with considerable variation in their distribution across infectious syndromes and locations. Compared with GBD Level 3 underlying causes of death, deaths associated with these bacteria would rank as the second leading cause of death globally in 2019; hence, they should be considered an urgent priority for intervention within the global health community. Strategies to address the burden of bacterial infections include infection prevention, optimised use of antibiotics, improved capacity for microbiological analysis, vaccine development, and improved and more pervasive use of available vaccines. These estimates can be used to help set priorities for vaccine need, demand, and development.

2.3.2 GBD 2019 LRI Collaborators. [Age-sex differences in the global burden of lower respiratory infections and risk factors, 1990-2019: results from the Global Burden of Disease Study 2019](#). *Lancet Infect Dis*. 2022 Nov;22(11):1626-1647.

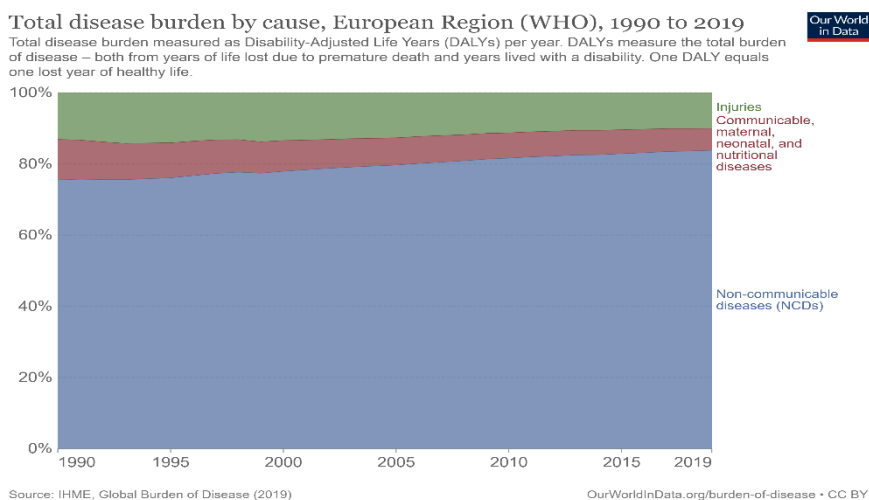
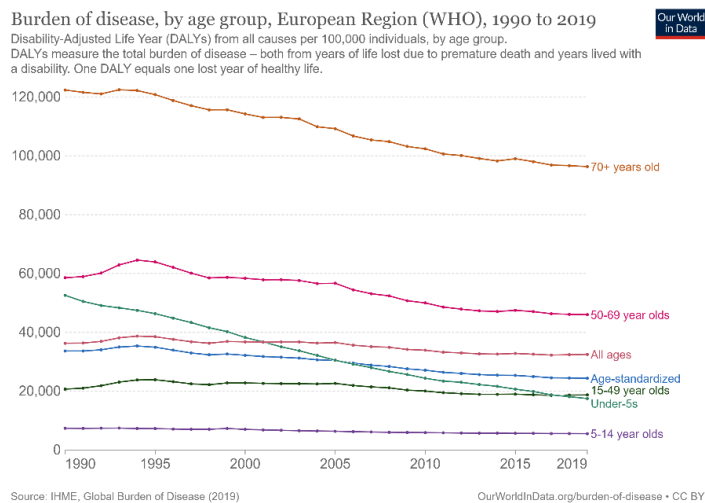
Abstract Background: The global burden of lower respiratory infections (LRIs) and corresponding risk factors in children older than 5 years and adults has not been studied as comprehensively as it has been in children younger than 5 years. We assessed the burden and trends of LRIs and risk factors across all age groups by sex, for 204 countries and territories. **Methods:** In this analysis of data for the Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019, we used clinician-diagnosed pneumonia or bronchiolitis as our case definition for LRIs. We included International Classification of Diseases 9th edition codes 079.6, 466-469, 470.0, 480-482.8, 483.0-483.9, 484.1-484.2, 484.6-484.7, and 487-489 and International Classification of Diseases 10th edition codes A48.1, A70, B97.4-B97.6, J09-J15.8, J16-J16.9, J20-J21.9, J91.0, P23.0-P23.4, and U04-U04.9. We used the Cause of Death Ensemble modelling strategy to analyse 23 109 site-years

of vital registration data, 825 site-years of sample vital registration data, 1766 site-years of verbal autopsy data, and 681 site-years of mortality surveillance data. We used DisMod-MR 2.1, a Bayesian meta-regression tool, to analyse age-sex-specific incidence and prevalence data identified via systematic reviews of the literature, population-based survey data, and claims and inpatient data. Additionally, we estimated age-sex-specific LRI mortality that is attributable to the independent effects of 14 risk factors. **Findings:** Globally, in 2019, we estimated that there were 257 million (95% uncertainty interval [UI] 240-275) LRI incident episodes in males and 232 million (217-248) in females. In the same year, LRIs accounted for 1.30 million (95% UI 1.18-1.42) male deaths and 1.20 million (1.07-1.33) female deaths. Age-standardised incidence and mortality rates were 1.17 times (95% UI 1.16-1.18) and 1.31 times (95% UI 1.23-1.41) greater in males than in females in 2019. Between 1990 and 2019, LRI incidence and mortality rates declined at different rates across age groups and an increase in LRI episodes and deaths was estimated among all adult age groups, with males aged 70 years and older having the highest increase in LRI episodes (126.0% [95% UI 121.4-131.1]) and deaths (100.0% [83.4-115.9]). During the same period, LRI episodes and deaths in children younger than 15 years were estimated to have decreased, and the greatest decline was observed for LRI deaths in males younger than 5 years (-70.7% [-77.2 to -61.8]). The leading risk factors for LRI mortality varied across age groups and sex. More than half of global LRI deaths in children younger than 5 years were attributable to child wasting (population attributable fraction [PAF] 53.0% [95% UI 37.7-61.8] in males and 56.4% [40.7-65.1] in females), and more than a quarter of LRI deaths among those aged 5-14 years were attributable to household air pollution (PAF 26.0% [95% UI 16.6-35.5] for males and PAF 25.8% [16.3-35.4] for females). PAFs of male LRI deaths attributed to smoking were 20.4% (95% UI 15.4-25.2) in those aged 15-49 years, 30.5% (24.1-36.9) in those aged 50-69 years, and 21.9% (16.8-27.3) in those aged 70 years and older. PAFs of female LRI deaths attributed to household air pollution were 21.1% (95% UI 14.5-27.9) in those aged 15-49 years and 18.2% (12.5-24.5) in those aged 50-69 years. For females aged 70 years and older, the leading risk factor, ambient particulate matter, was responsible for 11.7% (95% UI 8.2-15.8) of LRI deaths. **Interpretation:** The patterns and progress in reducing the burden of LRIs and key risk factors for mortality varied across age groups and sexes. The progress seen in children younger than 5 years was clearly a result of targeted interventions, such as vaccination and reduction of exposure to risk factors. Similar interventions for other age groups could contribute to the achievement of multiple Sustainable Development Goals targets, including promoting wellbeing at all ages and reducing health inequalities. Interventions, including addressing risk factors such as child wasting, smoking, ambient particulate matter pollution, and household air pollution, would prevent deaths and reduce health disparities.

2.3.3 Murray, C.J.L. [The Global Burden of Disease Study at 30 years](#). Nat Med 28, 2019–2026 (2022).

Abstract - The Global Burden of Disease Study (GBD) began 30 years ago with the goal of providing timely, valid and relevant assessments of critical health outcomes. Over this period, the GBD has become progressively more granular. The latest iteration provides assessments of thousands of outcomes for diseases, injuries and risk factors in more than 200 countries and territories and at the subnational level in more than 20 countries. The GBD is now produced by an active collaboration of over 8,000 scientists and analysts from more than 150 countries. With each GBD iteration, the data, data processing and methods used for data synthesis have evolved, with the goal of enhancing transparency and comparability of measurements and communicating various sources of uncertainty. The GBD has many limitations, but it remains a dynamic, iterative and rigorous attempt to provide meaningful health measurement to a wide range of stakeholders.

2.3.4 Roser M., Ritchie H and Spooner F (2021) - "**Burden of disease**". Published online at OurWorldInData.org. Retrieved from: <https://ourworldindata.org/burden-of-disease> [Online Resource]



2.3.5 GBD 2019 Diseases and Injuries Collaborators. [Global burden of 369 diseases and injuries in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019](#). Lancet. 2020 Oct 17;396(10258):1204-1222.

Abstract Background: In an era of shifting global agendas and expanded emphasis on non-communicable diseases and injuries along with communicable diseases, sound evidence on trends by cause at the national level is essential. The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) provides a systematic scientific assessment of published, publicly available, and contributed data on incidence, prevalence, and mortality for a mutually exclusive and collectively exhaustive list of diseases and injuries. **Methods:** GBD estimates incidence, prevalence, mortality, years of life lost (YLLs), years lived with disability (YLDs),

and disability-adjusted life-years (DALYs) due to 369 diseases and injuries, for two sexes, and for 204 countries and territories. Input data were extracted from censuses, household surveys, civil registration and vital statistics, disease registries, health service use, air pollution monitors, satellite imaging, disease notifications, and other sources. Cause-specific death rates and cause fractions were calculated using the Cause of Death Ensemble model and spatiotemporal Gaussian process regression. Cause-specific deaths were adjusted to match the total all-cause deaths calculated as part of the GBD population, fertility, and mortality estimates. Deaths were multiplied by standard life expectancy at each age to calculate YLLs. A Bayesian meta-regression modelling tool, DisMod-MR 2.1, was used to ensure consistency between incidence, prevalence, remission, excess mortality, and cause-specific mortality for most causes. Prevalence estimates were multiplied by disability weights for mutually exclusive sequelae of diseases and injuries to calculate YLDs. We considered results in the context of the Socio-demographic Index (SDI), a composite indicator of income per capita, years of schooling, and fertility rate in females younger than 25 years. Uncertainty intervals (UIs) were generated for every metric using the 25th and 975th ordered 1000 draw values of the posterior distribution. **Findings:** Global health has steadily improved over the past 30 years as measured by age-standardised DALY rates. After taking into account population growth and ageing, the absolute number of DALYs has remained stable. Since 2010, the pace of decline in global age-standardised DALY rates has accelerated in age groups younger than 50 years compared with the 1990-2010 time period, with the greatest annualised rate of decline occurring in the 0-9-year age group. Six infectious diseases were among the top ten causes of DALYs in children younger than 10 years in 2019: lower respiratory infections (ranked second), diarrhoeal diseases (third), malaria (fifth), meningitis (sixth), whooping cough (ninth), and sexually transmitted infections (which, in this age group, is fully accounted for by congenital syphilis; ranked tenth). In adolescents aged 10-24 years, three injury causes were among the top causes of DALYs: road injuries (ranked first), self-harm (third), and interpersonal violence (fifth). Five of the causes that were in the top ten for ages 10-24 years were also in the top ten in the 25-49-year age group: road injuries (ranked first), HIV/AIDS (second), low back pain (fourth), headache disorders (fifth), and depressive disorders (sixth). In 2019, ischaemic heart disease and stroke were the top-ranked causes of DALYs in both the 50-74-year and 75-years-and-older age groups. Since 1990, there has been a marked shift towards a greater proportion of burden due to YLDs from non-communicable diseases and injuries. In 2019, there were 11 countries where non-communicable disease and injury YLDs constituted more than half of all disease burden. Decreases in age-standardised DALY rates have accelerated over the past decade in countries at the lower end of the SDI range, while improvements have started to stagnate or even reverse in countries with higher SDI. **Interpretation:** As disability becomes an increasingly large component of disease burden and a larger component of health expenditure, greater research and development investment is needed to identify new, more effective intervention strategies. With a rapidly ageing global population, the demands on health services to deal with disabling outcomes, which increase with age, will require policy makers to anticipate these changes. The mix of universal and more geographically specific influences on health reinforces the need for regular reporting on population health in detail and by underlying cause to help decision makers to identify success stories of disease control to emulate, as well as opportunities to improve.

2.3.6 GBD 2019 Risk Factors Collaborators. [Global burden of 87 risk factors in 204 countries and territories, 1990-2019: a systematic analysis for the Global Burden of Disease Study 2019](#). Lancet. 2020 Oct 17;396(10258):1223-1249.

Abstract Background: Rigorous analysis of levels and trends in exposure to leading risk factors and quantification of their effect on human health are important to

identify where public health is making progress and in which cases current efforts are inadequate. The Global Burden of Diseases, Injuries, and Risk Factors Study (GBD) 2019 provides a standardised and comprehensive assessment of the magnitude of risk factor exposure, relative risk, and attributable burden of disease. Methods: GBD 2019 estimated attributable mortality, years of life lost (YLLs), years of life lived with disability (YLDs), and disability-adjusted life-years (DALYs) for 87 risk factors and combinations of risk factors, at the global level, regionally, and for 204 countries and territories. GBD uses a hierarchical list of risk factors so that specific risk factors (e.g., sodium intake), and related aggregates (e.g., diet quality), are both evaluated. This method has six analytical steps. (1) We included 560 risk-outcome pairs that met criteria for convincing or probable evidence on the basis of research studies. 12 risk-outcome pairs included in GBD 2017 no longer met inclusion criteria and 47 risk-outcome pairs for risks already included in GBD 2017 were added based on new evidence. (2) Relative risks were estimated as a function of exposure based on published systematic reviews, 81 systematic reviews done for GBD 2019, and meta-regression. (3) Levels of exposure in each age-sex-location-year included in the study were estimated based on all available data sources using spatiotemporal Gaussian process regression, DisMod-MR 2.1, a Bayesian meta-regression method, or alternative methods. (4) We determined, from published trials or cohort studies, the level of exposure associated with minimum risk, called the theoretical minimum risk exposure level. (5) Attributable deaths, YLLs, YLDs, and DALYs were computed by multiplying population attributable fractions (PAFs) by the relevant outcome quantity for each age-sex-location-year. (6) PAFs and attributable burden for combinations of risk factors were estimated taking into account mediation of different risk factors through other risk factors. Across all six analytical steps, 30 652 distinct data sources were used in the analysis. Uncertainty in each step of the analysis was propagated into the final estimates of attributable burden. Exposure levels for dichotomous, polytomous, and continuous risk factors were summarised with use of the summary exposure value to facilitate comparisons over time, across location, and across risks. Because the entire time series from 1990 to 2019 has been re-estimated with use of consistent data and methods, these results supersede previously published GBD estimates of attributable burden. Findings: The largest declines in risk exposure from 2010 to 2019 were among a set of risks that are strongly linked to social and economic development, including household air pollution; unsafe water, sanitation, and handwashing; and child growth failure. Global declines also occurred for tobacco smoking and lead exposure. The largest increases in risk exposure were for ambient particulate matter pollution, drug use, high fasting plasma glucose, and high body-mass index. In 2019, the leading Level 2 risk factor globally for attributable deaths was high systolic blood pressure, which accounted for 10·8 million (95% uncertainty interval [UI] 9·51-12·1) deaths (19·2% [16·9-21·3] of all deaths in 2019), followed by tobacco (smoked, second-hand, and chewing), which accounted for 8·71 million (8·12-9·31) deaths (15·4% [14·6-16·2] of all deaths in 2019). The leading Level 2 risk factor for attributable DALYs globally in 2019 was child and maternal malnutrition, which largely affects health in the youngest age groups and accounted for 295 million (253-350) DALYs (11·6% [10·3-13·1] of all global DALYs that year). The risk factor burden varied considerably in 2019 between age groups and locations. Among children aged 0-9 years, the three leading detailed risk factors for attributable DALYs were all related to malnutrition. Iron deficiency was the leading risk factor for those aged 10-24 years, alcohol use for those aged 25-49 years, and high systolic blood pressure for those aged 50-74 years and 75 years and older. Interpretation: Overall, the record for reducing exposure to harmful risks over the past three decades is poor. Success with reducing smoking and lead exposure through regulatory policy might point the way for a stronger role for public policy on other risks in addition to continued efforts to provide information on risk factor harm to the general public.

Session 3: The epidemiology and health burden of selected adult VPIs

Selection for the adult VPI was not based on burden of disease and/or vaccine effectiveness but on the inclusion of different adult vaccine target groups, circumstances and speakers/ publication availability.

Potential questions/outcomes: What are the opportunities and remaining challenges when measuring the health burden of different selected adult VPIs in Europe? What are the common challenges and opportunities? Which data sources are used? Is there a consensus on how to calculate the burdens? Was this research used to inform policy measures? Is there an increasing or declining trend? Reason? Aging population or vac coverage?

Session 3: The Epidemiology and health burden of selected adult VPIs	3.1 Health Burden of VPIs in pandemic situation: COVID-19 example	Sara Monteiro Pires
	3.2 Health Burden of VPIs in older adults: HZ, RSV and Influenza example	Angela Bechini Hester E de Melker Xiao Li Stefania Maggi
	3.3 Health Burden of VPIs in young adults: HPV example	Paolo Bonanni
	3.4 Health Burden of VPIs in travelers	Robert Steffen
	3.5 Health Burden of VPIs in immunocompromised adults	Per Lungman

3.1 Health Burden of VPIs in pandemic situation - new virus/ newly characterized disease: COVID-19 example

Potential questions/outcomes: What is the burden now and in the (near) future? Who is susceptible?

Related articles: Source: Pubmed search and/or proposed by speaker: Sara Monteiro Pires

3.1.1 Pires SM, Wyper GMA, Wengler A, Peñalvo JL, Haneef R, Moran D, Cuschieri S, Redondo HG, De Pauw R, McDonald SA, Moon L, Shedrawy J, Pallari E, Charalampous P, Devleeschauwer B, von Der Lippe E. [Burden of disease of COVID-19: strengthening the collaboration for national studies](#). Front Public Health. 2022;10:907012.

Abstract: Objectives: Quantifying the combined impact of morbidity and mortality is a key enabler to assessing the impact of COVID-19 across countries and within countries relative to other diseases, regions, or demographics. Differences in methods, data sources, and definitions of mortality due to COVID-19 may hamper comparisons. We describe efforts to support countries in estimating the national-level burden of COVID-19 using disability-adjusted life years. Methods: The European Burden of Disease Network developed a consensus methodology, as well as a range of capacity-building activities to support burden of COVID-19 studies. These activities have supported 11 national studies so far, with study periods

between January 2020 and December 2021. Results: National studies dealt with various data gaps and different assumptions were made to face knowledge gaps. Still, they delivered broadly comparable results that allow for interpretation of consistencies, as well as differences in the quantified direct health impact of the pandemic. Discussion: Harmonized efforts and methodologies have allowed for comparable estimates and communication of results. Future studies should evaluate the impact of interventions, and unravel the indirect health impact of the COVID-19 crisis.

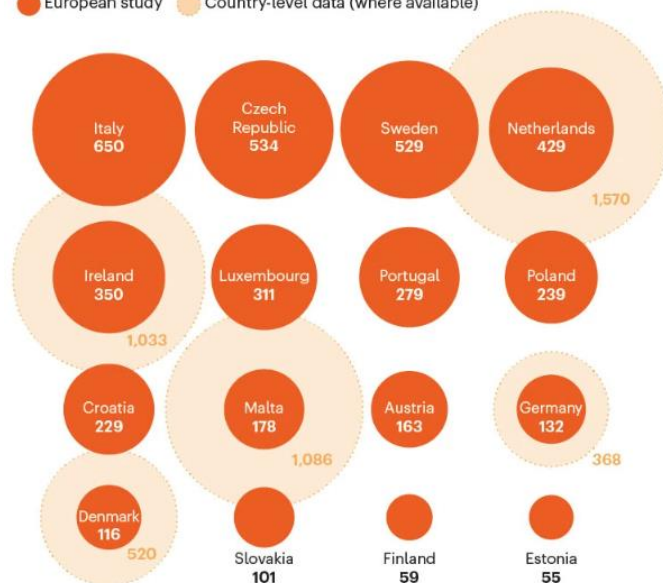
3.1.2 Else H. [The pandemic's true health cost: how much of our lives has COVID stolen?](#). Nature. 2022;605:411-413. doi: 10.1038/d41586-022-01341-7

The toll of COVID-19 in Europe

An analysis of 16 European countries using data from sources such as the World Health Organization suggests that the toll can vary widely depending on a population's age structure or, perhaps, a government's response to the pandemic. National estimates, using more detailed data, tend to yield larger burden estimates.

COVID-19 DALYs per 100,000 people (data for 2020):

● European study ● Country-level data (where available)



Research groups are exploring a number of ways to calculate the burden of COVID-19, and many are starting to report their results. Early data suggest that the impact is significant and varies by country. One study found that COVID-19 took a heavy toll across 16 European countries, but that the impacts on different nations varied owing to factors ranging from the population's age structure to political responses to the pandemic (see Figure on the left – the toll of COVID-19 in Europe).

3.1.3 Gianino MM, Savatteri A, Politano G, Nurchis MC, Pascucci D, Damiani G. [Burden of COVID-19: Disability-Adjusted Life Years \(DALYs\) across 16 European countries](#). Eur Rev Med Pharmacol Sci. 2021 Sep;25(17):5529-5541

Abstract - Objective: The aim of this study is to measure and compare the burden of disease of COVID-19 pandemic in 16 EU/EEA countries through the estimation of Disability-Adjusted Life Years (DALYs) over a long period of time. Materials and methods: The observational study was based on data from ECDC and WHO databases collected from 27 January 2020 to 15 November 2020. In addition to the absolute number of DALYs, a weekly trend of DALYs/100,000 inhabitants was computed for each country to assess the evolution of the pandemic burden over time. A cluster analysis and Kolmogorov-Smirnov (KS) test were performed to allow for a country-to-country comparison. Results: The total DALYs amount to 4,354 per 100,000 inhabitants. YLLs were accountable for 98% of total DALYs. Italy, Czechia and Sweden had the highest values of DALYs/100,000 while Finland, Estonia and Slovakia had the lowest. The latter three countries differed significantly from the others - in terms of DALYs trend over time - as shown by KS test. The cluster analysis allowed for the identification of three clusters of countries sharing similar trends of DALYs during the assessed period of time. These results show that notable

differences were observed among different countries, with most of the disease burden attributable to YLLs. Conclusions: DALYs have proven to be an effective measure of the burden of disease. Public health and policy actions, as well as demographic, epidemiological and cultural features of each country, may be responsible for the wide variations in the health impact that were observed among the countries analyzed.

3.1.4 Azarpazhooh MR, Morovatdar N, Avan A, Phan TG, Divani AA, Yassi N, Stranges S, Silver B, Biller J, Tokazebani Belasi M, Kazemi Neyfa S, Khorram B, Frydman A, Nilanont Y, Onorati E, Di Napoli M. [COVID-19 pandemic and burden of non-communicable diseases: an ecological study on data of 185 countries](#). J Stroke Cerebrovasc Dis. 2020;29(9):105089.

Abstract Background - The interaction between coronavirus disease 2019 (COVID-19) and non-communicable diseases may increase the global burden of disease. We assessed the association of COVID-19 with ageing and non-communicable diseases. Methods - We extracted data regarding non-communicable disease, particularly cardiovascular disease, deaths, disability-adjusted life years (DALYs), and healthy life expectancy (HALE) from the Global Burden of Disease Study (GBD) 2017. We obtained data of confirmed COVID-19 cases, deaths, and tests from the Our World in Data database as of May 28, 2020. Potential confounders of pandemic outcomes analyzed include institutional lockdown delay, hemispheric geographical location, and number of tourists. We compared all countries according to GBD classification and World Bank income level. We assessed the correlation between independent variables associated with COVID-19 caseload and mortality using Spearman's rank correlation and adjusted mixed model analysis. Findings High-income had the highest, and the Southeast Asia, East Asia, and Oceania region had the least cases per million population (3050.60 vs. 63.86). Sub-saharan region has reported the lowest number of COVID-19 mortality (1.9). Median delay to lockdown initiation varied from one day following the first case in Latin America and Caribbean region, to 34 days in Southeast Asia, East Asia, and Oceania. Globally, non-communicable disease DALYs were correlated with COVID-19 cases ($r = 0.32$, $p < 0.001$) and deaths ($r = 0.37$, $p < 0.001$). HALE correlated with COVID-19 cases ($r = 0.63$, $p < 0.001$) and deaths ($r = 0.61$, $p < 0.001$). HALE was independently associated with COVID-19 case rate and the number of tourists was associated with COVID-19 mortality in the adjusted model. Interpretation Preventive measures against COVID-19 should protect the public from the dual burden of communicable and non-communicable diseases, particularly in the elderly. In addition to active COVID-19 surveillance, policymakers should utilize this evidence as a guide for prevention and coordination of health services. This model is timely, as many countries have begun to reduce social isolation.

3.1.5 EU-Burden of disease network compile burden of disease resources specifically focus on COVID-19: <https://www.burden-eu.net/outputs/covid-19>

3.2 Health Burden of VPIs in older adults: HZ, RSV and Influenza example

Potential questions/outcomes: Heterogeneity between targeted individuals (large variation in age / heterogeneous risk profile within single age group: greater time over which to accumulate differences in relevant underlying conditions and exposures) in terms of risk of infection, severity of disease and response to vaccination

Related articles: Source: Pubmed search and/or proposed by speaker: Hester E de Melker, Angela Bechini, Xiao Li, Stefania Maggi

3.2.1 Preliminary scientific report. Osei-Yeboah, R., Spreeuwenberg, P., Riccio, M. D., et al. (2023). [Estimation of the Number of RSV-Associated Hospitalisations in Adults in the European Union](#). medRxiv.

This article is a preprint and has not been peer-reviewed

Abstract - Background: Respiratory syncytial virus (RSV) is a major cause of lower respiratory tract infections in older adults that can result in hospitalisations and death. Estimating RSV-associated hospitalisation is critical for planning RSV-related healthcare needs for the ageing population across Europe. Methods: We gathered national RSV-associated hospitalisation estimates from the REspiratory Syncytial virus Consortium in EUrope (RESCEU) for adults in Denmark, England, Finland, Norway, Netherlands, and Scotland from 2006 to 2017. We extrapolated these estimates to 28 EU countries using nearest-neighbour matching, multiple imputations, and two sets of 10 indicators. Results: On average, 158 229 (95%CI: 140 865, 175 592) RSV-associated hospitalisations occur annually among adults in the EU (above 18 years); 92% of these hospitalisations occur in adults over 65 years. Among 75-84 years old, the annual average is estimated at 74 519 (95%CI: 69 923, 79 115) at a rate of 2.24 (95%CI: 2.10, 2.38) per 1000 adults. Among adults aged 85 years and above, the annual average is estimated at 37 904 (95%CI: 32 444, 43 363) at a rate of 2.99 (95%CI: 2.56, 3.42). Conclusion: Our estimates of RSV-associated hospitalisations in older adults are the first analysis integrating available data to provide estimates of the disease burden in this population across the EU. Importantly, for a condition which was considered in the past to be primarily a disease of young children, the average annual hospitalisation estimate in adults was lower but of a similar magnitude to the estimate in young children aged 0-4 years: 158 229 (95%CI: 140 865, 175 592) versus 245 244 (95%CI: 224 688, 265 799).

3.2.2 Nguyen-Van-Tam JS, O'Leary M, Martin ET, Heijnen E, Callendret B, Fleischhackl R, Comeaux C, Tran TMP, Weber K. [Burden of respiratory syncytial virus infection in older and high-risk adults: a systematic review and meta-analysis of the evidence from developed countries](#). Eur Respir Rev. 2022 Nov 15;31(166):220105.

Abstract - Background: Respiratory syncytial virus (RSV) significantly impacts the health of older and high-risk adults (those with comorbidities). We aimed to synthesise the evidence on RSV disease burden and RSV-related healthcare utilisation in both populations. Methods: We searched Embase and MEDLINE for papers published between 2000 and 2019 reporting the burden and clinical presentation of symptomatic RSV infection and the associated healthcare utilisation in developed countries in adults aged ≥ 60 years or at high risk. We calculated pooled estimates using random-effects inverse variance-weighted meta-analysis. Results: 103 out of 3429 articles met the inclusion criteria. Among older adults, RSV caused 4.66% (95% CI 3.34-6.48%) of symptomatic respiratory infections in annual studies and 7.80% (95% CI 5.77-10.45%) in seasonal studies; RSV-related case fatality proportion (CFP) was 8.18% (95% CI 5.54-11.94%). Among high-risk adults, RSV caused 7.03% (95% CI 5.18-9.48%) of symptomatic respiratory infections in annual studies, and 7.69% (95% CI 6.23-9.46%) in seasonal studies; CFP was 9.88% (95% CI 6.66-14.43%). Data paucity impaired the calculation of estimates on population incidence, clinical presentation, severe outcomes and healthcare-related utilisation. Conclusions: Older and high-risk adults frequently experience symptomatic RSV infection, with appreciable mortality; however, detailed data are lacking. Increased surveillance and research are needed to quantify population-based disease burden and facilitate RSV treatments and vaccine development.

3.2.3 Maggi S, Veronese N, Burgio M, Cammarata G, Ciuppa ME, Ciriminna S, Di Gennaro F, Smith L, Trott M, Dominguez LJ, Giammanco GM, De Grazia S, Costantino C, Vitale F, Barbagallo M. [Rate of Hospitalizations and Mortality of Respiratory Syncytial Virus Infection Compared to Influenza in Older People: A Systematic Review and Meta-Analysis](#). *Vaccines (Basel)*. 2022 Dec 7;10(12):2092.

Abstract- Respiratory Syncytial Virus (RSV) is commonly regarded as an infection typical of children, but increasing literature is showing its importance in older people. Since the data regarding the impact of RSV are still limited for older people, the aim of this systematic review and meta-analysis is to compare the rate of hospitalization and mortality between RSV and influenza in this population. A systematic literature search until 15 June 2022 was done across several databases and including studies reporting incidence rate and cumulative incidence of hospitalization and mortality in RSV and influenza affecting older people. Among 2295 records initially screened, 16 studies including 762,084 older participants were included. Compared to older patients having influenza, patients with RSV did not show any significant different risk in hospitalization (either cumulative or incidence rate). Similar results were evident for mortality. The quality of the studies was in general good. In conclusion, our systematic review and meta-analysis showed that the rate of hospitalization and mortality was similar between RSV and influenza in older adults, suggesting the importance of vaccination for RSV in older people for preventing negative outcomes, such as mortality and hospitalization.

3.2.4 Mao Z, Li X, Korsten K, Bont L, Butler C, Wildenbeest J, Coenen S, Hens N, Bilcke J, Beutels P; RESCEU Investigators. [Economic Burden and Health-Related Quality of Life of Respiratory Syncytial Virus and Influenza Infection in European Community-Dwelling Older Adults](#). *J Infect Dis*. 2022 Aug 12;226(Suppl 1):S87-S94. doi: 10.1093/infdis/jiac069. PMID: 35961055.

Abstract Background: Respiratory syncytial virus (RSV) and influenza virus infections result in a considerable mortality and morbidity among the aging population globally. Influenza vaccination for older adults before the seasonal influenza epidemic has been evaluated to be cost-effective in many countries. Interventions against RSV in older adults are in the pipeline, and evaluating their cost-effectiveness is crucial for decision making. To inform such evaluations, our aim was to estimate average costs and health-related quality of life (HRQoL) in older adults with RSV and influenza infection. **Methods:** The European RESCEU observational cohort study followed 1040 relatively healthy community-dwelling older adults aged 60 years and older during 2 consecutive winter seasons. Health care resource use and HRQoL were collected and analyzed during RSV episodes, and also during influenza episodes. Country-specific unit cost data were mainly obtained from national databases. Direct costs were estimated from a patient, health care provider, and health care payers' perspective, whereas indirect costs were estimated from a societal perspective. Due to small sample size, no formal statistical comparisons were made. **Results:** Thirty-six RSV and 60 influenza episodes were reported, including 1 hospitalization. Means (median; first-third quartile) of €26.4 (€5.5; 0-47.3) direct and €4.4 (€0; 0-0) indirect costs were reported per nonhospitalized RSV episode, and €42.5 (€36; 3.3-66.7) direct and €32.1 (€0; 0-0) indirect costs per nonhospitalized influenza episode. For RSV episodes, the utility value decreased from 0.896 (0.928; 0.854-0.953) to 0.801 (0.854; 0.712-0.937) from pre-season to 1 week after symptom onset; for influenza, the change was from 0.872 (0.895; 0.828-0.953) to 0.664 (0.686; 0.574-0.797). **Conclusions:** The average costs and HRQoL estimates of older adults treated outside the hospital can be used to inform the design of future studies and the decision making regarding interventions to prevent RSV infection in older

adults. Larger studies are needed to provide better country-specific and complementary cost estimates and to allow for formal statistical comparison of costs between RSV and influenza.

3.2.5 van Lier A, de Gier B, McDonald SA, Mangen MJ, van Wijhe M, Sanders EAM, Kretzschmar ME, van Vliet H, de Melker HE. [Disease burden of varicella versus other vaccine-preventable diseases before introduction of vaccination into the national immunisation programme in the Netherlands](#). Euro Surveill. 2019 May;24(18):1800363. doi: 10.2807/1560-7917.ES.2019.24.18.1800363. PMID: 31064637; PMCID: PMC6505181.

Abstract – Introduction Estimating burden of disease (BoD) is an essential first step in the decision-making process on introducing new vaccines into national immunisation programmes (NIPs). For varicella, a common vaccine-preventable disease, BoD in the Netherlands was unknown. Aim To assess national varicella BoD and compare it to BoD of other vaccine-preventable diseases before their introduction in the NIP. Methods In this health estimates reporting study, BoD was expressed in disability-adjusted life years (DALYs) using methodology from the Burden of Communicable Diseases in Europe (BCoDE)-project. As no parameters/disease model for varicella (including herpes zoster) were available in the BCoDE toolkit, incidence, disease progression model and parameters were derived from seroprevalence, healthcare registries and published data. For most other diseases, BoD was estimated with existing BCoDE-parameters, adapted to the Netherlands if needed. Results In 2017, the estimated BoD of varicella in the Netherlands was 1,800 (95% uncertainty interval (UI): 1,800-1,900) DALYs. Herpes zoster mainly contributed to this BoD (1,600 DALYs; 91%), which was generally lower than the BoD of most current NIP diseases in the year before their introduction into the NIP. However, BoD for varicella was higher than for rotavirus gastroenteritis (1,100; 95%UI: 440-2,200 DALYs) and meningococcal B disease (620; 95%UI: 490-770 DALYs), two other potential NIP candidates. Conclusions When considering the introduction of a new vaccine in the NIP, BoD is usually estimated in isolation. The current approach assesses BoD in relation to other vaccine-preventable diseases' BoD, which may help national advisory committees on immunisation and policymakers to set vaccination priorities.

3.2.6 Alicino C, Trucchi C, Paganino C, Barberis I, Boccalini S, Martinelli D, Pellizzari B, Bechini A, Orsi A, Bonanni P, Prato R, Iannazzo S, Icardi G. [Incidence of herpes zoster and post-herpetic neuralgia in Italy: Results from a 3-years population-based study](#). Hum Vaccin Immunother. 2017 Feb;13(2):399-404.

Abstract - Herpes Zoster (HZ) and its main complication, post-herpetic neuralgia (PHN), represent important public health issues because of their relevant burden among older adults. However, data on the epidemiology of HZ and PHN in Italy are very limited. A population-based study was performed by seeking for cases of HZ and PHN, occurred in the period 2013-2015, in the clinical charts of 56 General Practitioners working in 4 Italian Regions (Liguria, Puglia, Toscana and Veneto). The main objective of the study was to estimate the incidence of HZ and the proportion of PHN (at 1 and 3 mo from the onset of HZ; PHN1 and PHN3) among people aged ≥ 50 y. Overall, 598 cases of HZ were identified over 93,146 person-years of observation, thus corresponding to an overall incidence of 6.42 (IC95%: 5.93 - 6.95) HZ cases per 1,000 person-years. The incidence of HZ increased with age and was higher in female than in male. In total, 22.7%, 12.7%, and 2.4% of HZ cases suffered PHN at 1 and 3 mo and 1 y from the onset of acute episode. The proportions of these complications significantly increased with age, with the peak occurring in people aged ≥ 85 y. Four per cent of patients suffered ophthalmic

zoster. The study provided an update of the epidemiological burden of HZ and PHN in Italy, confirming the relevant burden of the disease in the elderly population. The study was funded by the Italian Ministry of Health, Center for Disease Prevention and Control (CCM) in 2013.

3.2.7 Levi M, Bellini I, Capecchi L, Pieri L, Bechini A, Boccalini S, Callaioli S, Gasparini R, Panatto D, Tiscione E, Bonanni P. [The burden of disease of Herpes Zoster in Tuscany](#). Hum Vaccin Immunother. 2015;11(1):185-91. doi: 10.4161/hv.35859. Epub 2014 Nov 1. PMID: 25483534; PMCID: PMC4514367.

Abstract - Herpes zoster (HZ) is a disease caused by the reactivation of the latent α -herpes virus varicella zoster virus (VZV), for which, in Italy, a specific surveillance system does not exist, but around 200 000 cases are estimated each year. In older patients, who are at increased risk of developing HZ, symptoms are more severe and the chances to develop postherpetic neuralgia (PHN), the most severe complication, are substantially higher. A vaccine against HZ with demonstrated efficacy and an acceptable safety profile is now available and is recommended in Europe for adults >50 years. In anticipation of the possible introduction of an immunization programme for the elderly in Tuscany, the burden of disease caused by HZ and its complications was assessed through a retrospective analysis of the hospital discharge records between 2002 and 2012, using the ICD-9-CM 053 code. In the period 2002-2012, 4475 hospital admissions were registered with annual means of 368 hospitalizations and 39 day-hospital admissions. Most of the hospitalizations (68%) involved subjects > 65 years; the mean length of stay was 9.5 days. Slightly more than half (51.2%) of total hospital admissions were complicated cases. The most frequent were neurological complications (24.2% of total admissions), followed by ophthalmic complications (16.5%). Cases with neurological complications were those with the higher average length of stay and higher average costs for case. This study confirmed the epidemiological impact of HZ and its complications and the positive impact on morbidity that the introduction of the HZ vaccination could have in older age groups.

3.3 Health Burden of VPIs in young adults: HPV example

Potential questions/outcomes: How does the burden determine the upper age limit for HPV vaccination in young adults - catch-up vaccination programs // vaccination after treatment

Related articles: Source: Pubmed search and/or proposed by speaker: Paolo Bonanni

3.3.1 Sung H, Ferlay J, Siegel RL, Laversanne M, Soerjomataram I, Jemal A, Bray F. Global Cancer Statistics 2020: [GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries](#). CA Cancer J Clin. 2021 May;71(3):209-249.

Abstract This article provides an update on the global cancer burden using the GLOBOCAN 2020 estimates of cancer incidence and mortality produced by the International Agency for Research on Cancer. Worldwide, an estimated 19.3 million new cancer cases (18.1 million excluding nonmelanoma skin cancer) and almost 10.0 million cancer deaths (9.9 million excluding nonmelanoma skin cancer) occurred in 2020. Female breast cancer has surpassed lung cancer as the most commonly diagnosed cancer, with an estimated 2.3 million new cases (11.7%), followed by lung (11.4%), colorectal (10.0 %), prostate (7.3%), and stomach (5.6%) cancers. Lung cancer remained the leading cause of cancer death, with an

estimated 1.8 million deaths (18%), followed by colorectal (9.4%), liver (8.3%), stomach (7.7%), and female breast (6.9%) cancers. Overall incidence was from 2-fold to 3-fold higher in transitioned versus transitioning countries for both sexes, whereas mortality varied <2-fold for men and little for women. Death rates for female breast and cervical cancers, however, were considerably higher in transitioning versus transitioned countries (15.0 vs 12.8 per 100,000 and 12.4 vs 5.2 per 100,000, respectively). The global cancer burden is expected to be 28.4 million cases in 2040, a 47% rise from 2020, with a larger increase in transitioning (64% to 95%) versus transitioned (32% to 56%) countries due to demographic changes, although this may be further exacerbated by increasing risk factors associated with globalization and a growing economy. Efforts to build a sustainable infrastructure for the dissemination of cancer prevention measures and provision of cancer care in transitioning countries is critical for global cancer control.

3.3.2 Arbyn M, Weiderpass E, Bruni L, de Sanjosé S, Saraiya M, Ferlay J, Bray F. [Estimates of incidence and mortality of cervical cancer in 2018: a worldwide analysis](#). *Lancet Glob Health*. 2020 Feb;8(2):e191-e203.

Abstract Background: The knowledge that persistent human papillomavirus (HPV) infection is the main cause of cervical cancer has resulted in the development of prophylactic vaccines to prevent HPV infection and HPV assays that detect nucleic acids of the virus. WHO has launched a Global Initiative to scale up preventive, screening, and treatment interventions to eliminate cervical cancer as a public health problem during the 21st century. Therefore, our study aimed to assess the existing burden of cervical cancer as a baseline from which to assess the effect of this initiative. Methods: For this worldwide analysis, we used data of cancer estimates from 185 countries from the Global Cancer Observatory 2018 database. We used a hierarchy of methods dependent on the availability and quality of the source information from population-based cancer registries to estimate incidence of cervical cancer. For estimation of cervical cancer mortality, we used the WHO mortality database. Countries were grouped in 21 subcontinents and were also categorised as high-resource or lower-resource countries, on the basis of their Human Development Index. We calculated the number of cervical cancer cases and deaths in a given country, directly age-standardised incidence and mortality rate of cervical cancer, indirectly standardised incidence ratio and mortality ratio, cumulative incidence and mortality rate, and average age at diagnosis. Findings: Approximately 570 000 cases of cervical cancer and 311 000 deaths from the disease occurred in 2018. Cervical cancer was the fourth most common cancer in women, ranking after breast cancer (2.1 million cases), colorectal cancer (0.8 million) and lung cancer (0.7 million). The estimated age-standardised incidence of cervical cancer was 13.1 per 100 000 women globally and varied widely among countries, with rates ranging from less than 2 to 75 per 100 000 women. Cervical cancer was the leading cause of cancer-related death in women in eastern, western, middle, and southern Africa. The highest incidence was estimated in Eswatini, with approximately 6.5% of women developing cervical cancer before age 75 years. China and India together contributed more than a third of the global cervical burden, with 106 000 cases in China and 97 000 cases in India, and 48 000 deaths in China and 60 000 deaths in India. Globally, the average age at diagnosis of cervical cancer was 53 years, ranging from 44 years (Vanuatu) to 68 years (Singapore). The global average age at death from cervical cancer was 59 years, ranging from 45 years (Vanuatu) to 76 years (Martinique). Cervical cancer ranked in the top three cancers affecting women younger than 45 years in 146 (79%) of 185 countries assessed. Interpretation: Cervical cancer continues to be a major public health problem affecting middle-aged women, particularly in less-resourced countries. The global scale-up of HPV vaccination and HPV-based screening-including self-sampling-has potential to make cervical cancer a rare disease in the

decades to come. Our study could help shape and monitor the initiative to eliminate cervical cancer as a major public health problem.

3.3.3 [HPV Prevention and Control Board meeting: HPV Vaccination of Adults: Impact, Opportunities and Challenges](#) November 2019 - Antwerp, Belgium

3.3.4 Waheed, DeN., Schiller, J., Stanley, M. et al. [Human papillomavirus vaccination in adults: impact, opportunities and challenges – a meeting report](#). BMC Proc 15 (Suppl 7), 16 (2021).

Meeting objectives:

- Provide an overview of the current situation of the HPV vaccine for adults.
- Discuss the immunogenicity, safety and efficacy data of existing HPV vaccine studies in adults.
- Gain insight into the efficacy of the HPV vaccine at the mucosal level and systemic level.
- Discuss ways and methods to conduct research on the potential benefits of vaccinating exposed adults.
- Discuss the challenges and benefits of vaccination of adults including high risk groups.
- Discuss cervical cancer elimination strategies.
- Discuss the potential implications of vaccination of adults on vaccine supplies in Low and Middle-Income Countries (LMIC).

Abstract - For more than a decade human papillomavirus (HPV) vaccine have been implemented in most high-income countries, and more recently also in several low- and middle-income countries. The vaccines are safe and their impact and effectiveness in preventing HPV vaccine type infection and associated diseases has been thoroughly established. Currently, the primary recommended cohorts for immunisation are adolescents, 9–15 years of age but HPV is an ubiquitous infection that is mainly (but not exclusively) sexually transmitted. Sexually active adults remain susceptible to infection and continued transmission of the virus, representing a reservoir of infection in the population. A recent meeting, conducted by the HPV Prevention and Control Board (HPV-PCB), reviewed the current status of HPV vaccination of adults, discussed limitations, challenges and benefits of HPV vaccination of adults, evaluated the effectiveness of HPV vaccination after treatment of post cervical cancer and precancerous lesions, and discussed the potential impact of adult vaccination on cervical cancer elimination strategies in light of the current and future HPV vaccine shortage. HPV-PCB is an independent multidisciplinary board of international experts that disseminates relevant information on HPV to a broad array of stakeholders and provides guidance on strategic, technical and policy issues in the implementation of HPV prevention and control programs. The HPV-PCB concluded that, given the current data available on adult HPV vaccination and the ongoing vaccine supply constraints, it is too early to implement routine vaccination of adults. Many research gaps need to be filled before we have a better understanding of the efficacy and broader public health impact of HPV vaccination in adult women.

3.3.5 Serrano B, Brotons M, Bosch FX, Bruni L. [Epidemiology and burden of HPV-related disease](#). Best Pract Res Clin Obstet Gynaecol. 2018 Feb;47:14-26.

Abstract - Human papillomavirus (HPV) infection is recognized as one of the major causes of infection-related cancer in both men and women. High-risk HPV types

are not only responsible for virtually all cervical cancer cases but also for a fraction of cancers of the vulva, vagina, penis, anus, and head and neck cancers. Furthermore, HPV is also the cause of anogenital warts and recurrent respiratory papillomatosis. Despite the availability of multiple preventative strategies, HPV-related cancer remains a leading cause of morbi-mortality in many parts of the world, particularly in less developed countries. Thus, in this review, we summarize the latest estimates of the global burden of HPV-related diseases, trends, the attributable fraction by HPV types, and the potential preventative fraction.

3.3.6 Bosch FX, Robles C, Díaz M, Arbyn M, Baussano I, Clavel C, Ronco G, Dillner J, Lehtinen M, Petry KU, Poljak M, Kjaer SK, Meijer CJ, Garland SM, Salmerón J, Castellsagué X, Bruni L, de Sanjosé S, Cuzick J. [HPV-FASTER: broadening the scope for prevention of HPV-related cancer](#). *Nat Rev Clin Oncol*. 2016 Feb;13(2):119-32.

Abstract - Human papillomavirus (HPV)-related screening technologies and HPV vaccination offer enormous potential for cancer prevention, notably prevention of cervical cancer. The effectiveness of these approaches is, however, suboptimal owing to limited implementation of screening programmes and restricted indications for HPV vaccination. Trials of HPV vaccination in women aged up to 55 years have shown almost 90% protection from cervical precancer caused by HPV16/18 among HPV16/18-DNA-negative women. We propose extending routine vaccination programmes to women of up to 30 years of age (and to the 45-50-year age groups in some settings), paired with at least one HPV-screening test at age 30 years or older. Expanding the indications for HPV vaccination and much greater use of HPV testing in screening programmes has the potential to accelerate the decline in cervical cancer incidence. Such a combined protocol would represent an attractive approach for many health-care systems, in particular, countries in Central and Eastern Europe, Latin America, Asia, and some more-developed parts of Africa. The role of vaccination in women aged >30 years and the optimal number of HPV-screening tests required in vaccinated women remain important research issues. Cost-effectiveness models will help determine the optimal combination of HPV vaccination and screening in public health programmes, and to estimate the effects of such approaches in different populations.

3.4 Health Burden of VPIs in travelers

Related articles: Source: Pubmed search and/or proposed by speaker: Robert Steffen

3.4.1 Pavli A, Maltezou HC. [Travel vaccines throughout history](#). *Travel Med Infect Dis*. 2022 Mar-Apr;46:102278.

Abstract - Vaccinations are an important component of travel medicine. Beyond protection of travelers, vaccines are administered to prevent the importation of vaccine-preventable diseases at home and at destination. Proof of immunization to travel dates back to the first smallpox vaccine, developed by Edward Jenner in 1796. However, it took one century to generate the next vaccines against cholera, rabies, and typhoid fever. During the 20th century the armamentarium of vaccines used in travelers largely expanded with yellow fever, poliomyelitis, tetravalent meningococcal, and hepatitis A vaccines. The International Certificate of Inoculation and Vaccination was implemented in 1933. Currently there are vaccines administered to travelers following risk assessment, but also vaccines required

according to the 2005 International Health Regulations and vaccines required at certain countries. Finally, within less than one year after the declaration of the coronavirus disease 2019 (COVID-19) pandemic, the first COVID-19 vaccines were launched and approved for emergency use to control the pandemic. Despite practical and ethical challenges, COVID-19 vaccine verifications have been widely used since spring 2021 in many activities, including international travel. In this article, we review the course of development of travel vaccines focusing on those for which a proof of vaccination has been or is required.

3.4.2 Jilg W. [Vaccines for Older Travelers](#). *Interdiscip Top Gerontol Geriatr*. 2020;43:158-181.

Abstract - People who travel to countries where they are at risk of contracting specific infections often need specific vaccines. To make correct recommendations in this respect several points have to be considered. The state of health of the traveler should be known as well as his or her destination and travel style. Very important, however, is the age of the traveler. As advancing age leads to changes in the immune system, in older individuals many infections are more severe. On the other hand, most vaccines are less immunogenic in the elderly. In this chapter, we will discuss which vaccines are necessary for older travelers visiting (mainly) tropical and subtropical countries, how these vaccines have to be used, and if perhaps their use has to be altered in older individuals. First, standard vaccinations will be addressed. When the immunization state of the individual is incomplete because certain vaccinations are expired or missing, it has to be updated. Vaccinations against tetanus, diphtheria, influenza, pneumococcal diseases, measles, and poliomyelitis have to be considered in this respect, because the risk of getting infected with these diseases in tropical and subtropical regions or in regions with poor hygienic conditions is often higher or at least the same as in industrialized countries. The second and main part of this chapter contains the typical travel vaccines. We will deal with vaccinations against cholera, hepatitis A and B, Japanese encephalitis, invasive meningococcal diseases, rabies, typhoid fever, and yellow fever. Clinical courses and epidemiology of the different infections are presented. The respective vaccines are discussed in detail, especially their efficiency in older individuals as far as data are available in this respect. Finally, recommendations for their use in older travelers will be given.

3.4.3 Torresi J, Steffen R. [Redefining priorities towards graded travel-related infectious disease research](#). *J Travel Med*. 2017 Sep 1;24(6). doi: 10.1093/jtm/tax064. PMID: 29088486.

Abstract - Our knowledge of the health problems and infections encountered by international travellers has evolved considerably in the past decades. The growth of global networks such as the GeoSentinel Surveillance network, TropNet Europe, EuroTravNet and networks based in North America have provided valuable information on the frequency of a wide array of travel-related diseases and accidents, including details on the destination of travel and trends over time. The information gained from these network studies has provided important data for the practice of travel medicine and in some instances for the development of practice guidelines. However, network data due to a lack of denominators usually cannot serve as a basis for a GRADE approach to guideline development. Although epidemiological network studies will continue to serve an important role in travel medicine we encourage an additional strong focus towards translational scientific research questions and towards the broader use of novel techniques to obtain more accurate epidemiological analyses to address the many unanswered questions in our field.

3.4.4 Steffen R, Behrens RH, Hill DR, Greenaway C, Leder K. [Vaccine-preventable travel health risks: what is the evidence--what are the gaps?](#) J Travel Med. 2015 Jan-Feb;22(1):1-12. doi: 10.1111/jtm.12171. Epub 2014 Nov 6. PMID: 25378212.

Abstract - Background: Existing travel health guidelines are based on a variety of data with underpinning evidence ranging from high-quality randomized controlled trials to best estimates from expert opinion. For strategic guidance and to set overall priorities, data about average risk are useful. The World Health Organization (WHO) plans to base future editions of "International Travel and Health" on its new "Handbook for Guideline Development." **Methods:** Based on a systematic search in PubMed, the existing evidence and quality of data on vaccine-preventable disease (VPD) risks in travelers was examined and essentials of vaccine efficacy were briefly reviewed. The Grading of Recommendations, Assessment, Development and Evaluation (GRADE) framework was used to evaluate the quality of the data. **Results:** Moderate-quality data to determine the risk of VPD exist on those that are frequently imported, whereas in most others the level of confidence with existing data is low or very low. **Conclusions:** In order for the WHO to produce graded risk statements in the updated version of "International Travel and Health," major investment of time plus additional high-quality, generalizable risk data are needed.

3.5 Health Burden of VPIs in immunocompromised adults

Related articles: Source: Pubmed search and/or proposed by speaker: Per Ljungman

3.5.1 Ljungman P, Tridello G, Piñana JL, ..., Khan A, Lenhoff S, Grassi A, Dobsinska V, Miranda N, Jimenez MJ, Yonal-Hindilerden I, Wilson K, Averbuch D, Cesaro S, Xhaard A, Knelange N, Styczynski J, Mikulska M, de la Camara R. [Improved outcomes over time and higher mortality in CMV seropositive allogeneic stem cell transplantation patients with COVID-19; An infectious disease working party study from the European Society for Blood and Marrow Transplantation registry.](#) Front Immunol. 2023 Mar 7;14:1125824.

Abstract Introduction: COVID-19 has been associated with high morbidity and mortality in allogeneic hematopoietic stem cell transplant (allo-HCT) recipients. **Methods:** This study reports on 986 patients reported to the EBMT registry during the first 29 months of the pandemic. **Results:** The median age was 50.3 years (min - max; 1.0 - 80.7). The median time from most recent HCT to diagnosis of COVID-19 was 20 months (min - max; 0.0 - 383.9). The median time was 19.3 (0.0 - 287.6) months during 2020, 21.2 (0.1 - 324.5) months during 2021, and 19.7 (0.1 - 383.9) months during 2022 ($p = \text{NS}$). 145/986 (14.7%) patients died; 124 (12.6%) due to COVID-19 and 21 of other causes. Only 2/204 (1%) fully vaccinated patients died from COVID-19. There was a successive improvement in overall survival over time. In multivariate analysis, increasing age ($p < .0001$), worse performance status ($p < .0001$), contracting COVID-19 within the first 30 days ($p < .0001$) or 30 - 100 days after HCT ($p = .003$), ongoing immunosuppression ($p = .004$), pre-existing lung disease ($p = .003$), and recipient CMV seropositivity ($p = .004$) had negative impact on overall survival while patients contracting COVID-19 in 2020 ($p < .0001$) or 2021 ($p = .027$) had worse overall survival than patients with COVID-19 diagnosed in 2022. **Discussion:** Although the outcome of COVID-19 has improved, patients having risk factors were still at risk for severe COVID-19 including death.

3.5.2 Kolobova I, Nyaku MK, Karakusevic A, Bridge D, Fotheringham I, O'Brien M. [Burden of vaccine-preventable diseases among at-risk adult populations in the US](#). Hum Vaccin Immunother. 2022 Nov 30;18(5):2054602.

Abstract: Life-course immunization holds significant benefit for population health by reducing the burden of vaccine-preventable diseases (VPD) through vaccinating individuals at different stages and circumstances in life. The study aimed to determine the epidemiologic, clinical, economic, and societal burden of VPDs among at-risk adult subpopulations in the United States. A systematic literature review was conducted for articles published between January 2010 and June 2020, which identified 72 publications. There was heterogeneity in available epidemiology data, with the prevalence of VPDs ranging from 1.1% to 68.7%. Where the disease burden was described, outcomes were typically worse among high-risk subpopulations than in the general population. Several VPDs, including herpes zoster, meningococcal, and pneumococcal infections were associated with increased costs. This review suggests that subpopulations may not frequently interact with the healthcare system, or their risk factors may not be recognized by healthcare providers, and therefore individuals may not be appropriately targeted for vaccination.

3.5.3 van Aalst M, Lötsch F, Spijker R, van der Meer JTM, Langendam MW, Goorhuis A, Grobusch MP, de Bree GJ. [Incidence of invasive pneumococcal disease in immunocompromised patients: A systematic review and meta-analysis](#). Travel Med Infect Dis. 2018 Jul-Aug;24:89-100.

Abstract Background: Invasive pneumococcal disease (IPD) is associated with high morbidity and mortality, with immunocompromised patients (ICPs) at particular risk. Therefore, guidelines recommend pneumococcal vaccination for these patients. However, guidelines are scarcely underpinned with references to incidence studies of IPD in this population. This, potentially results in unawareness of the importance of vaccination and low vaccination rates. The objective of this systematic review and meta-analysis was to assess the incidence of IPD in ICPs. **Methods:** We systematically searched PubMed and Embase to identify studies in English published before December 6th, 2017 that included terms related to 'incidence', 'rate', 'pneumococcal', 'pneumoniae', 'meningitis', 'septicemia', or 'bacteremia'. We focused on patients with HIV, transplantation and chronic inflammatory diseases. **Results:** We included 45 studies in the systematic review reporting an incidence or rate of IPD, defined as isolation of Streptococcus pneumoniae from a normally sterile site. Random effects meta-analysis of 38 studies showed a pooled IPD incidence of 331/100,000 person years in patients with HIV in the late-antiretroviral treatment era in non-African countries, and 318/100,000 in African countries; 696 and 812/100,000 in patients who underwent an autologous or allogeneic stem cell transplantation, respectively; 465/100,000 in patients with a solid organ transplantation; and 65/100,000 in patients with chronic inflammatory diseases. In healthy control cohorts, the pooled incidence was 10/100,000. **Discussion:** ICPs are at increased risk of contracting IPD, especially those with HIV, and those who underwent transplantation. Based on our findings, we recommend pneumococcal vaccination in immunocompromised patients.

3.5.4 Kumar D, Ferreira VH, Blumberg E, ..., Fortun J, Torre-Cisneros J, Englund JA, Natori Y, Husain S, Reid G, Sharma TS, Humar A. [A 5-Year Prospective Multicenter Evaluation of Influenza Infection in Transplant Recipients](#). Clin Infect Dis. 2018 Oct 15;67(9):1322-1329.

Abstract Background: Seasonal influenza infection may cause significant morbidity and mortality in transplant recipients. The purpose of this study was to assess the epidemiology of symptomatic influenza infection posttransplant and determine risk

factors for severe disease. **Methods:** Twenty centers in the United States, Canada, and Spain prospectively enrolled solid organ transplant (SOT) or hematopoietic stem cell transplant (HSCT) recipients with microbiologically confirmed influenza over 5 consecutive years (2010-2015). Demographics, microbiology data, and outcomes were collected. Serial nasopharyngeal swabs were collected at diagnosis and upto 28 days, and quantitative polymerase chain reaction for influenza A was performed. **Results:** We enrolled 616 patients with confirmed influenza (477 SOT; 139 HSCT). Pneumonia at presentation was in 134 of 606 (22.1%) patients. Antiviral therapy was given to 94.1% for a median of 5 days (range, 1-42 days); 66.5% patients were hospitalized and 11.0% required intensive care unit (ICU) care. The receipt of vaccine in the same influenza season was associated with a decrease in disease severity as determined by the presence of pneumonia (odds ratio [OR], 0.34 [95% confidence interval {CI}, .21-.55], $P < .001$) and ICU admission (OR, 0.49 [95% CI, .26-.90], $P = .023$). Similarly, early antiviral treatment (within 48 hours) was associated with improved outcomes. In patients with influenza A, pneumonia, ICU admission, and not being immunized were also associated with higher viral loads at presentation ($P = .018$, $P = .008$, and $P = .024$, respectively). **Conclusions:** Annual influenza vaccination and early antiviral therapy are associated with a significant reduction in influenza-associated morbidity, and should be emphasized as strategies to improve outcomes of transplant recipients.

3.5.5 Shigayeva A, Rudnick W, Green K, Chen DK, Demczuk W, Gold WL, Johnstone J, Kitai I, Krajden S, Lovinsky R, Muller M, Powis J, Rau N, Walmsley S, Tyrrell G, Bitnun A, McGeer A; Toronto [Invasive Bacterial Diseases Network. Invasive Pneumococcal Disease Among Immunocompromised Persons: Implications for Vaccination Programs.](#) Clin Infect Dis. 2016 Jan 15;62(2):139-47.

Abstract Background: In 2012/2013, a single dose of 13-valent pneumococcal conjugate vaccine (PCV13) was recommended for immunocompromised adults in the United States and Canada. To assess the potential benefits of this recommendation, we assessed the serotype-specific burden of invasive pneumococcal disease (IPD) among immunocompromised individuals. **Methods:** From 1995 to 2012, population-based surveillance for IPD was conducted in Metropolitan Toronto and Peel Region, Canada. Disease incidence and case fatality were measured in immunocompromised populations over time, and the contribution of different serotypes determined. **Results:** Overall, 2115/7604 (28%) episodes of IPD occurred in immunocompromised persons. IPD incidence was 12-fold higher (95% confidence interval [CI], 8.7-15) in immunocompromised compared to immunocompetent persons; the case fatality rate was elevated in both younger (odds ratio [OR] 1.8) and older (OR 1.3) adults. Use of immunosuppressive medications was associated with a 2.1-2.7 fold increase in the risk of IPD. Five years after PPV23 program implementation, IPD incidence had declined significantly in immunocompromised adults (IRR 0.57, 95% CI, .40-.82). Ten years after pediatric PCV7 authorization, IPD due to PCV7 serotypes had decreased by 90% (95% CI, 77%-96%) in immunocompromised persons of all ages. In 2011/2012, 37% of isolates causing IPD in immunocompromised persons were PCV13 serotypes and 27% were PPV23/not PCV13 serotypes. **Conclusions:** Immunocompromised individuals comprised 28% of IPD. Both PPV23 and herd immunity from pediatric PCV7 were associated with reductions in IPD in immunocompromised populations. PCV13 vaccination of immunocompromised adults may substantially reduce the residual burden until herd immunity from pediatric PCV13 is fully established.

Session 4: From theory to practice: how are health burden estimates used to recommend adult vaccines in national immunization programs in Europe

Potential questions/outcomes: Get an overview of the process underlying burden of VPIs knowledge translation. What is needed for effective translation of evidence into practical and tangible NIPs advice. What are the common challenges, needs and output / policy barriers?

Session 4: From theory to practice	4.1 How are health burden estimates used to recommend adult vaccines in national immunization programs in Europe	Ziad El-Khatib Lois Privor-Dumm Chiara Cadeddu Heini Salo Roman Chlibek Thomas Weinke Sotirios Tsiodras
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Related articles: Source: Pubmed search and/or proposed by speakers: Ziad El-Khatib, Lois Privor-Dumm, Chiara Cadeddu, Heini Salo, Roman Chlibek. Thomas Weinke, Sotirios Tsiodras

4.1 Presentation by Hanna Nohynek – Secretary of NITAG (Finland) - Chair of WHO SAGE **Using CoP to guide the use of current SARS COV 2 vaccines - A NITAG point of view 16/02/2023**. IABS meeting Enabling the Evaluation of COVID-19 Vaccines with Correlates of Protection - University of Antwerp EPIV Vaccinopolis on February 16-17, 2023 <https://covid-19-correlates-of-protection-2023.iabs.org/>

Table 3. ETR Framework – Summary of Evidence to Recommendation

Introduction			
Specific policy question:			
<ul style="list-style-type: none"> • Specific intervention • Population targeted for the intervention • Goal that should be reached by the introduction of the intervention in the target group 			
Background:			
Criteria			
Criterion	Criteria questions and WIG/Secretariat judgements	Summary of evidence	Additional information
1. Problem			
2. Benefits and harms of the intervention			
3. Values and preferences of the target population			
4. Acceptability to stakeholders			
5. Resource use			
6. Equity			
7. Feasibility			
Balance of consequences of intervention			

Etujimi Sukunimi

16.2.2023 4

Most mature NITAGs use ETR framework for policy decision making

- **Problem:** Burden of Disease = SARS-CoV-2 infection, symptomatic disease/ hospitalization / ICU / Death
- **Benefits/Harms of intervention:** Prevention of the above / adverse events

NITAG networks - collaborations	Website
ECDC / EU/EEA National Immunisation Technical Advisory Groups (NITAG) collaboration	https://www.ecdc.europa.eu/en/about-us/partnerships-and-networks/national-immunisation-technical-advisory-groups-nitag

WHO Strategic Advisory Group of Experts on Immunization (SAGE)	https://www.who.int/groups/strategic-advisory-group-of-experts-on-immunization
Global NITAG network - resource center on national immunization policies and global recommendations on vaccine-preventable diseases	https://www.nitag-resource.org/

4.2 Laigle V, Postma MJ, Pavlovic M, Cadeddu C, Beck E, Kapusniak A, Toumi M. [Vaccine market access pathways in the EU27 and the United Kingdom - analysis and recommendations for improvements](#). Vaccine. 2021 Sep 15;39(39):5706-5718.

Abstract Background: Vaccine market access (VMA) pathways across the European Union (EU) and the United Kingdom (UK) are complex, lengthy, and heterogeneous, particularly when compared with pharmaceuticals. The knowledge base to inform recommendations for optimization of VMA is lacking. We therefore conducted a comprehensive evaluation of EU VMA pathways. Methods: Research in two phases included: (1) mapping VMA pathways in each EU member state (including the UK) based on a literature review, expert interviews, and mathematical archotyping; and (2) interviews with vaccine experts to identify barriers, drivers, and recommendations for regional VMA alignments. Results: Key steps in VMA across the EU include horizon scanning, early advice, National Immunization Technical Advisory Group (NITAG) recommendation for inclusion in national immunization programs, health technology assessment (HTA), final decision and procurement. We found significant complexity and heterogeneity, particularly for early advice, and in the roles, decision-making criteria, and transparency of NITAGs and HTA bodies. The most important drivers for rapid VMA included demonstration of disease burden and vaccine benefit (e.g., efficacy, safety, economic). Key barriers were budget limitations and complexity/clarity of VMA processes (e.g., need for national-regional consensus, clarity on process initiation, and clarity on the role of HTA). Recommendations for alignment at EU and member-state levels include information sharing, joint clinical assessment, initiatives to address funding and political barriers, and improved transparency by decision-making bodies. Early engagement with vaccine stakeholders was a key recommendation for manufacturers. Conclusions: There is significant potential for alignment, collaboration, and improvement of VMA across the EU. Roles, responsibilities, and transparency of key bodies can be clarified. The COVID-19 pandemic response should stimulate policies to improve access to all vaccines, including routine ones, and form the foundation upon which a consistent vaccine ecosystem can be created for the EU, one that is resilient, consistent between member states, and fit for purpose.

4.3 Lundkvist A, El-Khatib Z, Kalra N, Pantoja T, Leach-Kemon K, Gapp C, Kuchenmüller T. [Policy-makers' views on translating burden of disease estimates in health policies: bridging the gap through data visualization](#). Arch Public Health. 2021 Feb 4;79(1):17.

Abstract - Background: Knowledge Translation (KT) and data visualization play a vital role in the dissemination of data and information to improve healthcare systems. A better understanding of KT and its utility requires examining its processes, and how these interact with available data tools and platforms and various users. In this context, the aim of this paper is to understand how relevant users interact with data visualization tools, in particular Global Burden of Disease (GBD) visualizations, while also examining KT processes related to data visualization. Methods: A qualitative case-study consisting of semi-structured

interviews with eight policy officers. Interviewees were selected by the Institute for Health Metrics and Evaluation (IHME) from three countries: Canada, Kenya and New Zealand. Data were analyzed through framework coding, using qualitative analysis software. Results: Policy officers' responses indicated that data can prompt action by engaging users, and effective delivery and translation of data was enhanced by data visualization tools. GBD was considered valuable for use in policy (e.g., planning and prioritizing health policy; facilitating accountability; and tracking and monitoring progress and trends over time and between countries). Using GBD and data visualization tools, participants quickly and easily accessed key information and turned it into actionable messages; engaging visuals captured decision-makers' attention while providing information in a digestible, time-saving manner. However, participants emphasized an overall disconnect between research and public health. Functionality and technical issues, e.g., absence of tool guides and tool complexity, as well as lacking buy-in and awareness of certain tools from those less familiar with GBD, were named as major barriers. In order to address this "know-do" gap, user-friendly knowledge translation tools were stated as crucial, as was the importance of collaboration and leveraging different insights from data generators and users to inform health policy. Conclusions: Policy officers aware of KT are willing to utilize data visualization tools as they value them as an engaging and important mechanism to foster the use of GBD data in policy-making. To further facilitate policy officers' efforts to effectively use GBD data in policy and practice, further research is required into how users perceive and interact with data visualization and other KT tools.

4.4 Privor-Dumm L, Vasudevan P, Kobayashi K, Gupta J. [Archetype analysis of older adult immunization decision-making and implementation in 34 countries](#). *Vaccine*. 2020 May 27;38(26):4170-4182.

Abstract - The global population of adults over 65 years of age is growing rapidly and is expected to double by 2050. Countries will face substantial health, economic and social burden deriving from vaccine-preventable diseases (VPDs) such as influenza, pneumonia and herpes zoster in older adults. It will be essential that countries utilize several public health strategies, including immunization. Understanding the different approaches countries have taken on adult immunization could help provide future learnings and technical support for adult vaccines within life-course immunization strategies. In this study, we describe the priorities and approaches that underlie adult immunization decision-making and implementation processes in 32 high-and-middle-income countries and two territories ("34 countries") who recommend adult vaccines in their national schedule. We conducted an archetype analysis based on a subset of two dozen indicators abstracted from a larger database. The analysis was based on a mixed-methods study, including results from 120 key informant interviews in six countries and a landscape review of secondary data from 34 countries. We found four distinct archetypes: disease prevention-focused; health security-focused; evolving adult focus; and, child-focused and cost-sensitive. The highest performing countries belonged to the disease prevention-focused and health security archetypes, although there was a range of performance within each archetype. Considering common barriers and facilitators of decision-making and implementation of adult vaccines within a primary archetype could help provide a framework for strategies to support countries with similar needs and approaches. It can also help in developing context-specific policies and guidance, including for countries prioritizing adult immunization programs in light of COVID-19. Further research may be beneficial to further refine archetypes and expand the understanding of what influences success within them. This can help advance policies and action that will improve vaccine access for older adults and build a stronger appreciation of the value of immunization amongst a variety of stakeholders.

4.5 Hilderink HBM, Plasmans MHD, Poos MJJCR, Eysink PED, Gijzen R. [Dutch DALYs, current and future burden of disease in the Netherlands](#). Arch Public Health. 2020 Sep 22;78:85.

Abstract Background: The Disability Adjusted Life Year (DALY) is a measure to prioritize in the public health field. In the Netherlands, the DALY estimates are calculated since 1997 and are included in the Public Health Status and Foresight studies which is an input for public health priority setting and policy making. Over these 20 years, methodological advancements have been made, including accounting for multimorbidity and performing projections for DALYs into the future. Most important methodological choices and improvements are described and results are presented. Methods: The DALY is composed of the two components years of life lost (YLL) due to premature mortality and years lost due to disability (YLD). Both the YLL and the YLD are distinguished by sex, age and health condition, allowing aggregation to the ICD-10 chapters. The YLD is corrected for multimorbidity, assuming independent occurrence of health conditions and a multiplicative method for the calculation of combined disability weights. Future DALYs are calculated based on projections for causes of death, and prevalence and incidence. Results: The results for 2015 show that cancer is the ICD-10 chapter with the highest disease burden, followed by cardiovascular diseases and mental disorders. For the individual health conditions, coronary heart disease had the highest disease burden in 2015. In 2040, we see a strong increase in disease burden of dementia and arthrosis. For dementia this is due to a threefold increase in dementia as a cause of death, while for arthrosis this is mainly due to the increase in prevalence. Conclusions: To calculate the DALY requires a substantial amount of data, methodological choices, interpretation and presentation of results, and the personnel capacity to carry out all these tasks. However, doing a National Burden of Disease study, and especially doing that for more than 20 years, proved to have an enormous additional value in population health information and thus supports better public health policies.

4.6 Fafangel M, Grgič Vitek M, Klavs I. [Letter to the editor: Applying incidence-based disability-adjusted life years \(DALYs\) disease burden estimates to foster change in national vaccination policy, Slovenia, 2017 to 2018](#). Euro Surveill. 2018 Jul;23(27):1800354.

Abstract - Cassini et al. presented in Eurosurveillance the results of the burden of infectious diseases in European Union and European Economic Area (EU/EEA) countries, using the incidence-based methodology to calculate disability-adjusted life years (DALYs) developed within the Burden of Communicable Diseases in Europe (BCoDE) project. The description of the impact of diseases on the health of the population by means of a composite health measure provides clear and comprehensive information for transparent and accountable decision-making. Thus, measures such as DALYs have the potential to play a significant role in health policy formulation. We wish to add our first-hand experience using the BCoDE incidence-based approach to foster change in national vaccination policies. In a study published in 2017, based on the same methodology, we estimated the burden of tick-borne encephalitis (TBE) in Slovenia.

4.7 Salo H, Kilpi T. [National vaccination program - a success story of public health and economy](#). Duodecim. 2017;133(10):977-83. PMID: 29239578.

Abstract - The savings in treatment costs generated by disease cases prevented by the national vaccination program exceed the costs of the vaccination program by at least 60 million euros. In addition, other costs due to contracting the illness are avoided. Vaccinations serve the purpose of both increasing well-being and releasing resources for other uses. Financial support of vaccinations through the

health insurance system would be costly and targeted to those with the ability to pay. Public funds should be directed to the development of a vaccination program. New vaccines coming on the market are expensive. Adding a new vaccine to the vaccination program is based on scientific evidence-based expert assessments and cost-effectiveness. In addition to preliminary assessments carried out in support of decision-making, the National Institute of Health and Welfare monitors by using population-based health registers the effectiveness and cost-effectiveness of the vaccination program. From the standpoint of transparency of decision-making it would be preferred that the decision-makers define a willingness to pay threshold below which an intervention would be accepted and lead to funding.

4.8 Chlibek R, Anca I, André F, Čížman M, Ivaskeviciene I, Mangarov A, Mészner Z, Perenovska P, Pokorn M, Prymula R, Richter D, Salman N, Šimurka P, Tamm E, Tešović G, Urbancikova I, Zavadská D, Usonis V. [Adult vaccination in 11 Central European countries - calendars are not just for children](#). *Vaccine*. 2012 Feb 21;30(9):1529-40.

Abstract As Europe's population ages, disease morbidity and treatment costs in the adult population are likely to rise substantially, making this a pertinent time to review and revise preventive strategies such as vaccination. Vaccine uptake remains a problem for adults and there is a lack of coordinated programmes for vaccination of adults. Countries in Western Europe have begun to identify the need to increase adult vaccination, but the situation in Central European countries remains poorly identified and inadequately described. This paper summarises the evidence to support the development of an adult vaccination calendar in the Central European Vaccination Awareness Group (CEVAG) member countries (Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Romania, Slovakia, Slovenia and Turkey). CEVAG recommends the introduction of an adult vaccination calendar, which should include vaccination against diseases that represent a large burden in adults in terms of mortality and morbidity. This calendar could be modified to meet the priorities of individual countries.

4.9 Houweling H, Verweij M, Ruitenberg EJ; [National Immunisation Programme Review Committee of the Health Council of the Netherlands. Criteria for inclusion of vaccinations in public programmes](#). *Vaccine*. 2010 Apr 9;28(17):2924-31.

Abstract As more and more new vaccines are developed and brought to the market, governments have to make decisions about which vaccinations to include in public programmes. This paper describes the experience in the Netherlands in developing a framework for assessing whether a vaccination should be included in the National Immunization Programme (NIP). Bearing in mind the public nature, the factors that determine a vaccine's suitability for inclusion in a communal vaccination programme have been translated into seven selection criteria, grouped under five thematic headings: seriousness and extent of the disease burden, effectiveness and safety of the vaccination, acceptability of the vaccination, efficiency of the vaccination, and priority of the vaccination. The seven criteria and the explanation of them provide a framework for the systematic examination of arguments for and against the inclusion and prioritisation of particular vaccinations. As an illustration, the vaccinations currently provided in the Netherlands through public programmes as well as 23 'candidate' vaccinations are assessed against the seven criteria. The proposed assessment framework including the selection criteria can take full account of the values and specificities as they may differ between situations and countries; the transparency of the approach may help to clarify which elements of the assessment are pivotal in specific situations. Using the criteria furthers a trustworthy, transparent and accountable process of decision-making

about inclusion of new vaccinations in public vaccination programmes and may help to retain public confidence.

4.10 Patt, A. (2009). [Communicating uncertainty to policy makers](#). In: *Uncertainties in Environmental Modelling and Consequences for Policy Making*. Eds. Bavaye, P., Mysiak, J., & Laba, M., Dordrecht: Springer-Verlag.

Abstract As the types of problems that policy-makers attempt to solve grow more complex, they increasingly are turning to scientists for specific advice. A critical challenge in communicating the results of scientific research arises when those results contain a great deal of uncertainty. Different academic disciplines offer diverging advice on how scientists should proceed, based in large part on differences in how the various disciplines view the process of decision-making process itself. In this chapter, the author links the strategies for communicating uncertainty to the decision-making models of economics, psychology, and sociology, respectively. He suggests that the relative strength of each strategy depends on the context within which the decision-maker is operating. To resolve this ambiguity about how best to communicate uncertainty, he offers first-best and second-best approaches. The first-best approach is rooted in a process of dialogue, with attention to two-way communication and the relationship between scientists and policy-makers. The second-best approach is rooted in the goal not of giving all decision-makers all of the information they need, but rather in providing them with just enough information to judge whether they need more. To assist in that latter task, the author suggests particular guidelines for the aspects of uncertainty that scientists need to communicate.