

1 **Supplementary Material**

2 **Title: Epidemiology of pertussis and pertussis-related complications in adults – a German**
3 **claims data analysis**

4 Surmann Bastian¹, Witte Julian¹, Batram Manuel¹, Criée Carl Peter², Hermann Christiane³, Leischker
5 Andreas^{4,5}, Schelling Jörg⁶, Steinmüller Mirko⁷, Wahle Klaus⁸, Heiseke Alexander F^{9*}, Marijic Pavo^{9*}
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7 ¹ Vandage GmbH, Bielefeld, Germany

8 ² Department of Sleep and Respiratory Medicine, Evangelical Hospital Goettingen-Weende,
9 Bovenden, Germany

10 ³ Department of Clinical Psychology, Justus-Liebig University Giessen, Giessen, Germany

11 ⁴ Working Group " Vaccination", German Geriatric Society and Department for Geriatrics

12 ⁵ Asklepios Hospital Wandsbek, Hamburg, Germany

13 ⁶ Medizinische Klinik IV, Ludwig-Maximilians-University Munich, Munich, Germany

14 ⁷ PRAXIS DILLTAL, Ehringshausen, Germany

15 ⁸ Department of General Medicine, University of Muenster, Muenster, Germany

16 ⁹ GSK, Munich, Germany

17 * Heiseke A und Marijic P share last authorship

18 **Corresponding author:** Dr. Julian Witte

19 **Email:** julian.witte@vandage.de

20 **Postal address:** Detmolder Straße 30, 33604 Bielefeld, Germany

21 **Telephone number:** +49 151 5064 0017

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24 **Methods**

25 **Table S1 Definition of underlying conditions**

Underlying condition	ICD-10 code	Diagnosis	ATCs for out-patient diagnosis	Minimum DDD
Asthma	J45	HDIA, NDIA or ("G" and M2Q and min 1 ATC)	D11AH05 H02AB R03A R03BA R03BC R03C R03DA R03DB R03DC R03DX05 R03DX08 R03DX09 R03DX10	180
Chronic obstructive pulmonary disease	J44, J96	HDIA, NDIA or ("G" and M2Q)	R03A R03BB R03C R03DX07	1
Diabetes mellitus, type 1	E10 (NOT E11)	HDIA, NDIA or ("G" and M2Q and min 1 ATC)	A10A	180
Diabetes mellitus, type 2	E11	HDIA, NDIA or ("G" and M2Q and min 1 ATC)	A10A A10B A10X	180
Depression	F32, F33, F34	HDIA, NDIA or ("G" and M2Q and min 1 FA-Gruppe 68 OR 61 OR 60 OR 59 OR 58 OR 53 OR 51)	-	-
Coronary heart disease	I20, I21, I22, I25	HDIA, NDIA or ("G" and M2Q and min 1 ATC)	B01AC C01DA C01DX11 C01DX12 C07 C08 C09XA53 C09XA54 C09A C09B C09C C09D C10	180
Heart failure	I50	HDIA, NDIA or ("G" and M2Q and min 1 ATC)	C01A C03 C07 C09A C09B C09C C09D	180

Underlying condition	ICD-10 code	Diagnosis	ATCs for out-patient diagnosis	Minimum DDD
Osteoporosis	M80, M81	HDIA, NDIA or ("G" and M2Q and min 1 FA-Gruppe 10)	-	-
Rheumatoid arthritis	M05, M06	HDIA, NDIA or ("G" and M2Q and min 1 ATC)	M01A H02AB L04AA	1
Chronic kidney disease	N18, N03	HDIA, NDIA or "G" M2Q	-	-
Dialysis	Dialysis costs > 0	Only with sufficient sample size	-	-
Immunodeficiency	B20 – B24, R75, Z21, C00 – C97, D47.9, D55 - D59, D70, D71, D73.0, Q89.01, D73.5, D73.8, D76.1, D80 – D90, G35, K50, K51, L40, M07.0 – M07.3, M09.0, L87.1, L93, M32, M05, M06, M08, M09.0, M30.0, M30.1, M31.3, M31.4, M31.5, M31.6, M31.7, M33, M34, M35.0, M35.1, M35.2, M35.3, , M47.9, N18, S36.04, Z94, Z94.8	HDIA, NDIA or "G" M2Q	-	-

26 ICD-10 10th revision of the International Classification of Diseases, ATC Anatomical Therapeutic Chemical code,
27 DDD daily defined dose, "G" assured diagnosis (German "gesichert"), HDIA main diagnosis (German "Hauptdi-
28 agnose"), NDIA secondary diagnosis (German "Nebendiagnose")
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30 **Table S2 Definition of complications**

Complication	ICD-10 code	Diagnosis criteria
Severe complications		
Pneumonia	J12, J13, J14, J15, J16, J17, J18	M1Q (HDIA, NDIA, "G")
Rib fracture	S22.3, S22.4	M1Q (HDIA, NDIA, "G")
Hospital visit	All, but excluding all codes specified above and below	M1Q
Less severe complications		
Otitis media	H65, H66, H67.8	M1Q (HDIA, NDIA, "G")
Encephalopathy	G93.4	M1Q (HDIA, NDIA, "G")
Abnormalities of breathing	R06	M1Q (HDIA, NDIA, "G")
Seizure	R25.2, R56	M1Q (HDIA, NDIA, "G")
Inguinal and umbilical hernia	K40, K42	M1Q (HDIA, NDIA, "G")
Intracranial hemorrhage	I60, I61, I62, S06.4, S06.5, S06.6	M1Q (HDIA, NDIA, "G")
Incontinence	N39.3, N39.42	M1Q (HDIA, NDIA, "G")
Loss of weight	R63.4	M1Q (HDIA, NDIA, "G")
Sarcopenia	M62.5 (since 2018), R26.3	M1Q (HDIA, NDIA, "G")
Gait abnormality	R26	M1Q (HDIA, NDIA, "G")
Sensitivity		
All-cause hospitalization	All	M1Q

31
32 ICD-10 10th revision of the International Classification of Diseases, M1Q The complication needs to be present
33 in the same quarter as the initial pertussis-diagnosis either as an assured (German "gesichert"; "G") main diag-
34 nosis (German "Hauptdiagnose"; HDIA) or secondary diagnosis (German "Nebendiagnose"; NDIA).

35 **Results**

36 **3.1 Supplemental information on the study cohort**

37 **Table S3 Proportion of patients with underlying conditions in the database**

	2016	2017	2018	2019
Any UC	22.2%	23.2%	22.7%	23.5%
Asthma	4.0%	4.2%	4.2%	4.4%
Chronic obstructive pulmonary disease	2.3%	2.4%	2.4%	2.5%
Osteoporosis	1.8%	1.9%	1.8%	1.8%
Rheumatoid arthritis	0.8%	0.9%	0.9%	0.9%
Depression	7.4%	7.9%	7.9%	8.2%
Immunodeficiency	5.8%	6.3%	6.3%	6.6%
Heart failure	1.4%	1.4%	1.5%	1.5%
Chronic heart disease	3.6%	3.7%	3.7%	3.8%
Chronic kidney disease	1.4%	1.6%	1.7%	1.9%
Type 2 diabetes	5.5%	5.8%	5.7%	5.9%
Type 1 diabetes	0.5%	0.5%	0.5%	0.5%

38 *UC* underlying condition

39

40 **Table S4 Protocol of matching results**

	2016		2017		2018		2019	
	UC	No UC	UC	No UC	UC	No UC	UC	No UC
Age (years)								
Mean (SD)	60.4 (16.7)	60.4 (16.7)	60.6 (16.6)	60.6 (16.6)	60.3 (17.1)	60.3 (17.1)	60.7 (16.9)	60.7 (16.9)
Age groups (%)								
18–49	22.3%	22.3%	23.4%	23.4%	25.4%	25.4%	26.2%	26.2%
50–59	22.1%	22.1%	22.8%	22.8%	23.2%	23.2%	23.8%	23.8%
> 60	55.6%	55.6%	53.8%	53.8%	51.5%	51.5%	50.0%	50.0%
Sex (%)								
Male	46.6%	46.6%	46.6%	46.6%	46.8%	46.8%	46.8%	46.8%
Female	53.4%	53.4%	53.4%	53.4%	53.2%	53.2%	53.2%	53.2%

41 *UC* underlying condition, *SD* standard deviation

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44 **3.2 Pertussis incidence in patients with and without underlying condition based on the narrow-de-**
 45 **defined study cohort**

46 Note: In the narrow-defined study cohort, only the pertussis-specific diagnosis code "A37.0 pertussis
 47 due to *Bordetella pertussis*" is included in the population definition. The broad-defined study cohort
 48 additionally considers the pertussis-nonspecific diagnosis code "A37.9 pertussis, unspecified."

49 **Table S5 Narrow definition, pertussis incidence (cases per 100,000) in persons with underlying condition per year**

Underlying condition	2016	2017	2018	2019
Total	8.3	9.6	6.7	6.4
No underlying condition	7.6	8.1	5.5	4.9
Any underlying condition	10.4	14.5	10.7	10.9
Asthma	14.0	14.6	17.1	15.2
Chronic obstructive pulmonary disease	15.9	12.7	NA	15.1
Osteoporosis	NA	NA	NA	17.3
Rheumatoid arthritis	NA	NA	NA	NA
Depression	12.5	17.3	12.1	16.5
Immunodeficiency	12.1	13.0	10.5	11.2
Heart failure	NA	NA	NA	NA
Chronic heart disease	15.7	10.5	7.9	9.1
Chronic kidney disease	18.5	NA	NA	NA
Type 2 diabetes	9.7	15.0	7.5	6.3
Type 1 diabetes	NA	NA	NA	NA

50 *NA insufficient sample sizes (n<8)*

51

52 **Table S6 Narrow definition, pertussis incidence (cases per 100,000) in persons with underlying condition (UC) per year**
 53 **and age group**

UC	2016			2017			2018			2019		
	18– 49	50– 59	60+	18– 49	50– 59	60+	18– 49	50– 59	60+	18– 49	50– 59	60+
Total	15.3	5.5	3.9	16.9	9.3	3.2	12.7	4.2	2.6	10.6	4.9	2.7
No UC	15.7	5.0	2.3	16.6	6.7	1.1	12.1	2.7	0.9	10.5	1.9	1.1
Any UC	13.9	7.3	9.7	17.9	18.0	10.0	14.7	9.2	8.3	11.2	14.9	8.1

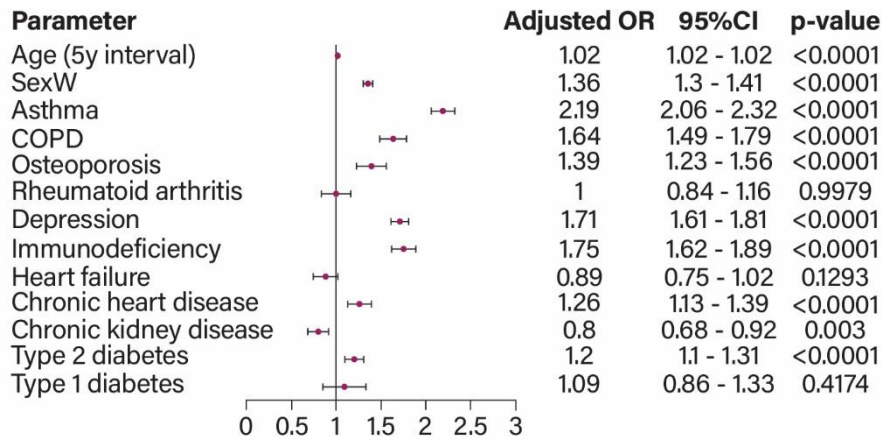
54 *UC underlying condition*

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57 **3.3 The risk of pertussis incidence in persons with underlying condition**

58 The model shown in Figure 1 checks for multicollinearity in multimorbid patients but does not disen-
 59 tangle the incremental effect of a multimorbid condition.



60

61 **Figure S1 Summary of a single logistic regression model, adjusting for age, sex and each prevalent underlying condition**
 62 **(UC), based on the broad pertussis definition. Study cohort: Rolling UC prevalence and pertussis incidence cohort, 2016–**
 63 **2019. 5y 5 years, COPD Chronic obstructive pulmonary disease, CI Confidence interval, OR Odds ratio, SexW female sex**

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66 **3.4 Pertussis-related complications**

67 **Table S4 Incidence (%) and absolute difference (percentage points) in the incidence in UC-cohorts experiencing pertussis-**
 68 **related severe complications in the sensitivity analysis where a complication can also occur in the quarter before and**
 69 **after the quarter of pertussis incidence**

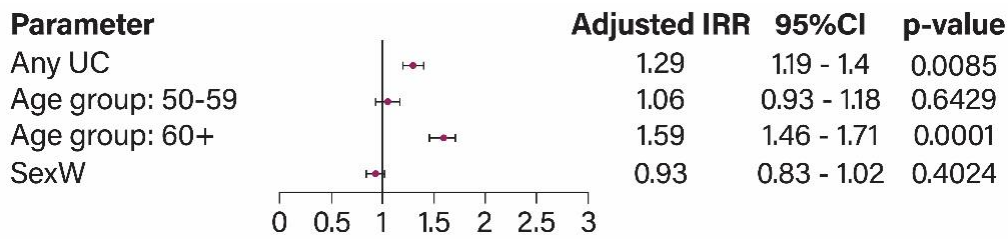
UC		Severe complications								Less severe complications	
		Overall		Hospitalization		Pneumonia		Rib fractures		Overall	
		%	Δ	%	Δ	%	Δ	%	Δ	%	Δ
Disregarded		16.1	-	13.1	-	5.0	-	0.8	-	9.4	-
Any	Yes	23.0	10.4	16.0	4.4	7.0	3.0	1.0	0.3	12.3	4.4
	No	12.5		11.5		3.9		0.7		7.9	
Asthma	Yes	20.4	4.6	15.6	2.8	6.3	1.5	NA	NA	17.5	8.8
	No	15.7		12.8		4.8		NA	NA	8.7	
COPD	Yes	27.5	11.9	18.6	5.7	10.2	5.4	NA	NA	19.8	10.7
	No	15.7		12.8		4.8		NA	NA	9.0	
Osteo	Yes	28.7	12.9	27.0	14.3	9.6	4.7	NA	NA	20.0	10.8
	No	15.8		12.7		4.9		NA	NA	9.2	
RA	Yes	24.7	8.7	16.9	3.9	NA	NA	NA	NA	13.0	3.6
	No	16.0		13.0		NA	NA	NA	NA	9.4	
Depr	Yes	23.9	9.0	15.4	2.7	6.1	1.3	NA	NA	11.3	2.1
	No	14.9		12.7		4.8		NA	NA	9.1	
Immun	Yes	23.5	8.2	14.8	2.0	7.3	2.6	NA	NA	13.6	4.7
	No	15.3		12.9		4.7		NA	NA	9.0	
HF	Yes	49.2	33.5	31.1	18.4	14.8	9.9	NA	NA	NA	NA
	No	15.7		12.8		4.8		NA	NA	NA	
CHD	Yes	30.7	15.1	20.2	7.5	9.8	5.0	NA	NA	14.7	5.5
	No	15.6		12.8		4.8		NA	NA	9.2	
CKD	Yes	37.7	21.9	16.9	3.9	11.7	6.8	NA	NA	16.9	7.6
	No	15.7		13.0		4.9		NA	NA	9.3	
DMT2	Yes	26.9	11.4	17.8	5.0	9.5	4.8	NA	NA	13.0	3.8
	No	15.5		12.8		4.7		NA	NA	9.2	
DMT1	Yes	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	No	NA		NA		NA		NA	NA	NA	

70 *CHD* Chronic heart disease; *CKD* Chronic kidney disease; *COPD* Chronic obstructive pulmonary disease; *Depr*
 71 *Depression*; *HF* Heart failure; *Immun* Immunodeficiency; *Osteo* Osteoporosis; *RA* Rheumatoid arthritis; *DMT1*
 72 *Type 1 diabetes mellitus*; *DMT2* *Type 2 diabetes mellitus*; *UC* Underlying condition
 73 *NA* Sample size too small ($n < 8$); Δ Absolute difference

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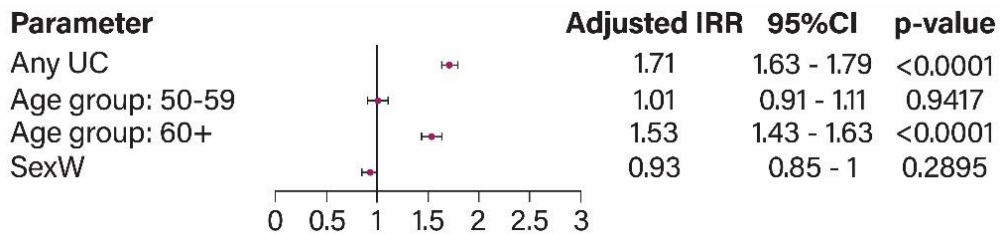
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78 **Figure S2** Incidence risk of pertussis-associated severe complications in persons with any UC, negative binomial model,
79 adjusting for age groups, sex and UC. Note: Age group 18–49 years, sex (male) and no UC are reference groups.

80 *UC* Underlying condition, *IRR* incidence rate ratio, *CI* confidence interval, *sexW* female sex

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83

84 **Figure S3** Incidence risk of persistent pertussis-associated severe complications in the sensitivity analysis in persons with
85 any UC, negative binomial model, adjusting for age groups, sex and UC. Note: Age group 18–49 years, sex (male) and no
86 UC are reference groups

87 *UC* Underlying condition, *IRR* incidence rate ratio, *CI* confidence interval, *sexW* female sex

88