

## Supplementary material

### Supplementary methods

**Table S1.** Inclusion and exclusion codes according to International Classification of Diseases for Oncology (3<sup>rd</sup> edition; <http://codes.iarc.fr/>)

**Table S2.** Association of missing versus available TNM stages with demographic, clinical and therapeutic parameters for pancreatic cancer patients in population-based registries estimated by multivariable logistic regression

**Table S3.** Demographic and clinical characteristics of resected stage I-II and III-IV pancreatic cancer patients in population-based registries

**Table S4.** Demographic and clinical characteristics of resected stage III and IV pancreatic cancer patients in population-based registries

**Table S5.** Association of surgical resection versus non-resection with demographic and clinical parameters for pancreatic cancer patients in population-based registries estimated by multivariable logistic regression after multiple imputations for missing TNM stages

**Table S6.** Association of resection versus non-resection with demographic and clinical variables for patients with cTNM stage I-II and III-IV pancreatic cancers in population-based registries estimated by multivariable logistic regression

**Table S7.** Association of resection versus non-resection with demographic and clinical variables for patients with cTNM stage III and IV pancreatic cancers in population-based registries estimated by multivariable logistic regression

**Table S8.** Association of surgical resection versus non-resection with tumour size, performance status, comorbidities, and hospital type in pancreatic cancer patients in population-based registries with available information estimated by multivariable logistic regression

### Supplementary results for the institution-based registries

**Table S9.** Demographic and clinical characteristics of overall pancreatic cancer patients in institution-based centres

**Table S10.** Demographic and clinical characteristics of resected pancreatic cancer patients in institution-based centres

**Table S11.** Association of surgical resection versus non-resection with demographic and clinical parameters for pancreatic cancer patients in large institution-based centres (> 500 cases) estimated by multivariable logistic regression

**Figure S1.** Stage-specific resection rates in population-based registries

**Figure S2.** Age standardized resection rates in the period 2012-2014 in institution-based registries

## Supplementary methods

### *Data quality*

The included registries generally follow international standards and classifications, and are controlled for quality using the International Agency for Research on Cancer (IARC) and International Association of Cancer Registries (IACR) rules. The data analysed are generally of high quality.

### *The Surveillance, Epidemiology, and End Results (SEER) Program*

The SEER Program of the National Cancer Institute (NCI) is an authoritative source of information on cancer epidemiology in the US, and collects data from population-based cancer registries. The SEER Program registries routinely collect data on patient demographics, primary tumour site, tumour morphology and stage at diagnosis, the first course of treatment, and follow-up for vital status. The SEER Program is the only comprehensive source of population-based information in the United States that includes stage of cancer at the time of diagnosis. SEER data are updated annually and provided as a public service. NCI staff work with the North American Association of Central Cancer Registries to guide all state registries to achieve data content and compatibility acceptable for pooling data and improving national estimates.

The SEER Program is viewed as the standard for quality among cancer registries around the world. Each SEER Program registry has a contractual obligation to meet specifically defined data quality goals on an ongoing basis. The SEER Program has also developed an extensive set of field edits that prevent and correct errors in the data. Electronic edits provide the means to authenticate codes, check for missing data, and check for interrelated data item errors. Collaborative efforts with national committees and national data standards contribute to high data quality.<sup>1</sup>

### *European population-based registries*

The European population-based cancer registries (CRs) included in the present paper participate in EUROCORE, whose criteria for inclusion and quality checks *etc.* have been extensively described<sup>2</sup>. The Netherlands CR (NCR)/Netherlands Comprehensive Cancer Organisation (IKNL) is a national organisation and is the quality institute for oncological research and practice. “The objective of IKNL is to serve the public interest by promoting the fight against cancer, particularly by helping those suffering from cancer.” NCR/IKNL supports this objective through the following four main processes: 1) Record: Information about every patient with cancer in the Netherlands is gathered in the NCR. 2) Report: The data in NCR are then reported in three domains: the public (science), political (the Ministry of Health, Welfare and Sport, the National Health Care Institute), and care domains (hospitals/care institutions, professionals, and patients). 3) Improve: The effect of all the improvement initiatives (*e.g.*, training) is evaluated in NCR/IKNL. IKNL responds to developments in the field by shifting its focus from a general to a tumour-specific approach to oncological care. 4) Regulate: Guidelines are deployed to improve quality and efficiency and to reduce unwanted variation in care.<sup>3</sup>

The Belgian CR is a population-based registry which has covered the entire country since 2004 and which relies on two major data sources: oncological care programs and pathology laboratories. It has a legal basis to use the national registration number which allows accurate linkage and follow-up. Detailed information about diagnostic and therapeutic procedures is obtained through linkage with administrative and clinical data bases for an active involvement in quality of care studies.

Records in the CR of Norway (CRN) are complete and nationwide, and CRN has since 1953 kept a complete registration of all new cases of malignancies. Regulated by the Norwegian law, medical practitioners are required to report cancerous and pre-cancerous lesions to the registry, and five sources of information are available: 1) copies of all pathology and autopsy reports from all laboratories in Norway, 2) registration forms filled in by clinicians providing the location and extent of disease and treatment, 3) copies of all death certificates that mention neoplastic disease, 4) hospital discharge data and outpatient diagnosis from all hospitals, and 5) radiotherapy data from all treating centres. The CRN has documented a high degree of data quality including key aspects such as comparability, completeness, and validity.<sup>4</sup>

The Danish data are based on the Danish national registries for pathology and treatment, which are well documented with a high data validity.<sup>5-8</sup> In Denmark, all hospitals are required to register diagnosis and treatment for every patient contact in the Danish National Patient Registry. All histological and cytological specimens are likewise required to be registered in the National Pathology Register. The Danish Civil Registry keeps track of the vital status of all Danes. The Danish Pancreatic Cancer Database gets data from all these three registers and combines the data. The combined data for each patient are validated by the relevant surgical and oncological department with regard to diagnosis and treatment. The completeness of clinical validation has been around 70%. The completeness regarding patients with a diagnosis of pancreatic cancer is close to 100%.

The quality and completeness indices of the CR of Slovenia (CRS) suggest that cancer registration in Slovenia adequately covers the entire population. To assure the completeness and to obtain additional information on registered cancer cases, CRS is linked with several governmental and health databases. Synchronisation of data between different sources is based on comparing unique personal identification number which is assigned to every resident in Slovenia and recorded in every state registry including CRS. Using unique personal identification number guarantees data integrity and quality, and prevents data duplication. CRS links with the Central Register of Population instantaneously through secure on-line connection (24/7 availability) and daily updates information on vital status and address for each person registered by CRS. The electronic linkage to the national Mortality Database is performed several times per year.<sup>9</sup> Data quality in Slovenia is also detailed in the Slovenian Cancer Registry (CR)'s annual report<sup>10</sup>.

In Estonia, overall completeness of reporting cancer cases has been estimated to be approximately 95-98%. The Estonian CR regularly performs data linkage with Estonian Causes of Death Registry. Additionally, the Estonian CR compares its database regularly with the databases of two biggest hospitals responsible for PaC surgical treatment for completeness assurance. Data are received on clinical and pathology notification forms. Data input and coding are done within registry. The registry has been using regularly the IARC Check Program for checking internal consistency of data. The data quality is evaluated using standard indicators for population-based registries.<sup>11</sup>

#### *Institution-based registries*

In Heidelberg, data were obtained by a study assistant in the clinics and then double-checked by a medical statistician. Furthermore, nearly all data have been re-checked in the past by residents and consultants when analysis for publications have been made. The REPCR performs quality controls of the data for each year of incidence, taking into account the various dates recorded in the register, the stage, the subsite, the kind of treatment, *etc.* through data crossing. In addition, in the cover area of REPCR, a Care Pathway for all patients with PaC has been created. The calculation of the 30 indicators for this Path allows for case-by-case checks for each year of incidence, and the cases are further controlled by individual professionals (radiologist, endoscopist, pathologist, surgeon, oncologist, *etc.*). The PanGenS data were obtained by reviewing thoroughly all the clinical records to collect detailed information on the clinical management of the patients (diagnosis and treatment), and by following-up the patients regarding outcomes. Quality controls imply consistency checks, for example in SQL databases. The Erlangen registry for pancreatic cancer (PaC) was established in 1978. The data are continuously checked for completeness and plausibility. International standards and classifications are applied. In IPOP, all registered cases are controlled for quality using the International Agency for Research on Cancer (IARC) rules, and validity and consistency are maintained through internal pre-defined algorithms. IPO-Porto has participated in several international studies including the European survival study EURO-CARE-5. In HPSG, data input is done by local institutional professionals, and data are checked centrally. There is a four-step quality control of the data: local administrative, local professional, central administrative, and central professional check. In INT, data are collected from the clinical, pathological and administrative documentation available; and by inspecting each patient's clinical records when necessary. All patients consecutively admitted to the INT for diagnosis and treatment of PaC are considered eligible for inclusion in the registry, regardless of the type of treatment. The INT PaC registry has been implemented on the prototype of the breast CR, whose inclusion criteria, methods of data collection, and checks for quality of data have been previously described<sup>12</sup>.

## References

1. Available from: <https://seer.cancer.gov/>. Accessed on October 9<sup>th</sup>, 2017.
2. Rossi S, Baili P, Capocaccia R, *et al.* The EURO CARE-5 study on cancer survival in Europe 1999-2007: Database, quality checks and statistical analysis methods. *Eur J Cancer* 2015;**51**(15):2104-19. doi: 10.1016/j.ejca.2015.08.001
3. Available from: <https://www.iknl.nl/over-iknl/about-iknl>. Accessed on October 9<sup>th</sup>, 2017.
4. Larsen IK, Smastuen M, Johannesen TB, *et al.* Data quality at the Cancer Registry of Norway: an overview of comparability, completeness, validity and timeliness. *Eur J Cancer* 2009;**45**(7):1218-31. doi: 10.1016/j.ejca.2008.10.037
5. Erichsen R, Lash TL, Hamilton-Dutoit SJ, *et al.* Existing data sources for clinical epidemiology: the Danish National Pathology Registry and Data Bank. *Clin Epidemiol* 2010;**2**:51-6.
6. Pedersen CB. The Danish Civil Registration System. *Scand J Public Health* 2011;**39**(7 Suppl):22-5. doi: 10.1177/1403494810387965
7. Schmidt M, Pedersen L, Sorensen HT. The Danish Civil Registration System as a tool in epidemiology. *Eur J Epidemiol* 2014;**29**(8):541-9. doi: 10.1007/s10654-014-9930-3
8. Schmidt M, Schmidt SA, Sandegaard JL, *et al.* The Danish National Patient Registry: a review of content, data quality, and research potential. *Clin Epidemiol* 2015;**7**:449-90. doi: 10.2147/clep.s91125
9. Zadnik V, Primic Zakelj M, Lokar K, *et al.* Cancer burden in slovenia with the time trends analysis. *Radiol Oncol* 2017;**51**(1):47-55. doi: 10.1515/raon-2017-0008
10. Available from: [https://www.onko-i.si/fileadmin/onko/datoteke/dokumenti/RRS/LP\\_2013.pdf](https://www.onko-i.si/fileadmin/onko/datoteke/dokumenti/RRS/LP_2013.pdf). Accessed on October 9<sup>th</sup>, 2017.
11. Innos K, Baburin A, Aareleid T. Cancer patient survival in Estonia 1995-2009: time trends and data quality. *Cancer Epidemiol* 2014;**38**(3):253-8. doi: 10.1016/j.canep.2014.03.008
12. Baili P, Torresani M, Agresti R, *et al.* A breast cancer clinical registry in an Italian comprehensive cancer center: an instrument for descriptive, clinical, and experimental research. *Tumori* 2015;**101**(4):440-6. doi: 10.5301/tj.5000341

**Table S1. Inclusion and exclusion codes according to International Classification of Diseases for Oncology (3<sup>rd</sup> edition; <http://codes.iarc.fr/>)**

Category		Code
<b>Topology</b>	Inclusion	C25.0 (head of pancreas), C25.1 (body of pancreas), C25.2 (tail of pancreas), C25.3 (pancreas duct), C25.7 (other specified parts of pancreas), C25.8 (overlapping lesion of pancreas), C25.9 (pancreas, NOS)
	Exclusion	C25.4
<b>Morphology</b>	Inclusion <sup>a</sup>	8000-8009 (unspecified neoplasms), 8010-8049 (epithelial neoplasms, NOS), 8050-8089 (squamous cell neoplasms), 8140-8389 (adenomas and adenocarcinomas), 8440-8499 (cystic, mucinous and serous neoplasms), 8500-8549 (ductal and lobular neoplasms), 8550-8559 (acinar cell neoplasms), 8560-8579 (complex epithelial neoplasms)
	Exclusion	8013, 8150-8153, 8155-8157, 8160, 8162, 8170, 8180, 8240-8243, 8246-8249, 8312, 8680, 8700, 8800-8802, 8810, 8825, 8830, 8851, 8852, 8858, 8890, 8891, 8900, 8920, 8936, 8982, 9043, 9100, 9120, 9250, 9364, 9473, 9500, 9591, 9673, 9680, 9687, 9691, 9695, 9702
<b>Behaviour</b>	Inclusion	3 (malignant tumour)
	Exclusion	0, 1, 2

<sup>a</sup>Based on Surveillance, Epidemiology, and End Results Program broad groupings.

NOS, not otherwise specified.

**Table S2. Association of missing versus available TNM stages with demographic, clinical and therapeutic parameters for pancreatic cancer patients in population-based registries estimated by multivariable logistic regression**

Parameter	The US (n = 96573)	The Netherlands (n = 22478)	Belgium (n = 12145)	Norway (n = 7686)	Denmark (n = 4086)	Slovenia (n = 3322)	Estonia (n = 1410)
	OR (95% CI) <sup>a</sup>	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
<b>Year of diagnosis</b>	<b>0.94</b> (0.94-0.95)	<b>0.89</b> (0.88-0.90)	<b>0.94</b> (0.93-0.95)	<b>1.02</b> (1.00-1.04)	<b>1.26</b> (1.20-1.32)	<b>0.97</b> (0.95-1.00)	<b>0.83</b> (0.77-0.90)
<b>Sex</b>							
Female	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Male	<b>0.91</b> (0.87-0.95)	1.04 (0.97-1.13)	1.01 (0.94-1.09)	1.06 (0.95-1.19)	1.06 (0.92-1.22)	0.89 (0.76-1.05)	0.79 (0.59-1.04)
<b>Age group</b>							
< 60 years	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
60-69 years	<b>1.20</b> (1.10-1.31)	<b>1.23</b> (1.08-1.39)	<b>0.84</b> (0.75-0.94)	1.15 (0.94-1.42)	1.10 (0.87-1.38)	1.10 (0.86-1.41)	0.95 (0.58-1.53)
70-79 years	<b>1.75</b> (1.62-1.90)	<b>1.71</b> (1.52-1.93)	<b>0.89</b> (0.80-0.99)	<b>1.41</b> (1.16-1.72)	<b>1.27</b> (1.01-1.59)	1.01 (0.80-1.27)	<b>1.57</b> (1.01-2.43)
≥ 80 years	<b>4.54</b> (4.22-4.89)	<b>2.49</b> (2.20-2.83)	0.93 (0.83-1.05)	<b>2.14</b> (1.77-2.60)	<b>1.90</b> (1.47-2.44)	<b>1.46</b> (1.14-1.87)	<b>3.61</b> (2.29-5.71)
<b>Tumour location</b>							
Pancreas head	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Pancreas body	<b>0.54</b> (0.48-0.60)	<b>0.46</b> (0.39-0.54)	<b>0.60</b> (0.50-0.71)	<b>0.57</b> (0.43-0.75)	1.09 (0.87-1.36)	<b>0.45</b> (0.32-0.64)	<b>0.62</b> (0.40-0.96)
Pancreas tail	<b>0.35</b> (0.30-0.39)	<b>0.24</b> (0.20-0.28)	<b>0.68</b> (0.59-0.79)	<b>0.38</b> (0.28-0.53)	0.88 (0.69-1.12)	<b>0.26</b> (0.18-0.38)	0.58 (0.33-1.00)
Other <sup>b</sup>	<b>4.13</b> (3.94-4.33)	<b>0.70</b> (0.63-0.78)	<b>1.39</b> (1.28-1.51)	0.89 (0.79-1.00)	<b>1.30</b> (1.09-1.54)	<b>0.52</b> (0.44-0.62)	1.03 (0.74-1.43)

<sup>a</sup>Odds ratios and 95% confidence intervals for missing versus available TNM stages were calculated using multivariable logistic regression models adjusting for year of diagnosis, sex, age group, and tumour location. ORs shown in bold are statistically significant.

<sup>b</sup>Other: pancreas duct, overlapping lesion, NOS, and other specified parts.

OR, odds ratio; CI, confidence interval; NA, not available; NE, not estimable.

**Table S3. Demographic and clinical characteristics of resected stage I-II and III-IV pancreatic cancer patients in population-based registries<sup>a</sup>**

Parameter	Stage I-II							Stage III-IV							
	Country	The US	Netherlands	Belgium	Norway	Denmark	Slovenia	Estonia	The US	Netherlands	Belgium	Norway	Denmark	Slovenia	Estonia
<b>n</b>		13303	2675	2155	526	635	406	159	1998	237	298	108	52	135	18
<b>Sex, female</b>		6604 (49.6)	1268 (47.4)	993 (46.1)	261 (49.6)	33.0 (52.0)	209 (51.5)	76 (47.8)	969 (48.5)	106 (44.7)	154 (51.9)	47 (43.5)	28 (53.9)	56 (41.5)	9 (50.0)
<b>Age [year]</b>		66 ± 11	65 ± 10	66 ± 10	65 ± 11	68 ± 9	65 ± 10	67 ± 10	65 ± 12	64 ± 10	64 ± 10	64 ± 10	64 ± 10	65 ± 10	66 ± 8
<b>Age group</b>															
< 60 years		3574 (26.9)	693 (25.9)	546 (25.3)	134 (25.5)	112 (17.6)	122 (30.1)	32 (20.1)	636 (31.8)	69 (29.1)	92 (30.9)	32 (29.6)	15 (28.9)	40 (29.6)	3 (16.7)
60-69 years		4272 (32.1)	978 (36.6)	698 (32.4)	195 (37.1)	239 (37.6)	131 (32.3)	60 (37.7)	622 (31.1)	96 (40.5)	103 (34.6)	43 (39.8)	19 (36.5)	45 (33.3)	8 (44.4)
70-79 years		4073 (30.6)	892 (33.4)	762 (35.4)	170 (32.3)	235 (37.0)	138 (34.0)	58 (36.5)	550 (27.5)	68 (28.7)	90 (30.2)	26 (24.1)	17 (32.7)	43 (31.9)	7 (38.9)
≥ 80 years		1384 (10.4)	112 (4.2)	149 (6.9)	27 (5.1)	49 (7.7)	15 (3.7)	9 (5.7)	190 (9.5)	4 (1.7)	13 (4.4)	7 (6.5)	1 (1.9)	7 (5.2)	0 (0.0)
<b>Tumour location<sup>b</sup></b>															
Pancreas head		9573 (80.4)	2187 (88.6)	1207 (79.6)	394 (83.3)	479 (85.4)	321 (87.2)	112 (79.4)	1069 (66.1)	166 (78.7)	126 (69.2)	57 (66.3)	42 (85.3)	80 (78.4)	12 (75.0)
Pancreas body		890 (7.5)	91 (3.7)	100 (7.3)	33 (7.4)	17 (3.0)	26 (7.1)	16 (11.4)	168 (10.4)	11 (5.2)	19 (10.4)	8 (9.3)	1 (3.1)	12 (11.8)	1 (6.3)
Pancreas tail		1448 (12.2)	191 (7.7)	169 (13.1)	41 (9.3)	65 (11.6)	21 (5.7)	13 (9.2)	381 (23.5)	34 (16.1)	37 (20.3)	21 (24.4)	5 (11.6)	10 (9.8)	3 (18.8)
Other		1392 (10.5)	206 (7.7)	679 (31.5)	58 (11.0)	74 (11.7)	38 (9.4)	18 (11.3)	380 (19.0)	26 (11.0)	116 (38.9)	22 (20.4)	4 (7.7)	33 (24.4)	2 (11.1)
<b>Neoadjuvant chemotherapy</b>		NA	50 (1.9)	53 (2.5)	NA	26 (4.1)	2 (0.5)	NA	NA	15 (6.3)	24 (8.1)	NA	2 (3.9)	0 (0.0)	NA
<b>Neoadjuvant radiotherapy</b>		522 (3.9)	34 (1.3)	20 (0.9)	NA	6 (0.9)	1 (0.3)	NA	139 (7.0)	5 (2.1)	9 (3.0)	NA	0 (0.0)	0 (0.0)	NA
<b>Resection type</b>															
Pancreatoduodenectomy		9479 (71.3)	2269 (84.8)	NA	NA	436 (68.7)	NA	NA	1140 (57.1)	178 (75.1)	NA	NA	37 (71.2)	NA	NA
Distal pancreatectomy		1878 (14.1)	256 (9.6)	NA	NA	82 (12.9)	NA	NA	295 (14.8)	39 (16.5)	NA	NA	7 (13.5)	NA	NA
Total pancreatectomy		1629 (12.3)	42 (1.6)	NA	NA	117 (18.4)	NA	NA	211 (10.6)	5 (2.1)	NA	NA	8 (15.4)	NA	NA
Other <sup>c</sup>		317 (2.4)	108 (4.0)	NA	NA	0 (0.0)	NA	NA	352 (17.6)	15 (6.3)	NA	NA	0 (0.0)	NA	NA
<b>Adjuvant chemotherapy</b>		NA	1078 (40.3)	1200 (55.7)	127 (24.1)	355 (55.9)	120 (29.6)	18 (11.3)	NA	81 (34.2)	195 (65.4)	25 (23.2)	28 (53.9)	39 (28.9)	4 (22.2)
<b>Adjuvant radiotherapy</b>		4193 (31.5)	33 (1.2)	190 (8.8)	17 (3.2)	1 (0.2)	8 (2.0)	11 (6.9)	383 (19.2)	7 (3.0)	35 (11.7)	4 (3.7)	0 (0.0)	5 (3.7)	1 (5.6)

<sup>a</sup>Enumeration data are shown as count (percentage [%]), and measurement data as mean ± standard deviation. Records are complete otherwise specified below.

<sup>b</sup>The percentages of pancreas head, body, and tail are the proportions compared to the total tumour cases of pancreas head, body, and tail; other: pancreas duct, overlapping lesion, NOS, and other specified parts.

<sup>c</sup>Pancreatectomy (NOS) and local resection.

SEER, Surveillance, Epidemiology, and End Results Program; NCR, Netherlands Cancer Registry; BCR, Belgian Cancer Registry; CRN, Cancer Registry of Norway; DPCD, Danish Pancreatic Cancer Database; CRS, Cancer Registry of Slovenia; NOS, not otherwise specified; NA, not available.

**Table S4. Demographic and clinical characteristics of resected stage III and IV pancreatic cancer patients in population-based registries<sup>a</sup>**

Parameter	Stage III							Stage IV						
	Country	The US	Netherlands	Belgium	Norway	Denmark	Slovenia	Estonia	The US	Netherlands	Belgium	Norway	Denmark	Slovenia
<b>n</b>		767	148	146	30	37	46	11	1231	89	152	78	15	89
<b>Sex, female</b>		364 (47.5)	65 (43.9)	73 (50.0)	13 (43.3)	19 (51.4)	21 (45.7)	7 (63.6)	605 (49.2)	41 (46.1)	81 (53.3)	34 (43.6)	9 (60.0)	35 (39.3)
<b>Age [year]</b>		65 ± 11	65 ± 10	64 ± 10	66 ± 7	66 ± 9	63 ± 11	66 ± 9	65 ± 12	63 ± 9	64 ± 10	64 ± 11	61 ± 11	66 ± 10
<b>Age group</b>														
< 60 years		229 (29.9)	40 (27.0)	50 (34.3)	5 (16.7)	8 (21.6)	16 (34.8)	2 (18.2)	407 (33.1)	29 (32.6)	42 (27.6)	27 (34.6)	7 (46.7)	24 (27.0)
60-69 years		262 (34.2)	58 (39.2)	43 (29.5)	16 (53.3)	15 (40.5)	13 (28.3)	4 (36.4)	360 (29.2)	38 (42.7)	60 (39.5)	27 (34.6)	4 (26.7)	32 (36.0)
70-79 years		215 (28.0)	46 (31.1)	48 (32.9)	8 (26.7)	13 (35.1)	16 (34.8)	5 (45.5)	335 (27.2)	22 (24.7)	42 (27.6)	18 (23.1)	4 (26.7)	27 (30.3)
≥ 80 years		61 (8.0)	4 (2.7)	5 (3.4)	1 (3.3)	1 (2.7)	1 (2.2)	0 (0.0)	129 (10.5)	0 (0.0)	8 (5.3)	6 (7.7)	0 (0.0)	6 (6.7)
<b>Tumour location<sup>b</sup></b>														
Pancreas head		487 (75.4)	112 (84.8)	70 (76.1)	21 (84.0)	32 (94.1)	33 (82.5)	8 (80.0)	582 (59.9)	54 (68.4)	56 (62.2)	36 (59.0)	10 (71.4)	47 (75.8)
Pancreas body		68 (10.5)	4 (3.0)	11 (12.0)	2 (8.0)	0 (0.0)	4 (10.0)	0 (0.0)	100 (10.3)	7 (8.9)	8 (8.9)	6 (9.8)	1 (7.1)	8 (12.9)
Pancreas tail		91 (14.1)	16 (12.1)	11 (12.0)	2 (8.0)	2 (5.9)	3 (7.5)	2 (20.0)	290 (29.8)	18 (22.8)	26 (28.9)	19 (31.1)	3 (21.4)	7 (11.3)
Other		121 (15.8)	16 (10.8)	54 (37.0)	5 (16.7)	3 (8.1)	6 (13.0)	1 (9.1)	259 (21.0)	10 (11.2)	62 (40.8)	17 (21.8)	1 (6.7)	27 (30.3)
<b>Neoadjuvant chemotherapy</b>		NA	12 (8.1)	17 (11.6)	NA	2 (5.4)	0 (0.0)	NA	NA	3 (3.4)	7 (4.6)	NA	0 (0.0)	0 (0.0)
<b>Neoadjuvant radiotherapy</b>		116 (15.1)	5 (3.4)	8 (5.5)	NA	0 (0.0)	0 (0.0)	NA	23 (1.9)	0 (0.0)	1 (0.7)	NA	0 (0.0)	0 (0.0)
<b>Resection type</b>														
Pancreatoduodenectomy		513 (66.9)	119 (80.4)	NA	NA	28 (75.7)	NA	NA	627 (50.9)	59 (66.3)	NA	NA	9 (60.0)	NA
Distal pancreatectomy		82 (10.7)	18 (12.2)	NA	NA	3 (8.1)	NA	NA	213 (17.3)	21 (23.6)	NA	NA	4 (26.7)	NA
Total pancreatectomy		93 (12.1)	2 (1.4)	NA	NA	6 (16.2)	NA	NA	118 (9.6)	3 (3.4)	NA	NA	2 (13.3)	NA
Other <sup>c</sup>		79 (10.3)	9 (6.1)	NA	NA	0 (0.0)	NA	NA	273 (22.2)	6 (6.7)	NA	NA	0 (0.0)	NA
<b>Adjuvant chemotherapy</b>		NA	59 (39.9)	96 (65.8)	7 (23.3)	18 (48.7)	13 (28.3)	1 (9.1)	NA	22 (24.7)	99 (65.1)	18 (23.1)	10 (66.7)	26 (29.2)
<b>Adjuvant radiotherapy</b>		257 (33.5)	6 (4.1)	28 (19.2)	1 (3.3)	0 (0.0)	3 (6.5)	1 (9.1)	126 (10.2)	1 (1.1)	7 (4.6)	3 (3.9)	0 (0.0)	2 (2.3)

<sup>a</sup>Enumeration data are shown as count (percentage [%]), and measurement data as mean ± standard deviation. Results for stage IV cancers in Estonia are not presented due to limited case number (n = 7). Records are complete otherwise specified below.

<sup>b</sup>The percentages of pancreas head, body, and tail are the proportions compared to the total tumour cases of pancreas head, body, and tail; other: pancreas duct, overlapping lesion, NOS, and other specified parts.

<sup>c</sup>Pancreatectomy (NOS) and local resection.

SEER, Surveillance, Epidemiology, and End Results Program; NCR, Netherlands Cancer Registry; BCR, Belgian Cancer Registry; CRN, Cancer Registry of Norway; DPCD, Danish Pancreatic Cancer Database; CRS, Cancer Registry of Slovenia; NOS, not otherwise specified; NA, not available.



**Table S5. Association of surgical resection versus non-resection with demographic and clinical parameters for pancreatic cancer patients in population-based registries estimated by multivariable logistic regression after multiple imputations for missing TNM stages<sup>a</sup>**

Parameter	The US (n = 96573)	The Netherlands (n = 22478)	Norway (n = 7686)	Denmark (n = 4086)	Slovenia (n = 3322)	Estonia (n = 1410)
	OR (95% CI) <sup>b</sup>	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
<b>Year of diagnosis</b>	<b>1.01</b> (1.01-1.02)	<b>1.15</b> (1.13-1.17)	1.00 (0.97-1.03)	<b>1.12</b> (1.01-1.24)	<b>1.07</b> (1.03-1.12)	1.02 (0.90-1.17)
<b>Sex</b>						
Female	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Male	0.98 (0.94-1.02)	1.08 (0.97-1.21)	1.18 (0.98-1.41)	1.08 (0.81-1.44)	0.91 (0.71-1.15)	1.11 (0.70-1.76)
<b>Age group</b>						
< 60 years	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
60-69 years	<b>0.83</b> (0.78-0.88)	<b>0.73</b> (0.63-0.85)	<b>0.75</b> (0.58-0.97)	0.69 (0.44-1.08)	0.82 (0.60-1.12)	1.14 (0.58-2.21)
70-79 years	<b>0.57</b> (0.54-0.60)	<b>0.34</b> (0.29-0.40)	<b>0.43</b> (0.33-0.55)	<b>0.50</b> (0.32-0.79)	<b>0.40</b> (0.29-0.54)	0.60 (0.32-1.14)
≥ 80 years	<b>0.15</b> (0.14-0.16)	<b>0.03</b> (0.03-0.04)	<b>0.06</b> (0.04-0.08)	<b>0.15</b> (0.09-0.25)	<b>0.04</b> (0.03-0.07)	<b>0.06</b> (0.02-0.15)
<b>Tumour location</b>						
Pancreas head	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Pancreas body	<b>0.66</b> (0.61-0.72)	<b>0.47</b> (0.37-0.61)	<b>0.53</b> (0.38-0.76)	<b>0.20</b> (0.11-0.36)	0.68 (0.44-1.07)	0.91 (0.43-1.93)
Pancreas tail	<b>2.04</b> (1.90-2.19)	<b>1.44</b> (1.16-1.80)	<b>1.62</b> (1.14-2.30)	1.73 (0.97-3.06)	0.63 (0.39-1.00)	<b>2.70</b> (1.10-6.67)
Other <sup>c</sup>	<b>0.67</b> (0.63-0.71)	<b>0.78</b> (0.64-0.94)	<b>0.16</b> (0.13-0.20)	<b>0.25</b> (0.18-0.36)	<b>0.35</b> (0.26-0.46)	0.69 (0.35-1.34)
<b>Imputed TNM stage<sup>d</sup></b>						
I-II	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
III	<b>0.12</b> (0.11-0.13)	<b>0.04</b> (0.03-0.05)	<b>0.08</b> (0.06-0.12)	<b>0.03</b> (0.02-0.04)	<b>0.14</b> (0.10-0.20)	<b>0.05</b> (0.02-0.09)
IV	<b>0.03</b> (0.03-0.03)	<b>0.01</b> (< 0.01-0.01)	<b>0.02</b> (0.02-0.03)	NE	<b>0.04</b> (0.03-0.05)	<b>&lt;0.01</b> (<0.01-0.01)

<sup>a</sup>Variables applied in imputation of missing cTNM stages were: year of diagnosis, sex, age, tumour location, resection, chemotherapy, radiotherapy, and survival status and time.

<sup>b</sup>Odds ratios and 95% confidence intervals for surgical resection versus non-resection were calculated using multivariable logistic regression models adjusting for year of diagnosis, sex, age group, tumour location, and cTNM stage. Multiple imputation was not performed for Belgium due to >30% missing TNM stages. ORs shown in bold are statistically significant.

<sup>c</sup>Other: pancreas duct, overlapping lesion, NOS, and other specified parts.

<sup>d</sup>For the US, Norway, and Estonia, TNM stage is a combination of clinical and pathological stages.

OR, odds ratio; CI, confidence interval; NE, not estimable due to small case number.

**Table S6. Association of resection versus non-resection with demographic and clinical variables for patients with cTNM stage I-II and III-IV pancreatic cancers in population-based registries estimated by multivariable logistic regression**

Variable	Value	The US	The Netherlands	Belgium	Norway	Denmark	Slovenia	Estonia
		OR (95% CI) <sup>a</sup>	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
<i>cTNM stage I-II<sup>b</sup></i>		n <sup>c</sup> = 31313	n = 5184	n = 2123	n = 1545	n = 801	n = 457	n = 283
<b>Year of diagnosis</b>		<b>1.02</b> (1.01-1.03)	<b>1.17</b> (1.15-1.19)	<b>1.04</b> (1.00-1.07)	0.98 (0.95-1.02)	<b>1.18</b> (1.05-1.32)	1.00 (0.92-1.07)	1.04 (0.89-1.23)
<b>Sex</b>	Female	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Male	1.00 (0.95-1.05)	1.03 (0.90-1.17)	1.12 (0.93-1.36)	1.16 (0.90-1.50)	1.09 (0.78-1.51)	0.72 (0.45-1.15)	0.97 (0.57-1.67)
<b>Age group</b>	< 60 years	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
	60-69 years	<b>0.85</b> (0.80-0.91)	<b>0.74</b> (0.61-0.90)	<b>0.74</b> (0.56-0.99)	0.84 (0.58-1.21)	0.79 (0.46-1.35)	0.74 (0.37-1.47)	0.99 (0.44-2.24)
	70-79 years	<b>0.57</b> (0.53-0.60)	<b>0.35</b> (0.29-0.41)	<b>0.43</b> (0.33-0.56)	<b>0.44</b> (0.31-0.63)	0.68 (0.40-1.14)	<b>0.29</b> (0.15-0.54)	0.51 (0.23-1.12)
	≥ 80 years	<b>0.14</b> (0.13-0.15)	<b>0.03</b> (0.02-0.04)	<b>0.08</b> (0.06-0.12)	<b>0.05</b> (0.03-0.07)	<b>0.16</b> (0.09-0.30)	<b>0.01</b> (< 0.01-0.04)	<b>0.07</b> (0.03-0.20)
<b>Tumour location</b>	Pancreas head	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Pancreas body	<b>0.72</b> (0.66-0.79)	<b>0.52</b> (0.39-0.71)	<b>0.57</b> (0.38-0.86)	<b>0.56</b> (0.34-0.91)	<b>0.24</b> (0.12-0.49)	1.44 (0.51-4.13)	1.52 (0.59-3.94)
	Pancreas tail	<b>2.79</b> (2.52-3.08)	<b>1.62</b> (1.22-2.16)	1.17 (0.78-1.74)	<b>2.47</b> (1.31-4.66)	<b>2.65</b> (1.21-5.77)	0.58 (0.20-1.69)	NE
	Other <sup>d</sup>	<b>0.70</b> (0.65-0.75)	<b>0.58</b> (0.46-0.74)	<b>0.46</b> (0.37-0.57)	<b>0.14</b> (0.10-0.19)	<b>0.54</b> (0.35-0.85)	<b>0.22</b> (0.12-0.39)	0.69 (0.32-1.50)
<i>cTNM stage III-IV<sup>b</sup></i>		n = 55153	n = 13930	n = 5153	n = 4633	n = 2204	n = 1978	n = 839
<b>Year of diagnosis</b>		0.99 (0.97-1.01)	<b>1.06</b> (1.01-1.11)	<b>0.93</b> (0.88-0.98)	0.97 (0.92-1.03)	1.07 (0.88-1.30)	<b>1.07</b> (1.00-1.14)	0.99 (0.76-1.30)
<b>Sex</b>	Female	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Male	<b>0.89</b> (0.81-0.97)	0.92 (0.69-1.22)	0.85 (0.61-1.18)	1.20 (0.81-1.78)	1.18 (0.67-2.09)	1.18 (0.80-1.74)	1.16 (0.45-2.99)
<b>Age group</b>	< 60 years	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
	60-69 years	<b>0.81</b> (0.73-0.91)	0.73 (0.52-1.03)	0.70 (0.46-1.04)	0.80 (0.50-1.28)	0.84 (0.41-1.74)	0.78 (0.48-1.25)	1.87 (0.48-7.26)
	70-79 years	<b>0.69</b> (0.61-0.78)	<b>0.52</b> (0.36-0.75)	<b>0.49</b> (0.32-0.74)	<b>0.43</b> (0.26-0.74)	0.48 (0.22-1.07)	<b>0.56</b> (0.34-0.90)	1.20 (0.30-4.77)
	≥ 80 years	<b>0.31</b> (0.26-0.36)	<b>0.02</b> (< 0.01-0.14)	<b>0.10</b> (0.04-0.25)	<b>0.13</b> (0.06-0.30)	<b>0.27</b> (0.08-0.98)	<b>0.24</b> (0.11-0.50)	NE
<b>Tumour location</b>	Pancreas head	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Pancreas body	<b>0.41</b> (0.35-0.48)	<b>0.37</b> (0.21-0.66)	0.60 (0.33-1.08)	<b>0.45</b> (0.21-0.95)	<b>0.08</b> (0.01-0.60)	0.65 (0.35-1.21)	0.17 (0.02-1.33)
	Pancreas tail	<b>0.83</b> (0.74-0.94)	<b>0.63</b> (0.42-0.94)	<b>0.53</b> (0.30-0.91)	1.08 (0.64-1.83)	0.58 (0.24-1.40)	<b>0.35</b> (0.18-0.70)	0.78 (0.22-2.84)
	Other <sup>d</sup>	<b>0.44</b> (0.39-0.50)	<b>0.61</b> (0.39-0.95)	<b>0.36</b> (0.25-0.53)	<b>0.16</b> (0.10-0.27)	<b>0.37</b> (0.16-0.83)	<b>0.26</b> (0.17-0.41)	0.28 (0.06-1.29)

<sup>a</sup>Odds ratios and 95% confidence intervals for surgical resection versus non-resection were calculated using multivariable logistic regression models adjusting for year of diagnosis, sex, age group, and tumour location. ORs shown in bold are statistically significant.

<sup>b</sup>For the US, Norway, and Estonia, TNM stage is a combination of clinical and pathological stages.

<sup>c</sup>Indicate numbers of cases available for analyses.

<sup>d</sup>Other: pancreas duct, overlapping lesion, NOS, and other specified parts.

OR, odds ratio; CI, confidence interval; NE, not estimable due to small case number.

**Table S7. Association of resection versus non-resection with demographic and clinical variables for patients with cTNM stage III and IV pancreatic cancers in population-based registries estimated by multivariable logistic regression**

Variable	Value	The US	The Netherlands	Belgium	Norway	Denmark	Slovenia
		OR (95% CI) <sup>a</sup>	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
<b>cTNM stage III<sup>b</sup></b>		n <sup>c</sup> = 8033	n = 1937	n = 936	n = 395	n = 419	n = 205
<b>Year of diagnosis</b>		<b>1.03</b> (1.00-1.06)	<b>1.09</b> (1.02-1.16)	0.95 (0.88-1.04)	0.90 (0.80-1.02)	1.03 (0.84-1.27)	<b>1.22</b> (1.05-1.41)
<b>Sex</b>	Female	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Male	1.01 (0.87-1.17)	1.17 (0.80-1.72)	1.11 (0.70-1.75)	1.73 (0.78-3.85)	1.18 (0.64-2.18)	1.25 (0.56-2.79)
<b>Age group</b>	< 60 years	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
	60-69 years	0.93 (0.77-1.13)	0.79 (0.50-1.26)	0.76 (0.43-1.36)	1.87 (0.63-5.61)	0.56 (0.25-1.26)	0.41 (0.14-1.20)
	70-79 years	<b>0.76</b> (0.62-0.92)	0.73 (0.45-1.17)	<b>0.44</b> (0.24-0.81)	0.67 (0.20-2.23)	<b>0.31</b> (0.13-0.75)	0.69 (0.27-1.77)
	≥ 80 years	<b>0.32</b> (0.24-0.43)	<b>0.07</b> (0.01-0.49)	<b>0.10</b> (0.03-0.34)	<b>0.11</b> (0.01-0.96)	<b>0.16</b> (0.04-0.60)	0.22 (0.04-1.13)
<b>Tumour location</b>	Pancreas head	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
	Pancreas body	<b>0.44</b> (0.38-0.57)	<b>0.36</b> (0.16-0.78)	1.06 (0.51-2.17)	0.28 (0.06-1.27)	<b>0.10</b> (0.01-0.74)	0.54 (0.17-1.77)
	Pancreas tail	<b>2.28</b> (1.77-2.93)	<b>2.18</b> (1.16-4.10)	1.07 (0.35-3.25)	1.57 (0.29-8.64)	2.16 (0.79-5.93)	1.74 (0.21-14.41)
	Other <sup>d</sup>	<b>0.58</b> (0.47-0.72)	0.98 (0.54-1.77)	<b>0.54</b> (0.32-0.92)	<b>0.19</b> (0.07-0.54)	0.80 (0.33-1.95)	<b>0.16</b> (0.05-0.58)
<b>cTNM stage IV<sup>b</sup></b>		n = 47120	n = 11993	n = 4217	n = 4238	-	n = 1773
<b>Year of diagnosis</b>		<b>0.97</b> (0.95-0.99)	0.99 (0.93-1.06)	0.93 (0.85-1.01)	0.99 (0.92-1.06)	-	1.06 (0.98-1.14)
<b>Sex</b>	Female	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	-	1.00 (reference)
	Male	<b>0.85</b> (0.76-0.95)	0.81 (0.51-1.26)	0.76 (0.46-1.24)	1.16 (0.73-1.83)	-	1.24 (0.78-1.95)
<b>Age group</b>	< 60 years	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	-	1.00 (reference)
	60-69 years	<b>0.74</b> (0.64-0.86)	0.77 (0.46-1.28)	0.58 (0.31-1.06)	0.59 (0.34-1.03)	-	1.01 (0.57-1.76)
	70-79 years	<b>0.65</b> (0.56-0.76)	<b>0.36</b> (0.19-0.66)	<b>0.47</b> (0.25-0.86)	<b>0.37</b> (0.20-0.68)	-	0.58 (0.32-1.05)
	≥ 80 years	<b>0.31</b> (0.26-0.38)	NE	<b>0.08</b> (0.02-0.35)	<b>0.13</b> (0.05-0.33)	-	<b>0.28</b> (0.12-0.69)
<b>Tumour location</b>	Pancreas head	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)	-	1.00 (reference)
	Pancreas body	<b>0.43</b> (0.35-0.54)	0.50 (0.21-1.19)	0.30 (0.09-1.01)	0.54 (0.22-1.29)	-	0.73 (0.34-1.54)
	Pancreas tail	0.98 (0.85-1.13)	0.92 (0.53-1.61)	0.81 (0.40-1.61)	1.38 (0.78-2.46)	-	<b>0.39</b> (0.18-0.86)
	Other <sup>d</sup>	<b>0.50</b> (0.43-0.57)	0.68 (0.34-1.35)	<b>0.39</b> (0.22-0.69)	<b>0.19</b> (0.10-0.33)	-	<b>0.35</b> (0.21-0.57)

<sup>a</sup>Odds ratios and 95% confidence intervals for surgical resection versus non-resection were calculated using multivariable logistic regression models adjusting for year of diagnosis, sex, age group, and tumour location. For subgroups with resected cases <30 (stage IV in Denmark, 15; stage III in Estonia, 11; stage IV in Estonia, 7), results are not shown due to insufficient statistical power. ORs shown in bold are statistically significant.

<sup>b</sup>For the US, Norway, and Estonia, TNM stage is a combination of clinical and pathological stages.

<sup>c</sup>Indicate numbers of cases available for analyses.

<sup>d</sup>Other: pancreas duct, overlapping lesion, NOS, and other specified parts.

OR, odds ratio; CI, confidence interval; NE, not estimable due to small case number.

**Table S8. Association of surgical resection versus non-resection with tumour size, performance status, comorbidities, and hospital type in pancreatic cancer patients in population-based registries with available information estimated by multivariable logistic regression**

Variable	Category	The US		The Netherlands		Belgium		Denmark	
		n	OR (95% CI) <sup>a</sup>	n	OR (95% CI)	n	OR (95% CI)	n	OR (95% CI)
<b>Tumour size</b>	< 20 mm	4648	1.00 (reference)	NA	NA	NA	NA	NA	NA
	20-29 mm	13350	<b>0.70</b> (0.64-0.76)	NA	NA	NA	NA	NA	NA
	30-39 mm	17743	<b>0.56</b> (0.51-0.61)	NA	NA	NA	NA	NA	NA
	40-49 mm	13855	<b>0.48</b> (0.43-0.52)	NA	NA	NA	NA	NA	NA
	≥ 50 mm	18386	<b>0.49</b> (0.45-0.54)	NA	NA	NA	NA	NA	NA
<b>ECOG score</b>	0	NA	NA	NA	NA	756	1.00 (reference)	609	1.00 (reference)
	1	NA	NA	NA	NA	5162	<b>0.63</b> (0.49-0.82)	939	<b>0.57</b> (0.37-0.89)
	2	NA	NA	NA	NA	1246	<b>0.36</b> (0.26-0.52)	523	<b>0.25</b> (0.14-0.45)
	3	NA	NA	NA	NA	445	<b>0.16</b> (0.07-0.36)	294	<b>0.18</b> (0.09-0.36)
	4	NA	NA	NA	NA	146	<b>0.06</b> (0.01-0.47)	70	<b>0.17</b> (0.04-0.71)
<b>Comorbidity<sup>b</sup></b>	Cardiac disease	NA	NA	757	<b>0.59</b> (0.41-0.87)	NA	NA	NA	NA
	Vascular disease	NA	NA	530	<b>0.59</b> (0.38-0.91)	NA	NA	NA	NA
	Hypertension	NA	NA	935	0.99 (0.71-1.38)	NA	NA	NA	NA
	Neurological disease	NA	NA	174	<b>0.47</b> (0.23-0.97)	NA	NA	NA	NA
	Diabetes	NA	NA	832	0.95 (0.69-1.33)	NA	NA	NA	NA
	Pulmonary disease	NA	NA	335	<b>0.59</b> (0.35-0.99)	NA	NA	NA	NA
<b>Comorbidity number</b>	0	NA	NA	1332	1.00 (reference)	NA	NA	NA	NA
	1	NA	NA	1122	0.91 (0.63-1.32)	NA	NA	NA	NA
	≥ 2	NA	NA	1591	<b>0.60</b> (0.41-0.87)	NA	NA	NA	NA
<b>Hospital type</b>	Non-academic	NA	NA	17866	1.00 (reference)	7004	1.00 (reference)	NA	NA
	Academic	NA	NA	4612	<b>2.81</b> (2.46-3.20)	4767	<b>2.13</b> (1.80-2.52)	NA	NA

<sup>a</sup>Odds ratios and 95% confidence intervals for surgical resection versus non-resection were calculated using multivariable logistic regression models adjusting for year of diagnosis, sex, age group, tumour location, and cTNM stage, with the respective variable added in the models. Results for each new model revealed consistent patterns in associations of resection with sex, age group, tumour location, and stage compared to the main analyses. ORs shown in bold are statistically significant.

<sup>b</sup>In the Netherlands, comorbidity information at diagnosis was available in the Eindhoven Cancer Registry. Patients without the respective comorbidities were referenced.

HR, hazard ratio; CI, confidence interval; ECOG, Eastern Collaborative Oncology Group; NA, not available.

## **Supplementary results**

Data from nine institution-based (Heidelberg, Reggio Emilia Pancreatic Cancer Registry (REPCR), Spanish arm of PanGenEU (PanGenS), Erlangen Cancer Registry (ErCR), Portuguese Oncology Institute of Porto (IPOP), Hungarian Pancreatic Study Group (HPSG), Jules Bordet Institute (IJB), Istituto Nazionale dei Tumori (INT) in Milan, and Netherlands Cancer Institute (NKI) in Amsterdam) registries from 7 European countries were additionally explored. The included centres are among the leading cancer centres in the respective countries. Large institution-based datasets with  $\geq 500$  records were included in the association analyses. The cut-off value 500 was chosen as stratified results in registries with smaller case numbers were mostly unavailable or with very limited statistical power.

### ***Demographic and clinical characteristics***

A total of 6,168 patients from 9 European institution-based registries were included. Mean ages were 63-73 years. Female proportions were 44.0%-53.3%. Most patients had head tumours (57.5%-87.0%), and metastatic diseases were most commonly diagnosed (36.6%-78.8%). (**Table S9**)

Mean ages of resected patients were mostly younger (63-69 years), and most had stage I-II tumours (54.7%-97.2%). Neoadjuvant chemotherapy (0.0%-12.2%; except in ErCR and INT) and radiotherapy (0.0%-5.5%; except in ErCR) were rarely administered. Pancreatoduodenectomy was the most common surgical approach in registries with available information (37.4%-74.6%). Adjuvant chemotherapy utilization varied strongly with proportions between 21.9% (HPSG) and 68.3% (IJB). Proportions of adjuvant radiotherapy ranged from 5.1% (Heidelberg) to 48.8% (IJB). (**Table S10**)

### ***Resection rates***

As shown in **Figure S2**, in the period 2012-2014, variations in resection were strong across European institutions with resection rates ranging from 9.4% (NKI) to 52.6% (Heidelberg) overall, and were even stronger for the subgroup of stage I-II tumours, where the proportions of resected patients ranged from 19.7% (IJB) to 96.9% (Heidelberg).

### ***Association of resection with demographic and clinical parameters***

Associations of resection with sex, age, tumour location, and stage in large institution-based datasets are shown in **Table S11**, where the corresponding 95% confidence intervals (CIs) for the OR estimates are detailed. While resection was not significantly associated with sex, it was less frequently conducted with increasing age and cTNM stage. Specifically, compared to patients  $<60$  years, odds ratios (ORs) for resection among patients aged 70-79 and  $\geq 80$  years were 0.44-0.65 and 0.08-0.46 across registries (except ErCR), respectively. Compared to stage I-II tumours, ORs of stages III and IV cancers were 0.01-0.35 and 0.01-0.22, respectively. In PanGenS, tail tumours were significantly more often resected than head cancers (OR=2.66), while no significant differences were observed in Heidelberg or ErCR. In REPCR, even an opposite pattern was seen (OR=0.52).

**Table S9. Demographic and clinical characteristics of overall pancreatic cancer patients in institution-based centres<sup>a</sup>**

Parameter	Heidelberg	REPCR	PanGenS	ErCR	IPOP	HPSG	IJB	INT	NKI
<b>Country</b>	Germany	Italy	Spain	Germany	Portugal	Hungary	Belgium	Italy	Netherlands
<b>Incidence period</b>	2009-2016	2008-2015	2007-2013	2003-2015	2012-2014	2006-2015	2003-2014	2012-2016	2003-2015
<b>n</b>	2758	978	741	533	323	291	238	170	136
<b>Sex, female</b>	1216 (44.1)	480 (49.1)	334 (45.1)	248 (46.5)	142 (44.0)	155 (53.3)	113 (47.5)	80 (47.1)	64 (47.1)
<b>Age [year]</b>	64 ± 11	73 ± 11	67 ± 12	67 ± 10	68 ± 11	67 ± 11	64 ± 11	65 ± 12	63 ± 12
<b>Age group</b>									
< 60 years	889 (32.2)	109 (11.2)	197 (26.6)	110 (20.6)	67 (20.7)	67 (23.0)	75 (31.5)	53 (31.2)	44 (32.4)
60-69 years	939 (34.1)	202 (20.7)	230 (31.0)	199 (37.3)	95 (29.4)	103 (35.4)	87 (36.6)	46 (27.1)	46 (33.8)
70-79 years	809 (29.3)	348 (35.6)	216 (29.2)	187 (35.1)	117 (36.2)	88 (30.2)	60 (25.2)	62 (36.5)	37 (27.2)
≥ 80 years	121 (4.4)	319 (32.6)	98 (13.2)	37 (6.9)	44 (13.6)	33 (11.3)	16 (6.7)	9 (5.3)	9 (6.6)
<b>Tumour location<sup>b</sup></b>									
Pancreas head	1553 (72.3)	587 (74.1)	454 (69.8)	378 (75.1)	139 (57.5)	242 (87.0)	91 (62.4)	59 (60.8)	63 (61.2)
Pancreas body	289 (13.4)	107 (13.5)	113 (17.4)	64 (12.7)	56 (23.1)	20 (7.2)	25 (17.1)	23 (23.7)	20 (19.4)
Pancreas tail	307 (14.3)	98 (12.4)	83 (12.8)	61 (12.1)	47 (19.4)	16 (5.8)	30 (20.5)	15 (15.5)	20 (19.4)
Other	609 (22.1)	186 (19.0)	91 (12.3)	30 (5.6)	81 (25.1)	13 (4.5)	92 (38.7)	73 (42.9)	33 (24.3)
<b>cTNM stage<sup>c</sup></b>									
I-II	1336 (54.3)	304 (32.2)	182 (33.1)	130 (30.0)	19 (8.1)	47 (17.7)	74 (37.8)	46 (33.6)	3 (3.5)
III	143 (5.8)	110 (11.7)	159 (28.4)	79 (18.2)	53 (22.6)	121 (45.7)	2 (1.0)	5 (3.7)	15 (17.7)
IV	982 (39.9)	529 (56.1)	209 (40.3)	225 (51.8)	163 (69.4)	97 (36.6)	120 (61.2)	86 (62.8)	67 (78.8)
<b>Resection</b>	1469 (53.3)	262 (26.8)	269 (36.9)	177 (33.2)	67 (20.7)	32 (11.0)	41 (17.2)	60 (35.3)	9 (6.6)
<b>Chemotherapy</b>	1060 (38.4)	73 (7.5)	199 (26.9)	369 (69.2)	134 (41.5)	20 (6.9)	186 (78.2)	109 (64.1)	4 (2.9)
<b>Radiotherapy</b>	87 (3.2)	22 (2.3)	58 (7.8)	81 (15.2)	48 (14.9)	NA	67 (28.2)	33 (19.4)	2 (1.5)

<sup>a</sup>Enumeration data are shown as count (percentage [%]), and measurement data as mean ± standard deviation. Records are complete otherwise specified below.

<sup>b</sup>The percentages of pancreas head, body, and tail are the proportions compared to the total tumour cases of pancreas head, body, and tail; other: pancreas duct, overlapping lesion, NOS, and other specified parts.

<sup>c</sup>Unknown cTNM stage: Heidelberg, 297 (10.8%); REPCR, 35 (3.6%); PanGenS, 191 (25.8%); ErCR, 99 (18.6%); IPOP, 88 (27.2%), HPSG, 26 (8.9%); IJB, 42 (17.6%); INT, 33 (19.4%); and NKI, 51 (37.5%). For Heidelberg and HPSG, the stage is a combination of clinical and pathological ones.

NCT, National Centre for Tumour Diseases (Heidelberg); PanGenS, Spanish arm of the PanGenEU study; REPCR, Reggio Emilia Pancreatic Cancer Registry; ErCR, Erlangen Cancer Registry; IPOP, Portuguese Oncology Institute of Porto; HPSG, Hungarian Pancreatic Study Group; IJB, Jules Bordet Institute (Brussels); INT, Istituto Nazionale dei Tumori (Milan); NKI, Netherlands Cancer Institute (Amsterdam); NOS, not otherwise specified; NA, not available.

**Table S10. Demographic and clinical characteristics of resected pancreatic cancer patients in institution-based centres<sup>a</sup>**

<b>Parameter</b>	<b>Heidelberg</b>	<b>REPCR</b>	<b>PanGenS</b>	<b>ErCR</b>	<b>IPOP</b>	<b>HPSG</b>	<b>IJB</b>	<b>INT</b>
<b>n</b>	1469	262	269	177	67	32	41	60
<b>Sex, female</b>	686 (46.7)	128 (48.9)	136 (50.6)	85 (48.0)	33 (49.3)	14 (43.8)	16 (39.0)	36 (60.0)
<b>Age [year]</b>	64 ± 11	69 ± 10	64 ± 12	66 ± 11	67 ± 10	66 ± 11	63 ± 12	64 ± 14
<b>Age group</b>								
< 60 years	472 (32.1)	47 (17.9)	84 (31.2)	37 (20.9)	12 (17.9)	9 (28.1)	15 (36.6)	19 (31.7)
60-69 years	509 (34.7)	68 (26.0)	93 (34.6)	71 (40.1)	22 (32.8)	8 (25.0)	13 (31.7)	14 (23.3)
70-79 years	429 (29.2)	112 (42.8)	73 (27.1)	57 (32.2)	32 (47.8)	12 (37.5)	11 (26.8)	24 (40.0)
≥ 80 years	59 (4.0)	35 (13.4)	19 (7.1)	12 (6.8)	1 (1.5)	3 (9.4)	2 (4.9)	3 (5.0)
<b>Tumour location<sup>b</sup></b>								
Pancreas head	928 (79.3)	190 (82.3)	181 (72.4)	129 (75.9)	39 (75.0)	24 (77.4)	25 (61.0)	26 (96.3)
Pancreas body	99 (8.5)	26 (11.3)	31 (12.4)	24 (14.1)	8 (15.4)	4 (12.9)	2 (4.9)	1 (3.7)
Pancreas tail	143 (12.2)	15 (6.5)	38 (15.2)	17 (10.0)	5 (9.6)	3 (9.7)	4 (9.8)	0 (0.0)
Other	299 (20.4)	31 (11.8)	19 (7.1)	7 (4.0)	15 (22.4)	1 (3.1)	10 (24.4)	33 (55.0)
<b>pTNM stage<sup>c</sup></b>								
I-II	1282 (88.8)	141 (54.7)	156 (89.1)	170 (96.6)	52 (78.8)	27 (87.1)	35 (97.2)	46 (82.1)
III	27 (1.9)	39 (15.1)	12 (6.9)	2 (1.1)	4 (6.1)	1 (3.2)	0	2 (3.6)
IV	134 (9.3)	78 (30.2)	7 (4.0)	4 (2.3)	10 (15.2)	3 (9.7)	1 (2.8)	8 (14.3)
<b>Neoadjuvant chemotherapy</b>	171 (11.6)	17 (6.5)	27 (10.0)	40 (22.6)	1 (1.5)	0 (0.0)	5 (12.2)	12 (20.0)
<b>Neoadjuvant radiotherapy</b>	80 (5.5)	2 (0.8)	10 (3.7)	41 (23.2)	0 (0.0)	NA	1 (2.4)	3 (5.0)
<b>Resection type</b>								
Pancreatoduodenectomy	853 (58.1)	98 (37.4)	159 (59.6)	132 (74.6)	40 (59.7)	NA	NA	24 (40.0)
Distal pancreatectomy	287 (19.5)	30 (11.5)	25 (9.4)	41 (23.2)	10 (14.9)	NA	NA	25 (41.7)
Total pancreatectomy	287 (19.5)	8 (3.1)	17 (6.4)	3 (1.7)	1 (1.5)	NA	NA	6 (10.0)
Other <sup>d</sup>	42 (2.9)	126 (48.1)	66 (24.6)	1 (0.5)	16 (23.9)	NA	NA	5 (8.3)
<b>Adjuvant chemotherapy</b>	386 (26.3)	71 (27.1)	143 (53.2)	89 (50.3)	40 (59.7)	7 (21.9)	28 (68.3)	37 (61.7)
<b>Adjuvant radiotherapy</b>	75 (5.1)	22 (8.4)	49 (18.2)	10 (5.7)	25 (37.3)	NA	20 (48.8)	10 (16.7)

<sup>a</sup>Enumeration data are shown as count (percentage [%]), and measurement data as mean ± standard deviation. Records are complete otherwise specified below. Results in NKI were not shown due to insufficient data.

<sup>b</sup>The percentages of pancreas head, body, and tail are the proportions compared to the total tumour cases of pancreas head, body, and tail; other: pancreas duct, overlapping lesion, NOS, and other specified parts.

<sup>c</sup>Unknown pTNM stage: Heidelberg, 33 (2.2 %); REPCR, 4 (1.5%); PanGenS, 94 (34.9%); ErCR, 1 (0.6%); IPOP, 1 (1.5%); HPSG, 1 (3.1%); IJB, 5 (12.2%); and INT, 4 (6.7%). For Heidelberg and HPSG, the stage is a combination of clinical and pathological ones.

<sup>d</sup>Pancreatectomy (NOS) and local resection.

NCT, National Centre for Tumour Diseases (Heidelberg); PanGenS, Spanish arm of the PanGenEU study; REPCR, Reggio Emilia Pancreatic Cancer Registry; ErCR, Erlangen Cancer Registry; IPOP, Portuguese Oncology Institute of Porto; HPSG, Hungarian Pancreatic Study Group; IJB, Jules Bordet Institute (Brussels); INT, Istituto Nazionale dei Tumori (Milan); NKI, Netherlands Cancer Institute (Amsterdam); NOS, not otherwise specified; NA, not available.

**Table S11. Association of surgical resection versus non-resection with demographic and clinical parameters for pancreatic cancer patients in large institution-based centres (> 500 cases) estimated by multivariable logistic regression**

Parameter	Heidelberg (n = 2461)	REPCR (n = 943)	PanGenS <sup>e</sup> (n = 542)	ErCR (n = 434)
	OR (95% CI)	OR (95% CI)	OR (95% CI)	OR (95% CI)
<b>Sex</b>				
Female	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Male	0.84 (0.63-1.13)	0.87 (0.63-1.21)	0.64 (0.37-1.11)	1.05 (0.61-1.78)
<b>Age group</b>				
< 60 years	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
60-69 years	0.85 (0.60-1.20)	0.66 (0.39-1.11)	0.56 (0.28-1.12)	1.22 (0.60-2.48)
70-79 years	<b>0.65</b> (0.45-0.94)	<b>0.59</b> (0.37-0.96)	<b>0.44</b> (0.21-0.90)	0.93 (0.45-1.92)
≥ 80 years	0.46 (0.21-1.01)	<b>0.13</b> (0.08-0.23)	<b>0.08</b> (0.03-0.23)	1.01 (0.32-3.18)
<b>Tumour location</b>				
Pancreas head	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
Pancreas body	0.71 (0.44-1.15)	0.87 (0.52-1.47)	1.65 (0.78-3.50)	1.97 (0.88-4.45)
Pancreas tail	1.05 (0.68-1.61)	<b>0.52</b> (0.28-0.98)	<b>2.66</b> (1.13-6.21)	1.92 (0.84-4.36)
Other <sup>c</sup>	0.86 (0.60-1.23)	<b>0.55</b> (0.34-0.88)	0.56 (0.21-1.41)	0.60 (0.12-3.00)
<b>cTNM stage<sup>d</sup></b>				
I-II	1.00 (reference)	1.00 (reference)	1.00 (reference)	1.00 (reference)
III	<b>0.01</b> (0.01-0.02)	<b>0.35</b> (0.21-0.59)	<b>0.02</b> (0.01-0.05)	<b>0.15</b> (0.07-0.32)
IV	<b>0.01</b> (0.01-0.01)	<b>0.22</b> (0.15-0.31)	<b>0.01</b> (< 0.01-0.02)	<b>0.09</b> (0.05-0.16)

<sup>a</sup>Numbers in table heads indicate numbers of cases available for analyses after excluding the missing.

<sup>b</sup>Odds ratios and 95% confidence intervals for surgical resection versus non-resection were calculated using multivariable logistic regression models adjusting for sex, age group, tumour location, and cTNM stage. ORs shown in bold are statistically significant.

<sup>c</sup>Other: pancreas duct, overlapping lesion, NOS, and other specified parts.

<sup>d</sup>For Heidelberg, TNM stage is a combination of clinical and pathological stages.

<sup>e</sup>Also adjusted for surgery centre (central (Salamanca and Madrid), east (Barcelona), and north (Asturias) Spain).

REPCR, Reggio Emilia Pancreatic Cancer Registry; PanGenS, Spanish arm of the PanGenEU study; ErCR, Erlangen Cancer Registry; OR, odds ratio; CI, confidence interval; NE, not estimable due to small case number.



**Figure S1. TNM stage-specific resection proportions for pancreatic cancer in population-based registries**

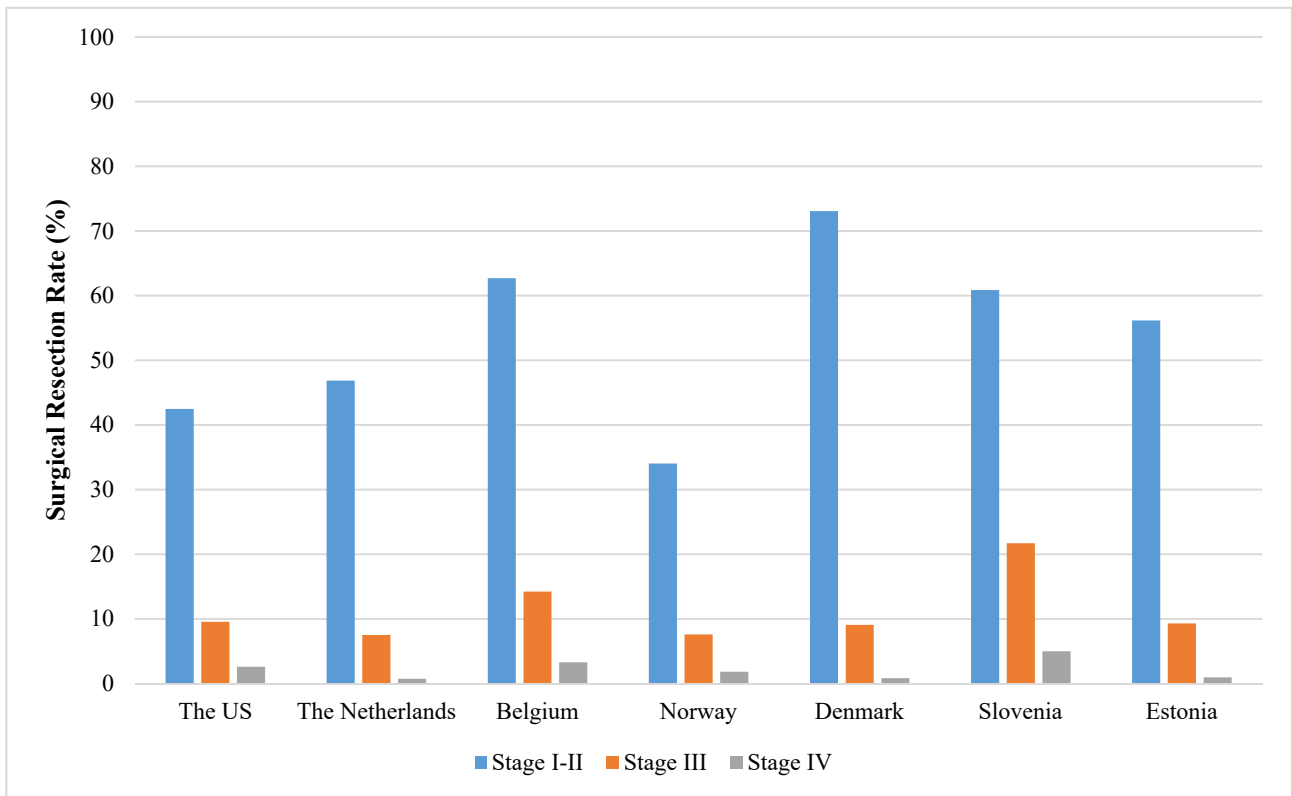
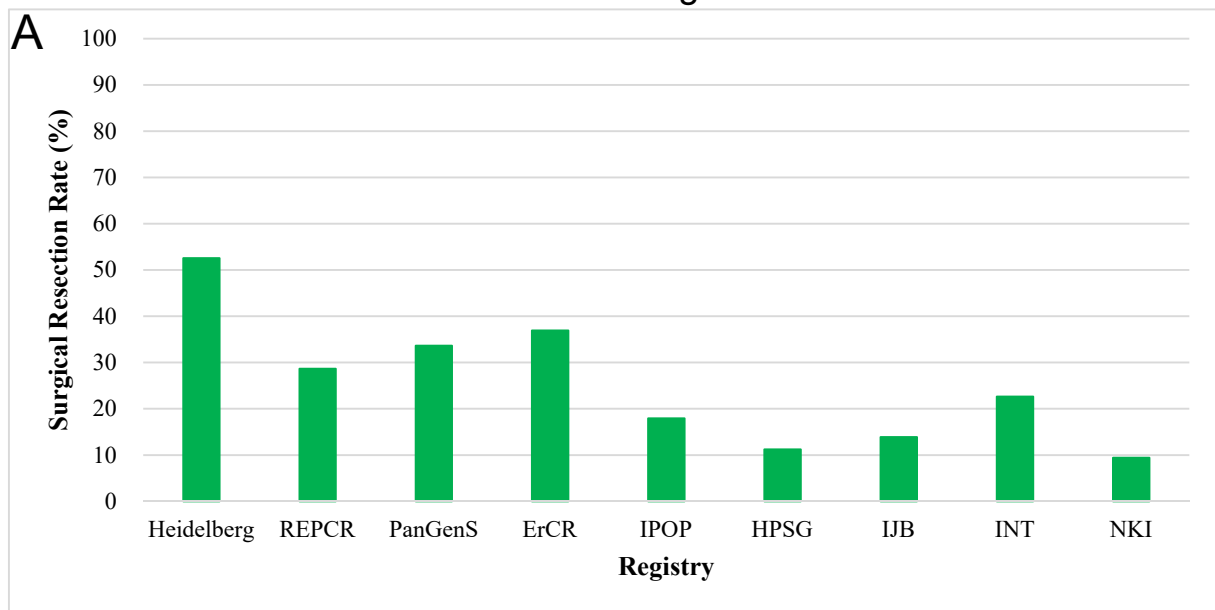
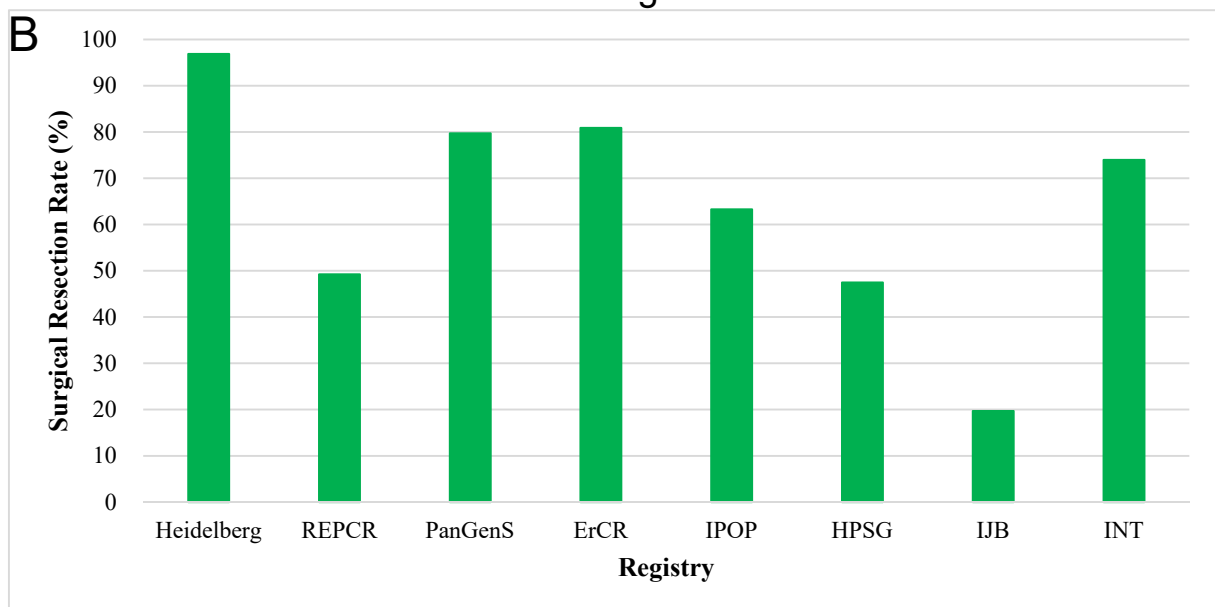


Figure S2. Age-standardised resection rates in the period 2012-2014 in institution-based registries

All stages



Stage I-II



Age-standardised resection rates in the period 2012-2014 in overall pancreatic cancer patients (A) and those with TNM stage I-II cancers (B) in institution-based registries. Result for stage I-II cancer patients in NKI is not shown due to very small case number ( $n = 2$ ; one of the two patients received resection). REPCR, Reggio Emilia Pancreatic Cancer Registry; PanGenS, Spanish arm of the PanGenEU study; ErCR, Erlangen Cancer Registry; IPOP, Portuguese Oncology Institute of Porto; HPSG, Hungarian Pancreatic Study Group; IJB, Jules Bordet Institute; INT, Istituto Nazionale dei Tumori; NKI, The Netherlands Cancer Institute in Amsterdam.