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# Impact of nationwide centralization of oesophageal, gastric, and pancreatic surgery on travel distance and experienced burden in the Netherlands

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## ABSTRACT

*Background:* This study aims to assess the impact of nationwide centralization of surgery on travel distance and travel burden among patients with oesophageal, gastric, and pancreatic cancer according to age in the Netherlands. As centralization of care increases to improve postoperative outcomes, travel distance and experienced burden might increase.

*Materials and methods:* All patients who underwent surgery between 2006 and 2017 for oesophageal, gastric and pancreatic cancer in the Netherlands were included. Travel distance between patient's home address and hospital of surgery in kilometres was calculated. Questionnaires were used to assess experienced travel burden in a subpopulation ($n = 239$). Multivariable ordinal logistic regression models were constructed to identify predictors for longer travel distance.

*Results:* Over 23,838 patients were included, in whom median travel distance for surgical care increased for oesophageal cancer ($n = 9217$) from 18 to 28 km, for gastric cancer ($n = 6743$) from 9 to 26 km, and for pancreatic cancer ($n = 7878$) from 18 to 25 km (all $p < 0.0001$). Multivariable analyses showed an increase in travel distance for all cancer types over time. In general, patients experienced a physical and social burden, and higher financial costs, due to traveling extra kilometres. Patients aged >70 years travelled less often independently (56% versus 68%), as compared to patients aged ≤70 years.

*Conclusion:* With nationwide centralization, travel distance increased for patients undergoing oesophageal, gastric, and pancreatic cancer surgery. Younger patients travelled longer distances and experienced a lower travel burden, as compared to elderly patients. Nevertheless, on a global scale, travel distances in the Netherlands remain limited.



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## 1. Introduction

Currently, oesophageal, gastric and pancreatic cancer are the sixth, second, and seventh leading cause of cancer-related death worldwide respectively [1]. For potentially curable patients, surgical resection with or without (neo)adjuvant treatment remains the corner stone of treatment [2–4]. These resections and the postoperative care are highly complex with, a relatively high risk of postoperative morbidity and mortality [5]. Previous studies have shown an inverse relationship between hospital volume and postoperative mortality and long-term survival for these malignancies [6–8]. This can be attributed to increased surgical expertise and the ability to rescue patients from postoperative complications in high-volume centres [9–11]. In the Netherlands, the centralization of surgical treatment for oesophageal and pancreatic cancer started in 2005 and 2006 respectively. Initially, the annual minimum volume was set at 10 resections, which was increased to 20 resections in 2011. For gastric cancer a minimum of 10 resections was mandated in 2012 and this was increased to a minimum of 20 resections in 2013 [6,12–14]. Centralization of these oncological resections is associated with better outcomes such as decreased postoperative morbidity and mortality [15–17].

Nowadays, elderly patients who are fit for surgery, undergo surgery more frequently with similar outcomes to younger patients [18–20]. As centralization of care increases, the number of hospitals performing these resections are decreasing. Therefore, more patients may need to travel longer distances to obtain specialized surgical care. Little is known, however, about the impact of centralization of care on travel distance and experienced travel burden for elderly patients in particular.

This study aims to assess the impact of centralization on travel distance and experienced travel burden to obtain surgical care among patients with oesophageal, gastric and pancreatic cancer in the Netherlands, with a specific focus on elderly patients.

## 2. Methods

### 2.1. Study population

All patients who underwent surgery (resection/surgery without resection in which the decision not to pursue resection, due to advanced disease, was taken during exploration) in the period 2006–2017 for oesophageal cancer including cardia carcinoma (C15 and C16.0), gastric cancer (C16.1-C16.9) or pancreatic cancer (C25) were selected from the Netherlands Cancer Registry (NCR). Topography was coded according to the third edition of the international classification of diseases for Oncology [21]. The NCR, a nationwide population-based cancer registry comprising all patients with cancer in the Netherlands, is primarily based on the notification of the pathological national automated archive. Additionally, non-pathologically verified cases were identified through the national registry of hospital care and discharge. Information on patient, tumour and treatment characteristics are routinely extracted from medical records by trained data managers of the NCR. Patients were excluded if they underwent surgery abroad (n = 367, 1%).

Patient-specific information retrieved from the NCR included sociodemographic characteristics (i.e. age, sex, postal code, socioeconomic status (SES)), tumour location, treatment details (surgery, year of surgery and hospital of surgical treatment) and hospital surgery volume. SES scores were categorized into low, medium and high SES. SES was determined at the neighbourhood level using four-digit postal codes, combining mean household income and mean value of housing at aggregated level [22]. Annual hospital surgery volume per hospital per year was calculated for each of these malignancies and was divided in 3 groups (<20, 20–40, >40).

All data of the NCR were de-identified and anonymized. According to the Central Committee on Research involving Human Subjects in The Hague, the Netherlands, this type of study does not require approval from an ethics committee in the Netherlands. The privacy review board of the NCR approved this study.

### 2.2. Hospital of diagnosis, travel distance and referral

Single trip travel distance in kilometres (km) between patient's home address and the hospital of surgical treatment was calculated based on patient's and hospital's four-digit two letters zip codes using Google maps. In case the four-digit two letters postal code was not available, the four-digit postal code was used (n = 261, 1%). Referral for surgery was assessed based on hospital of diagnosis and hospital of surgical treatment. As hospital of diagnosis for pancreatic cancer was only completely registered in the NCR from 2009 onwards, referral for pancreatic cancer could only be calculated from 2009 onwards.

### 2.3. Travel burden

The Prospective Observational Cohort Study of Oesophageal-gastric Cancer Patients (POCOP) and Dutch Pancreatic Cancer Project (PACAP) aim to facilitate research to improve quality of life and survival of oesophageal, gastric and pancreatic cancer patients using clinical data, tumour tissue, blood samples and Patient Reported Outcomes (PROMs). Within the POCOP and PACAP, (non-validated) questionnaires on travel burden were included between June 2014 and November 2018 [23]. Questionnaires on experienced travel burden were filled out by a subpopulation of patients who were referred for surgery and participated in the POCOP and PACAP cohort (n = 240). These questions included the following topics: physical burden, travel time, ability to travel independent, costs and preference for hospital of surgery of patients (Appendix A). All patients participating in the POCOP or PACAP cohort gave written informed consent prior to participation.

### 2.4. Statistical analysis

Baseline data were described as frequencies with percentages according to age categories (≤65, 66–70, 71–75, >75 years). The chi-square test, student's *t*-test, Wilcoxon Two-Sample test and Kruskal-Wallis Test were used, when appropriate, to evaluate statistical differences for baseline characteristics. Travel distance was expressed in medians with interquartile range (IQR). The trend in median travel distance was calculated with the Jonckheere-Terpstra test with two-sided p-values [24]. Travel distance could not be analysed continuously as the assumption that error terms should follow a normal distribution was not met. Therefore ordinal logistic regression models were constructed stratified by tumour type, with travel distances in tumour specific tertiles (short, medium, long travel distance) as the dependent variable (i.e. for oesophageal cancer (i.e. ≤15.7 km, 15.8–34.7 km and >34.7 km), gastric cancer (i.e. ≤8 km, 8.1–21.4 km, >21.4 km) and pancreatic cancer (i.e. ≤15.1 km, 15.2–33.5 km, >33.5 km)). Age, sex, year of surgery and SES were included as confounders in this multivariable model. For all independent variables the proportional odds assumption was checked graphically. This assumption was not met for SES, thus a partial proportional odds model was constructed in which different parameters for each SES category on the travel distance tertiles were estimated. For all other independent variables in the model the proportional odds structure was held. Results were expressed in odds ratios (ORs) with 95% confidence intervals (95%CI). Outcomes regarding experienced travel burden (experienced no burden (not at all) versus experienced burden (a little, quite some, a lot)) were described in frequencies for all patients. Results for travel burden were stratified by two age groups (i.e. ≤70 and > 70 years), due to the limited sample size. To assess the association between travel distance and physical travel burden, a multivariable logistic regression analysis was conducted, with physical travel burden as the dependent variable (yes/no). Age (i.e. ≤70 and > 70 years), sex and tumour location were included as confounders in this multivariable model.

All analyses were performed using SAS software version 9.4 (SAS institute, Cary, North Carolina, USA). P < 0.05 was considered statistically significant.

## 3. Results

### 3.1. Study population

In total 23,838 patients were included in this study of whom 9217 (39%) underwent surgery for oesophageal cancer, 6743 (28%) for gastric cancer and 7878 (33%) for pancreatic cancer. The number of hospitals that performed surgery significantly decreased between 2006 and 2017 for oesophageal cancer from 53 to 22, for gastric cancer from 95 to 24 and for pancreatic cancer from 46 to 25, (test for trend $p < 0.001$ for all tumour types, Fig. 1).

### 3.2. Baseline characteristics

The majority of the patients was male (66%). Forty-five percent of the patients were aged ≤65 years and 35% underwent surgery in a hospital performing >40 resections annually (Table 1). Over time the proportion of patients who underwent surgery in a hospital preforming >40 resections annually increased from 17% in 2006–2008, to 27%, 38% and 54%, for the period of 2009–2011, 2012–2014 and 2015–2017 respectively. More patients were referred for surgery (68%) in the recent period (2015–2017), compared to 23%, 44%, and 61%, in 2006–2008, 2009–2011 and 2012–2014 period, respectively. Elderly patients (>75 years) were less often referred for surgery (42%), while this was 49%, 53% and 53% for patients aged 71–75, 66–70 and ≤ 65 years, respectively ($p < 0.0001$). In total, 37% of patients ≤65 years and between 66 and 70 years, underwent surgery in a hospital performing >40 resections annually, while this was slightly lower among patients between 71 and 75 years (35%) and lower among patients aged >75 years (27%, $p < 0.0001$, Appendix B).

### 3.3. Travel distance

Median travel distance in the period 2006–2017 was 24 km (IQR 12–43) for patients who underwent surgery for oesophageal cancer, for gastric cancer 14 km (IQR 6–26) and for pancreatic cancer 23 km (IQR 11–41). Median travel distance significantly increased for oesophageal (from 18 to 28 km, $p < 0.0001$), gastric (9–26 km, $p < 0.0001$) and pancreatic cancer (18–25 km, $p < 0.0001$) between 2006 and 2017 (Fig. 2A).

As shown in Fig. 2B median travel distance increased significantly for all age categories over the years.

Multivariable, ordinal logistic regression analyses, showed for all tumour types that travel distance increased over time. Moreover, an increasing age was significantly associated with a shorter travel distance. Also, SES was of influence on the travel distance. A medium versus low SES was significantly associated with a longer travel distance, whereas patients with high SES were more likely to travel a medium distance (Table 2).

### 3.4. Travel burden

In total, 240 patients who were referred for surgery filled out the questionnaire regarding experienced travel burden of whom the majority was diagnosed with oesophageal cancer (n = 159, 66%), followed by pancreatic cancer (n = 55, 23%) and gastric cancer (n = 26, 11%). Most patients were male (n = 182, 76%) and ≤70 years (n = 182, 76%).

Of the patients who experienced an increased travel time due to referral (n = 207, 86%), 75% (n = 155) was ≤70 years and 25% (n = 52) was >70 years.

Extra physical burden due to traveling was reported by 57% (n = 88) of patients aged ≤ 70 years and 67% (n = 35) of patients >70 years ($p = 0.07$). Most patients did not mind traveling longer to an expert centre for surgery, and this was similar for patients aged ≤70 years (68%, n = 105) and patients aged >70 years (67%, n = 35, $p = 0.934$). Seventeen percent of the patients aged ≤70 years (n = 27) and 23% (n = 12) of the patients aged >70 years found it troublesome to travel to a different hospital ($p = 0.367$). Patients aged >70 years were more often not able to travel independently as compared to the patients aged ≤70 years (69% (n = 36) vs 56% (n = 87), p = 0.033). Ninety-six percent (n = 149) of the patients aged ≤ 70 years and 98% (n = 51) of the patients aged >70 years experienced that they encountered higher financial costs due to the travel distance to the hospital of surgical care ($p = 0.193$, Fig. 3).

Multivariable logistic regression analyses showed that an

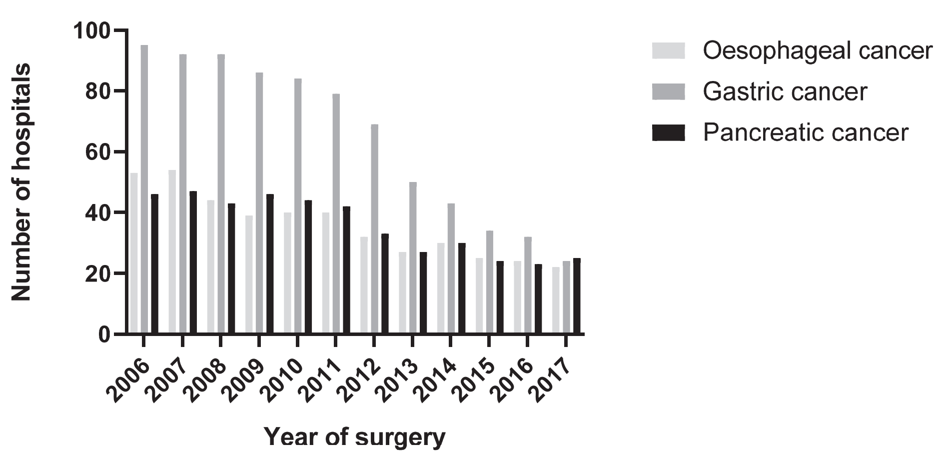


**Fig. 1.** Number of hospitals performing oesophageal, gastric, and pancreatic cancer surgery.

**Table 1**
Patient characteristics according to period of diagnosis.

| | Total group | | 2006–2008 | | 2009–2011 | | 2012–2014 | | 2015–2017 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | N | % | N | % | N | % | N | % | N | % | P value |
| Age | | | | | | | | | | | <.0001 |
| ≤65 | 10627 | 45% | 2364 | 46% | 2831 | 46% | 2792 | 44% | 2640 | 42% | |
| 66-70 | 4565 | 19% | 874 | 17% | 1059 | 17% | 1308 | 21% | 1324 | 21% | |
| 71-75 | 4184 | 18% | 899 | 18% | 1024 | 17% | 1105 | 18% | 1156 | 18% | |
| >75 | 4456 | 19% | 992 | 19% | 1226 | 20% | 1096 | 17% | 1142 | 18% | |
| Sex | | | | | | | | | | | 0.801 |
| Female | 8197 | 34% | 1748 | 34% | 2121 | 35% | 2193 | 35% | 2135 | 34% | |
| Male | 15635 | 66% | 3381 | 66% | 4019 | 65% | 4108 | 65% | 4127 | 66% | |
| Tumour type | | | | | | | | | | | <.0001 |
| Oesophageal cancer | 9216 | 39% | 1989 | 39% | 2334 | 38% | 2310 | 37% | 2583 | 41% | |
| Gastric cancer | 6740 | 28% | 1810 | 35% | 1866 | 30% | 1700 | 27% | 1364 | 22% | |
| Pancreatic cancer | 7876 | 33% | 1330 | 26% | 1940 | 32% | 2291 | 36% | 2315 | 37% | |
| Surgery volume hospital | | | | | | | | | | | <.0001 |
| <20 | 7952 | 33% | 3428 | 67% | 2730 | 44% | 1251 | 20% | 543 | 9% | |
| 20–40 | 7556 | 32% | 845 | 16% | 1752 | 29% | 2642 | 42% | 2317 | 37% | |
| >40 | 8324 | 35% | 856 | 17% | 1658 | 27% | 2408 | 38% | 3402 | 54% | |
| SES | | | | | | | | | | | 0.901 |
| Low | 7338 | 31% | 1586 | 31% | 1887 | 31% | 1932 | 31% | 1933 | 31% | |
| Medium | 9754 | 41% | 2064 | 40% | 2517 | 41% | 2615 | 42% | 2558 | 41% | |
| High | 6740 | 28% | 1479 | 29% | 1736 | 28% | 1754 | 28% | 1771 | 28% | |
| Referral for surgery* | | | | | | | | | | | <.0001 |
| Not referred for surgery | 10449 | 44% | 2610 | 51% | 3372 | 55% | 2471 | 39% | 1996 | 32% | |
| Referred for surgery | 12001 | 50% | 1189 | 23% | 2716 | 44% | 3830 | 61% | 4266 | 68% | |

*For pancreatic cancer referral for surgery is solely registered since 2009.


**Fig. 2a.** Median travel distance (solid lines) with IQR (dotted lines) over the years.

increase of 10 km in travel distance was associated with a higher likelihood of physical travel burden (OR 1.16, 95%CI 1.02–1.31). Moreover, sex, tumour location and age were not significantly associated with an increased extra physical travel burden.

## 4. Discussion

Over time, as a result of centralization, travel distance increased for patients in all age groups undergoing surgery for oesophageal, gastric and pancreatic cancer. Younger age, more recent year of surgery or higher hospital volume, and medium SES were associated with longer travel distance. In general, patients experienced physical and social burden, and higher financial costs, due to traveling extra kilometres. As travel distance increased, so did travel burden. Elderly patients travelled shorter distance and were less often able to travel independently compared to younger patients.

Our results are in line with the results of previous studies [25–27], which have shown that regionalization and centralization of surgical care was associated with an increased travel distance in the United States. This study described a significant increase in travel distance of 72% in oesophageal cancer and 40% in pancreatic cancer [26]. In the current study, the steepest increase in travel distance was seen for gastric cancer due to the more recent centralization as compared to oesophageal and pancreatic cancer. Another Dutch simulation study assessed the effect of different hypothetical scenarios on travel distance in oesophageal, gastric and colon cancer and predicted that increasing centralization would result in a stronger increase in travel distance for elderly patients, as compared to younger patients [28]. A simulation study in patients undergoing surgery for pancreatic cancer was performed in the states of California (423.970 $km^2$, population density 251 $mi^2$) and New York (141.300 $km^2$, population density 421 $mi^2$) in the US in which further regionalization was simulated by


**Fig. 2b.** Travel distance in different age groups.

**Table 2**
Multivariable ordinal logistic regression analysis for determining predictors for an increased travel distance for oesophageal, gastric and pancreatic cancer.

| | Oesophageal cancer | | | Gastric cancer | | | Pancreatic cancer | | |
|---|---|---|---|---|---|---|---|---|---|
| | Odds ratio | 95%CI | | Odds ratio | 95%CI | | Odds ratio | 95%CI | |
| Age | | | | | | | | | |
| ≤65 years | 1 | | | 1 | | | 1 | | |
| 66–70 years | 0.975 | 0.884 | 1.075 | 1.032 | 0.9 | 1.184 | 0.987 | 0.884 | 1.102 |
| 71–75 years | 0.891 | 0.799 | 0.994 | 0.906 | 0.794 | 1.035 | 0.873 | 0.781 | 0.975 |
| >75 years | 0.711 | 0.625 | 0.809 | 0.767 | 0.686 | 0.858 | 0.796 | 0.708 | 0.895 |
| Sex | | | | | | | | | |
| Male | 1.051 | 0.961 | 1.15 | 1.061 | 0.967 | 1.164 | 1.075 | 0.99 | 1.167 |
| Female | 1 | | | 1 | | | 1 | | |
| Year of surgery | | | | | | | | | |
| 2006–2008 | 1 | | | 1 | | | 1 | | |
| 2009–2011 | 1.232 | 1.102 | 1.378 | 1.337 | 1.184 | 1.511 | 1.167 | 1.024 | 1.329 |
| 2012–2014 | 1.305 | 1.167 | 1.458 | 3.072 | 2.706 | 3.488 | 1.492 | 1.315 | 1.693 |
| 2015–2017 | 1.628 | 1.46 | 1.816 | 4.832 | 4.213 | 5.543 | 1.574 | 1.387 | 1.786 |
| SES -medium vs low travel distance | | | | | | | | | |
| Low | 1 | | | 1 | | | 1 | | |
| Medium | 1.678 | 1.509 | 1.865 | 2.727 | 2.407 | 3.088 | 1.784 | 1.59 | 2.001 |
| High | 1.159 | 1.037 | 1.296 | 1.825 | 1.595 | 2.089 | 1.053 | 0.934 | 1.187 |
| SES - high versus low travel distance | | | | | | | | | |
| Low | 1 | | | 1 | | | 1 | | |
| Medium | 1.367 | 1.231 | 1.519 | 1.333 | 1.181 | 1.506 | 1.245 | 1.113 | 1.394 |
| High | 0.819 | 0.727 | 0.922 | 0.896 | 0.778 | 1.03 | 0.751 | 0.661 | 0.853 |

Tertile 1 is used as reference tertile in this analyses. For all independent variables the proportional odds assumption was checked graphically. This assumption was not met for SES, thus a partial proportional odds model was constructed in which different parameters for each SES category on the travel distance tertiles were estimated. For all other independent variables in the model the proportional odds structure was held.
Travel distance tertiles in kilometres for oesophageal cancer were (≤15.7, 15.8–34.7, >34.7), travel distance tertiles for gastric cancer were (≤8, 8.1–21.4, >21.4), travel distance tertiles for pancreatic cancer were (≤15.1, 15.2–33.5, >33.5).

eliminating hospitals that did not reach 20 cases per year, resulted in an increased median round-trip driving time of 24.1 min [27]. In comparison, the Netherlands is small (41.534 km$^2$) but more densely populated (1316 per mi$^2$) and thus the effects of centralization of surgical care on travel distance will be comparable or even higher to other countries. This is the reason why the calculated distances were google maps generated, taking real-world roads into account.

In line with the current study, previous research showed that elderly patients had a shorter travel distance compared to the younger groups, especially in the earlier years [25]. One could hypothesize whether elderly patients who reside close to a hospital of surgical treatment and receive their usual care in a hospital of surgical treatment, have a higher probability of undergoing surgery as compared to elderly who reside farther away from hospital of surgical treatment. Furthermore, a previous qualitative study shows that patients consider travel distance to decide which hospital for complex cancer care is chosen. Some patients argued that it is easier for family members to support in transportation and emotional support when the cancer care is conducted in a hospital at close proximity [29]. This argumentation might especially be applicable to the elderly population and may explain the shorter travel distance in this group in our study. In addition, younger patients might be more critical in choosing a hospital for their treatment and opt more often for a second opinion, and therefore travel a longer distance compared to elderly patients.

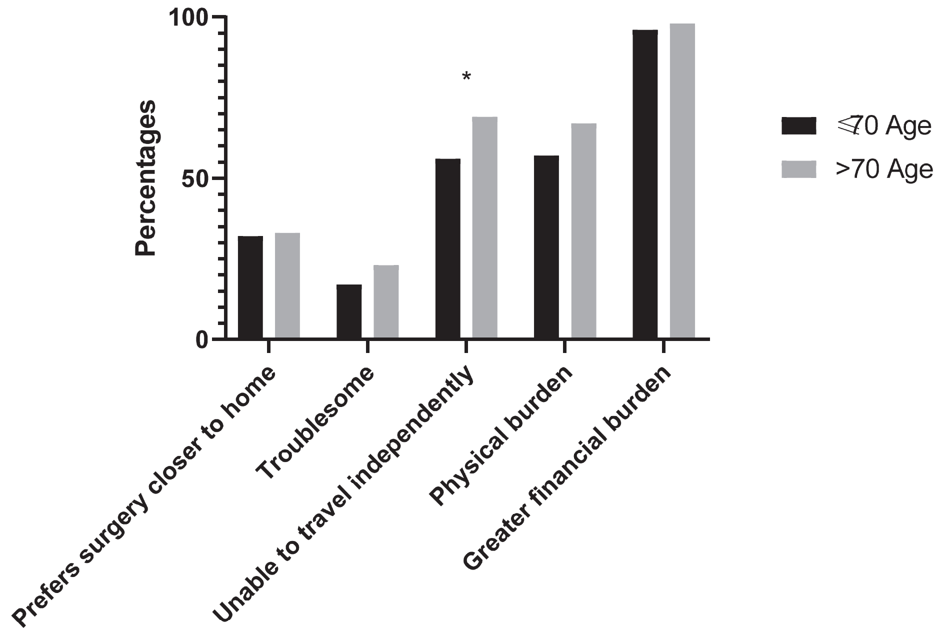


**Fig. 3.** Travel burden in different age groups, *Statistically significant, $p < 0.05$.

Previous studies described predictors for a longer travel distance such as age [25], increasing hospital volume [26], living in outer regional/remote areas and insurance type [26,30]. In line with the aforementioned studies, higher age, was associated with a shorter travel distance in this study. Furthermore, previous studies have shown disparities in diagnostics and treatment by SES in breast- [31,32] and oesophageal cancer [33]. In the current study, a medium SES had a higher likelihood for longer travel and a high SES had a higher likelihood of medium travel. This might be attributed to the possibility that higher educated patients reside in larger cities with high volume surgery hospitals [34]. Although no information regarding living in outer regional/remote areas and insurance type was available in this study, we believe that these factors did not influence our outcomes. First, the Netherlands is small and densely populated (17 million inhabitants), meaning that remote areas are less common in the Netherlands. Since the majority of the Dutch population lives in urban areas and most Dutch citizens live within 5 km from a hospital facility [35], the Dutch population are less accustomed to further travel and might experience traveling differently. Secondly, the treatment regimen under study is covered by the basic health insurance which is mandatory for Dutch citizens by law. Nevertheless, the financial costs for traveling for surgery are not covered by the basic health insurance, whereas traveling for chemo (radiation) therapy is covered by the basic health insurance.

A narrative review including 11 studies analysing the impact of travel in all cancer patients, found that the majority of patients experienced traveling for cancer treatment as a practical hardship and inconvenience [36]. Moreover, traveling longer distances to obtain specialized surgical care may present with additional economic and social burdens to patients including problems in managing domestic responsibilities [30,37]. The current study showed that travel burden was high, with more than half of patients experiencing a physical and social burden and higher financial costs even though patients did not mind traveling to the hospital of surgical treatment. Moreover, an increasing travel distance was associated with an increased travel burden. Despite these burdens, most patients did not mind traveling longer to an expert centre for surgery. Previous studies found that patient's willingness to travel to a hospital farther away, increased if that hospital provided superior oncological care [29,38]. Therefore it can be speculated that patients accept the physical and social burden and higher financial costs due to traveling in order to undergo the most adequate curative treatment plan at an expert centre.

Travel distance and burden should be discussed with the patient and taken into consideration during treatment decision-making. Additionally, video outpatient consultation have become increasingly common in clinical practice [39,40], and may be an alternative solution to overcome barriers associated with an increased travel distance and travel burden to the hospital of surgery. Implications for further research might be identifying at what timelines in the clinical pathway video outpatient consultations might be feasible, such as for instance, during the postoperative outpatient clinic consults.

The present study generates a preliminary understanding of travel distance and travel burden in patients with oesophageal, gastric and pancreatic cancer, in the era of centralization of surgical care. A strength of this study is the large population-based cohort using data from the NCR. In addition, the experienced burden associated with travel distance with the emphasis on elderly patients which has not been reported previously. In addition, as most patients will not just have one two-way trip but multiple trips during follow up at the same hospital, the presented single travel distances are a proxy parameter for the total travel burden, which patients experienced. There are also some limitations to consider while interpreting the results, such as the travel burden questionnaire, which is not validated but based on inductive reasoning. Nonetheless, to the best of our knowledge we are not aware of validated travel burden questionnaires in patients diagnosed with cancer. In addition, it can be speculated that frailty, performance status and comorbidities might influence patient's decision-making for farther travel but this data was not available. However, all patients were deemed fit enough to undergo surgery. Unfortunately, patients who were not referred for surgical care were not included in the subpopulation regarding travel burden outcomes in this study, it would have been interesting to have gained information regarding their considerations regarding travel burden. Furthermore, even after centralization of surgery in the Netherlands travel distance is limited, therefore these results cannot simply be extrapolated to other larger countries and vice versa. Finally, the patient's choice regarding the hospital of surgery was not registered in the NCR and could not be assessed in this study.

In conclusion, travel distance for patients diagnosed with oesophageal, gastric, or pancreatic cancer increased over time due to centralization. Also, as travel distance increased, experienced travel burden increased. However, all age groups seemed to be prepared to travel for surgery, as travel distance increased overtime in all age groups. Elderly patients travelled shorter distance and were less often able to travel independently compared to younger patients.

## Credit author statement

JCHBM Luijten: Conceptualization, Methodology, Validation, Formal analysis, Investigation, Data curation, Writing original draft, writing review & editing, visualization,. AP Nieuwenhuijzen: Conceptualization, Methodology, writing review & editing, supervision. M Sosef: Conceptualization, writing review & editing. IHJT de Hingh: Conceptualization, writing review & editing. C Rosman: Conceptualization, writing review & editing. J Ruurda: Conceptualization, writing review & editing. P van Duijvendijk: Conceptualization, writing review & editing. J Heisterkamp: Conceptualization, writing review & editing. WO de Steur: Conceptualization, writing review & editing. HWM van Laarhoven: Conceptualization, writing review & editing. MG Besselink: Conceptualization, writing review & editing. B Groot Koerkamp: Conceptualization, writing review & editing. HC van Santvoort: Conceptualization, writing review & editing. VEP Lemmens: Conceptualization, Methodology, writing review & editing, supervision, Funding acquisition. PAJ Vissers: Conceptualization, Methodology, Formal analysis, Validation, writing review & editing, supervision, Project administration, Resources.

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## Declaration of competing interest

None declared.

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Because of the sensitive nature of the data collected for this study, requests to access the dataset from qualified researchers trained in human subject confidentiality protocols may be sent to the Netherlands Comprehensive Cancer Organization. No preregistration exists for the reported studies reported in this article.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.ejso.2021.07.023.

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