

SURVIVAL OF BRAZILIAN PATIENTS DIAGNOSED WITH MALIGNANT NEOPLASMS IN THE DIGESTIVE SYSTEM

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- **ABSTRACT:** *Data analysis of patients diagnosed with malignant neoplasms can be useful to identify factors affecting their survival and also to assist physicians in the choice of treatments and palliative measures. In this context, the log-normal regression model was used in this article to analyze the survival of 1,232 patients diagnosed with esophageal cancer and 981 diagnosed with stomach cancer. These patients were admitted between 1990 and 2004 to a Brazilian cancer center and followed up until December 2009. Factors found to play an important role in determining the survival of these patients were: gender, age, clinical staging, disease extent and treatment. Despite advances in the quality of surgical techniques and other medical management that have occurred in recent decades, our findings were consistent with those of other studies, in the sense that patient survival for these two types of cancers remain poor, particularly when they are diagnosed in advanced clinical stages.*
- **KEYWORDS:** *Esophageal cancer; log-normal model; stomach cancer; survival analysis.*

1 Introduction

Malignant neoplasms can occur in various areas of the digestive system as esophagus and stomach. Typical interests in studies addressing these malignancies

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are the identification of factors that increase the risk of developing them and the identification of factors that affect the survival of patients with these cancers.

In regards to factors that increase the risk of these malignant neoplasms, several studies have been conducted and their results published in the literature. Concerning the esophageal cancer, for instance, it is believed that high consumption of alcoholic beverages and tobacco products make this cancer more likely (Nomura et al., 1990; Trédaniel et al., 1997; Shimazu et al., 2008). It is also possible, although it has not yet been proven, that a diet high in processed meat may increase the risk of esophageal cancer. Also, people who are obese or have family history may have an increased risk to develop this cancer (Polednak, 2008; Roberts et al., 2010; Wolin et al., 2010; Brooks-Wilson et al., 2004). Studies also suggest that people who eat a diet high in foods that are smoked, salted, or pickled have an increased risk for stomach cancer (Buckland et al., 2009).

Nonetheless, when the interest lies on identifying factors that affect the survival of patients with these cancers, factors that have usually been analyzed are: age, gender and treatment, that depends on clinical stage and may include surgery, chemotherapy, and/or radiation therapy, or combinations of surgery, chemotherapy and radiation therapy (Scartozzi et al., 2009; MacDonald et al., 2001; Crane et al., 2008). Results from several studies have reported that the overall five-year survival rate of patients with esophageal cancer is low, approximately 5 to 15% (Braghetto et al., 2000; Polednak, 2003; Thuler et al., 2006; Crane et al., 2008; Terciotti Jr et al., 2009). Moreover, the percentage of patients surviving at least 5 years after stomach cancer is diagnosed has been reported to vary from 10 to 20% (Akoh and Macintyre, 1992; Heise et al., 2009). One reason for these low percentages is that most patients with esophageal or stomach cancer are usually at an advanced stage or metastatic period when the diagnosis is made (Henry et al., 2007). Although important advances have occurred in the treatment of these cancers over the past decade (Paterson et al., 2006; Gonzales et al., 2009), they are difficult to cure unless it is found in an early stage (before it has begun to spread).

The purpose of this article consists of identifying factors affecting the survival of Brazilian patients diagnosed with esophageal or stomach cancer. For this, two data sets are analyzed using regression models in the context of survival data. The first comes from 1,232 patients diagnosed with esophageal cancer and the second from 981 diagnosed with stomach cancer. These data sets are the result of a twenty-year follow-up. Hence, they offer a valuable opportunity to evaluate the impact of several factors on the survival of these patients. Factors considered for both data sets were: gender, age, disease extent, clinical staging and treatment. As advances in the quality of surgical techniques and other medical management have been occurred in the past decade, patient survival was also evaluated according to the year of diagnosis.

The article is organized as follows. Section 2 describes the data sets and the statistical methodology used for analyzing them, Section 3 discusses the results obtained from the analysis and Section 4 presents some concluding remarks.

2 Methodology

2.1 The data

The data was supplied by a Brazilian cancer center that assists patients from all over the country. Due to its location in the city of Curitiba, state of Parana (southern Brazil), around 90% of the patients come from of that State. The first data set assessed comes from 1,232 patients diagnosed with esophageal cancer at this center between the years 1990 and 2004 and followed up until December, 2009. From these patients was recorded a total of 1,064 (84.36%) deaths. The second data set comes from 981 patients diagnosed with stomach cancer over the same period, of whom 763 (77.8%) have died until the last follow-up (December, 2009).

For both data sets the covariates considered in the analysis were: age, gender, disease extent (indicating the size of the tumor and if it has spread to nearby lymph nodes or other parts of the body), clinical staging at the time of diagnosis (describing disease severity according to stages I to IV, where IV is the most severe), and the treatment administered (surgery, surgery combined with radiotherapy or chemotherapy or both, only radiotherapy, only chemotherapy or radiotherapy plus chemotherapy). All patients underwent complete treatment at the cancer center mentioned. As advances in surgical techniques and other medical management have occurred over the past decade, year of diagnosis was also taken into account in the analysis as a way to evaluate whether the survival of patients with esophageal or stomach cancer has improved over the follow-up period.

A common feature of the data sets is they contain right censored observations (Klein and Moeschberger, 2003), meaning that for those patients who have not died until the last follow-up time, all is known is that they are still alive. As for the data sets considered the event is defined as patient death due to the disease, the outcome variable is the time (in days) from the beginning of follow-up (defined as the date of diagnosis) to patient death or last follow-up. Thus, for those patients who have died, survival time was measured from the date of diagnosis to the date of death, while for those who have not died it was censored at the last date of patient contact. This study was approved by the Ethics Committee of the cancer center.

Table 1 provides some descriptive information of both data sets according to the covariates considered in the analysis performed.

2.2 Statistical methods

When the interest is to analyze survival data, methods that take into account censored observations are usually required. A basic quantity often used to describe time-to-event is the survival function. This function provides the probability of an individual experiencing the event after time t , that is, $S(t) = P(T > t)$.

To estimate $S(t)$ one can use nonparametric, parametric or semiparametric approaches. The most known nonparametric method was proposed by Kaplan and Meier (1958). This method has, however, limitations when there is interest in considering several covariates simultaneously. In such cases, the Cox model

Table 1 - Descriptive statistics of patients diagnosed with esophageal or stomach cancer

Covariates	Esophageal		Covariates	Stomach	
	<i>n</i>	%		<i>n</i>	%
Gender			Gender		
Male	911	74	Male	708	72.2
Female	321	26	Female	273	27.8
Age (years)			Age (years)		
35 to 45	91	7.4	18 to 44	134	13.6
46 to 55	307	24.9	45 to 54	209	21.3
56 to 65	457	37.1	55 to 59	141	14.4
66 to 75	292	23.7	60 to 69	308	31.4
76 to 93	85	6.9	70 to 91	189	19.3
Disease extent			Disease extent		
Localized	579	47.0	Localized	160	16.3
Regional	494	40.1	Regional	492	50.2
Metastasis	143	11.6	Metastasis	301	30.7
Missing information	16	1.3	Missing information	28	2.8
Clinical staging			Clinical staging		
Stage I	19	1.6	Stage I	110	11.2
Stage II	195	15.8	Stage II	106	10.8
Stage III	529	42.9	Stage III	178	18.2
Stage IV	140	11.4	Stage IV	384	39.1
Could not be assessed	167	13.6	Could not be assessed	171	17.4
Missing information	182	14.7	Missing information	32	3.3
Treatment			Treatment		
Surgery	149	12.1	Surgery	295	30.1
Surgery + adjuvant therapy*	75	6.1	Surgery + adjuvant therapy*	191	19.5
Radiotherapy	694	56.3	Radiotherapy	73	7.4
Chemotherapy	104	8.5	Chemotherapy	255	26.0
Radiotherapy + Chemo	205	16.6	Radiotherapy + Chemo	160	16.3
Missing information	5	0.4	Missing information	7	0.7
Year of diagnosis			Year of diagnosis		
1990 to 1994	392	31.8	1990 to 1994	291	29.7
1995 to 1999	481	39.1	1995 to 1999	361	36.8
2000 to 2004	359	29.1	2000 to 2004	329	33.5

Localized = confined to primary site, regional = spread to nearby lymph nodes, metastasis = cancer has spread from the primary site to distant organs or distant lymph nodes; adjuvant therapy* = following surgery patients received radiotherapy or chemotherapy or a combination of both.

(Cox, 1972) is a semiparametric alternative that has been widely used, particularly in clinical studies. Proportional hazards is, however, a key assumption to use this model. Unfortunately, such assumption was not satisfied for both data sets described in the previous section. Hence, a parametric regression model in the context of survival data was considered to analyze them.

In general terms, to analyze the data sets described in Section 2.1, an exploratory univariate analysis was initially performed. The nonparametric method of Kaplan-Meier was used for such purpose. The interest in this analysis was to assess which covariates described in Table 1 could be associated with patient survival time. The survival function under this method is given as

$$S(t) = \begin{cases} 1 & \text{if } t < t_1 \\ \prod_{t_i \leq t} \left(1 - \frac{d_i}{n_i}\right) & \text{if } t \geq t_1 \end{cases}$$

where d_i indicates the number of events occurring at time t_i and n_i the number of patients who are at risk at time t_i . The survival curve $S(t)$ is a step function with jumps at the observed k death times $t_1 < t_2 < \dots < t_k$.

Differences between survival curves were tested by the logrank test (Mantel, 1966) whose statistic for the comparison of $r \geq 2$ survival curves is asymptotically chi-square distributed with $r - 1$ degrees of freedom.

After performing the exploratory analysis, the log-normal regression model (Klein and Moeschberger, 2003), which allows several covariates simultaneously, was chosen amongst several others (Weibull, exponential, gama and log-logistic) as the most appropriate parametric model for analyzing both data sets. Under this model, the survival function for an individual with covariate vector $\mathbf{x} = (1, x_1, \dots, x_p)$ is expressed as

$$S(t | \mathbf{x}) = \Phi\left(\frac{-\log(t) + \mu(\mathbf{x})}{\sigma}\right) = 1 - \Phi\left(\frac{\log(t) - \mu(\mathbf{x})}{\sigma}\right) \quad (1)$$

where $\mu(\mathbf{x}) = \mathbf{x}'\boldsymbol{\beta}$ with $\boldsymbol{\beta} = (\beta_0, \beta_1, \dots, \beta_p)'$ a vector of parameters, σ is a scale parameter, and Φ denotes the standard normal cumulative distribution function. Parameter estimates are obtained by maximization of the likelihood function that, for a sample of $i = 1, \dots, n$ individuals, is given as

$$L(\boldsymbol{\beta}, \sigma) = \prod_{i=1}^n (f(t_i | \mathbf{x}))^{\delta_i} (S(t_i | \mathbf{x}))^{1-\delta_i}$$

where $f(t | \mathbf{x}) = \frac{\partial}{\partial t} F(t | \mathbf{x}) = \frac{\partial}{\partial t} [1 - S(t | \mathbf{x})]$ corresponds to the probability density function, and δ_i is equal to 1 if the time of the i -th individual corresponds to a fail and 0 otherwise.

In order to select the covariates with significant effect in model (1), all covariates were initially included in the model and then it was performed a stepwise selection procedure (Montgomery et al., 2001) based on the Wald test (Wald, 1943). Only covariates significant at a 5% significance level remained in the model. Moreover, for checking the overall goodness-of-fit of model (1), the Cox-Snell residuals (Cox and Snell, 1968) were examined. These residuals are defined as $e_i = \int_0^{t_i} \lambda(s, \mathbf{x}_i) ds = -\log(S(t_i | \mathbf{x}_i))$ for $i = 1, \dots, n$, where $\lambda(\cdot)$ is termed hazard function. For model (1), the Cox-Snell residuals are therefore given as

$$e_i = -\log(S(t_i | \mathbf{x}_i)) = -\log\left[1 - \Phi\left(\frac{\log(t_i) - \mu(\mathbf{x}_i)}{\sigma}\right)\right].$$

For model (1) to provide a satisfactory fit to the data, the survival probabilities of the residuals e_i 's obtained by considering the unit exponential distribution plotted

against those obtained by the Kaplan-Meier estimator, should be roughly a straight line through the origin with slope 1. Similarly, if the log-normal distribution holds, the standardized residuals defined as

$$z_i = \frac{(\log(t_i) - \mathbf{x}'_i \boldsymbol{\beta})}{\sigma},$$

$i = 1, \dots, n$, should resemble a censored sample from a standard normal distribution. Equivalently, $\exp(z_i)$, $i = 1, \dots, n$, should resemble a censored sample from a standard log-normal distribution (Klein and Moeschberger, 2003).

Different from the Cox model (Cox, 1972), where exponentiation of parameters β_j ($j = 1, \dots, p$) correspond to hazard ratios, in the log-normal model $\exp(\beta_j)$ correspond to ratios of median survival times, denoted here by R_{MT} . For more details on this subject see Hosmer and Lemeshow (1999) and Colosimo and Giolo (2006). Confidence intervals for R_{MT} are obtained by $\exp(\hat{\beta}_j + z_{\alpha/2} \times \text{s.e.})$, where s.e. denotes the standard error of $\hat{\beta}_j$ and $z_{\alpha/2}$ the $\alpha/2$ -percentile of the standard normal distribution.

All computations were performed using the survival library of the R software (R Development Core Team, 2012).

3 Results

3.1 Descriptive statistics

Table 1 indicates that men account for 74% amongst patients with esophageal cancer and 72.2% amongst those with stomach cancer. Moreover, from the 911 men and 321 women with esophageal cancer there were 88.5% and 80.4% deaths, respectively. Similarly, from the 708 men and 273 women with stomach cancer, such percentages were 80.9% and 69.6%, respectively.

The average age of the esophageal cancer patients was 60 years-old (s.d. = 10.2) with minimum and maximum ages of 35 and 93. For the stomach cancer patients the average age was 59 years-old (s.d. = 12.3) with minimum and maximum ages of 18 and 91. Moreover, when the diagnosis was made for both diseases, more than 50% of the patients were at clinical staging III and IV. In regards to the disease extent, localized and regional cancers were the most prevalent amongst the patients with esophageal cancer while regional and metastasis cancers were most frequently amongst those with stomach cancer.

Radiotherapy was the most common treatment given to patients with esophageal cancer (56.3%) followed by radiotherapy combined with chemotherapy (16.6%) and surgery alone (12.1%). For those with stomach cancer, 30.1% underwent surgery, 26% received chemotherapy and 16.3% a combination of radiotherapy and chemotherapy. Surgery combined with adjuvant therapies (radiotherapy, chemotherapy or both) were also most frequently administered amongst patients with stomach cancer (19.5% against 6.1%).

3.2 Exploratory univariate analysis

As a preliminary analysis, the Kaplan-Meier estimator was first used to obtain the overall survival curves depicted in Figure 1. From these curves, patients with stomach cancer have presented higher probability to survive over time. The mean survival time for them was estimated at 1224 days (\approx 41 months) with a 95% confidence interval (CI) of (1035; 1492) days. This estimate for patients with esophageal cancer was 788 days (\approx 26 months) with 95% CI of (670; 868) days. Thus, patients diagnosed with stomach cancer have survived longer than those diagnosed with esophageal cancer.

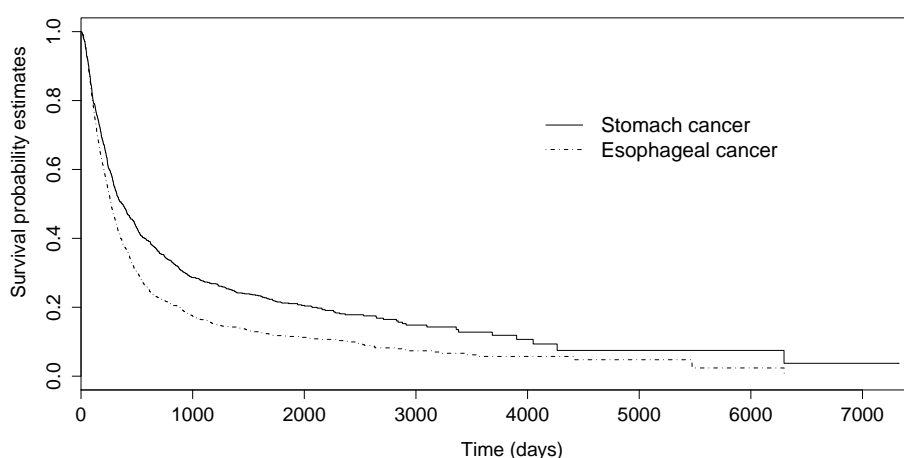


Figure 1 - Kaplan-Meier survival curves estimated from the Brazilian patients diagnosed with esophageal or stomach cancer.

The Kaplan-Meier estimator and the logrank test were then used to investigate the six covariates displayed in Table 1. Considering first the patients diagnosed with esophageal cancer, statistical evidence of association was found between patient survival and the first five covariates (p -values < 0.05 from the logrank test). The only exception was year of diagnosis (p -value = 0.7). Figure 2a indicates that female patients have presented higher probability to survive over time. It is also suggested for those patients diagnosed with localized cancer (Figure 2b), at clinical staging I or II (Figure 2c) and underwent surgery or surgery combined with adjuvant therapies (Figure 2d).

Considering now the patients diagnosed with stomach cancer, the logrank test showed statistical evidence (p -values < 0.001) of association between patient survival and the first five covariates in Table 1. Year of diagnosis was also not significantly associated with patient survival (p -value = 0.38). Figure 3 suggests

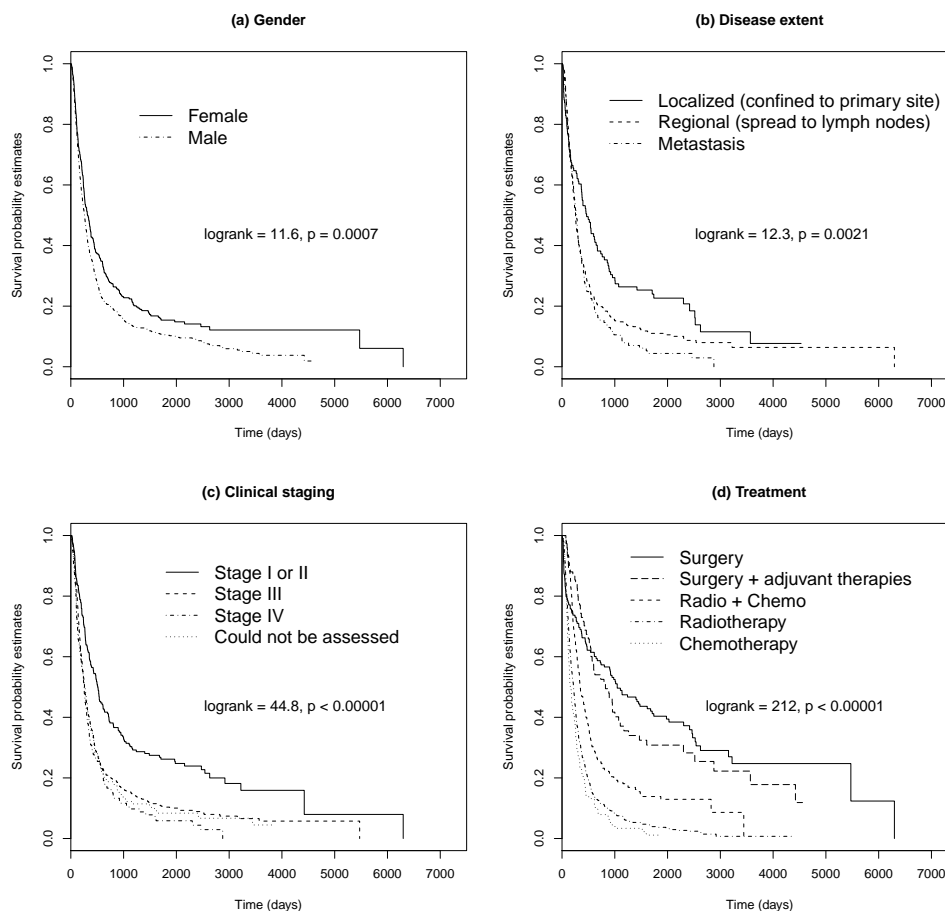


Figure 2 - Kaplan-Meier survival curves for the patients with esophageal cancer by the covariates (a) gender, (b) disease extent, (c) clinical staging and (d) treatment.

that female have survived longer than male patients, as well as those diagnosed at clinical staging I or II. Similar evidence is indicated for those with localized cancer and underwent surgery.

Although the Kaplan-Meier estimator is a useful tool, it was not designed to evaluate a covariate effect adjusted for a set of other covariates. Thus, to investigate the effect of several covariates simultaneously on patient survival, the results obtained from the log-normal regression model, described in Section 2.2, are next presented.

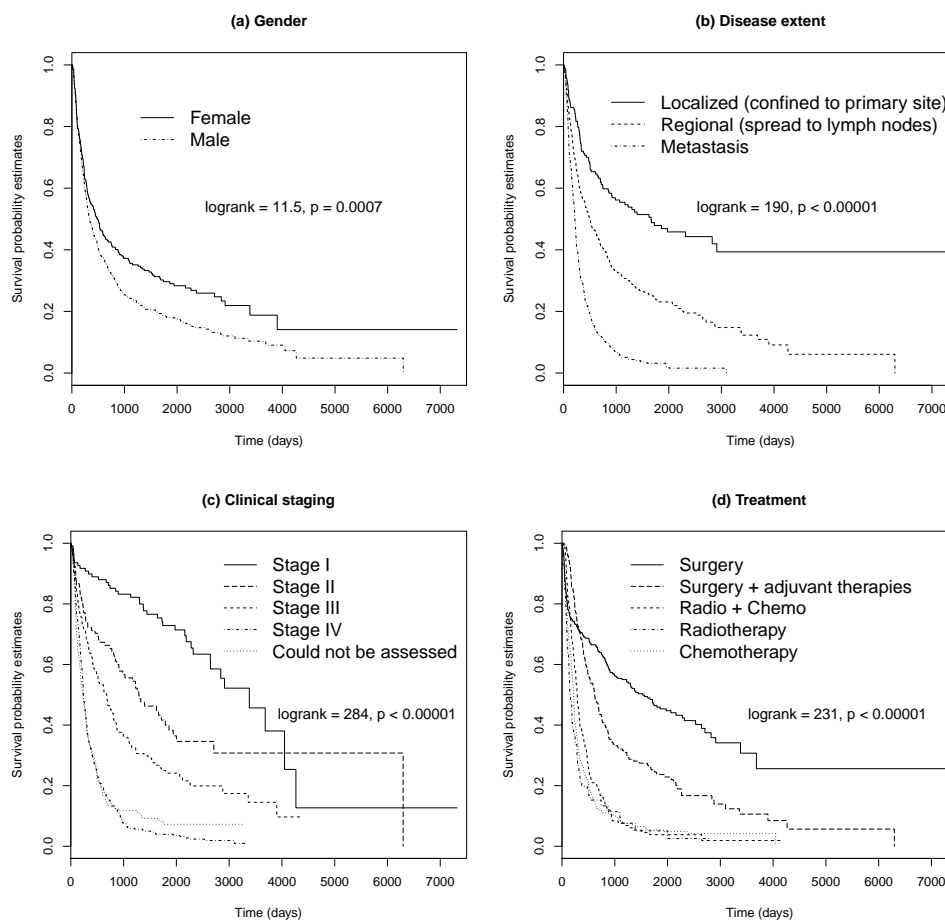


Figure 3 - Kaplan-Meier survival curves for the patients diagnosed with stomach cancer by the covariates (a) gender, (b) disease extent, (c) clinical staging and (d) treatment.

3.3 Results of the log-normal model: patients with esophageal cancer

To select which covariates have a significant effect in the log-normal regression model, all six, described in Table 1, were initially included. The covariate age was considered as continuous. Patients diagnosed at clinical staging I and II were pooled into one category since few patients were diagnosed at stage I. Dummy variables were used to include the categorical covariates in the model. The first category shown in Figure 2 was taken as the reference level. At a significance level of 5%, age and year of diagnosis presented no significant effects (p -values > 0.6). Parameter

estimates obtained from the final model are displayed in Table 2.

Table 2 - Parameter estimates obtained from the log-normal regression model fitted to the survival data of patients diagnosed with esophageal cancer

Parameters	Estimates	s.e.	Z	p-value	R_{MT} and 95% CI
Intercept	6.680	0.1573	42.48	< 0.001	
Gender					
Male*					
Female	0.295	0.0839	3.52	< 0.001	1.34 (1.14, 1.58)
Disease extent					
Localized*					
Regional	-0.251	0.1092	-2.29	0.022	0.78 (0.63, 0.96)
Metastasis	-0.353	0.1435	-2.46	0.014	0.70 (0.53, 0.93)
Clinical staging					
Stage I or II*					
Stage III	-0.476	0.1000	-4.76	< 0.001	0.62 (0.51, 0.76)
Stage IV	-0.780	0.1547	-5.04	< 0.001	0.46 (0.34, 0.62)
Could not be assessed	-0.403	0.1274	-3.17	0.0015	0.67 (0.52, 0.86)
Treatment					
Surgery*					
Surgery + adjuvant	0.237	0.1782	1.33	0.184	1.27 (0.89, 1.80)
Radiotherapy	-1.265	0.1271	-9.95	< 0.001	0.28 (0.22, 0.36)
Chemotherapy	-1.258	0.1725	-7.30	< 0.001	0.29 (0.20, 0.40)
Radio + Chemotherapy	-0.464	0.1464	-3.17	0.0015	0.63 (0.47, 0.84)
$\log(\sigma)$	0.135	0.0244	5.54	< 0.001	

*Reference levels considered in the dummy variables, s.e.= standard error, R_{MT} = ratios of median survival times and CI = confidence interval.

To check the overall fit of the model, plots based on the Cox-Snell residuals and also on the standardized residuals (shown in Figure 4a) suggest that the log-normal regression model fits very well to the data. Thus, as in the log-normal model parameter exponentiation can be interpreted as ratios of median survival times (Hosmer and Lemeshow, 1999), one can conclude that female patients is expected to survive longer since its median survival time is $\exp(0.295) = 1.34$ times greater than of the male patients. Also, patients diagnosed with localized cancer have a median survival time $1/\exp(-0.251) = 1.28$ times greater than of those diagnosed with regional cancer and $1/\exp(-0.353) = 1.42$ times greater than of those diagnosed with metastasis.

In addition, patients diagnosed at clinical staging IV presented a median survival time approximately half ($\exp(-0.78) = 0.46$) of those diagnosed at clinical staging I or II. Furthermore, patients who underwent surgery or surgery combined with adjuvant therapies showed the highest median survival time, followed by those submitted to radiotherapy combined with chemotherapy. Actually, patients who underwent surgery with or without adjuvant therapies showed no significant differences with respect to their survival times ($p = 0.184$). Patients who received only radiotherapy or chemotherapy presented low median survival time. As $\exp(-1.258 - (-1.265)) \approx 1$, there is evidence of no statistical difference between these two therapies.

3.4 Results of the log-normal model: patients with stomach cancer

Analogous to the previous analysis, the log-normal regression model was fitted to the survival data of 981 patients diagnosed with stomach cancer. In this case, the first five covariates described in Table 1 showed significant effect at a significance level of 5%. The plot based on the standardized residuals depicted in Figure 4b suggests that the model fits very well to the data. Parameter estimates are displayed in Table 3.

Table 3 - Parameter estimates obtained from the log-normal regression model fitted to the survival data of patients diagnosed with stomach cancer

Parameters	Estimates	s.e.	Z	p-value	R_{MT} and 95% <i>CI</i>
Intercept	9.013	0.1573	42.48	< 0.001	
Gender					
male*					
Female	0.173	0.0998	-1.73	0.042	1.19 (0.98, 1.44)
Age	-0.012	0.0363	-3.27	0.001	0.99 (0.92, 1.06)
Disease extend					
Localized*					
Regional	-0.505	0.1371	-3.68	< 0.001	0.60 (0.46, 0.79)
Metastasis	-0.785	0.1542	-5.09	< 0.001	0.45 (0.34, 0.62)
Clinical staging					
Stage I*					
Stage II	-0.999	0.2046	-4.88	< 0.001	0.37 (0.25, 0.55)
Stage III	-1.571	0.2003	-7.85	< 0.001	0.21 (0.14, 0.31)
Stage IV	-2.144	0.2028	-10.57	< 0.001	0.12 (0.08, 0.17)
Could not be assessed	-2.173	0.2154	-10.09	< 0.001	0.11 (0.07, 0.17)
Treatment					
Surgery*					
Radiotherapy	-0.521	0.1931	-2.70	0.007	0.59 (0.41, 0.87)
Chemotherapy	-0.501	0.1041	-4.81	< 0.001	0.61 (0.49, 0.74)
Surgery + adjuvant	-0.256	0.1407	-1.82	0.034	0.77 (0.59, 1.02)
Radio + chemotherapy	-0.559	0.1203	-4.65	< 0.001	0.57 (0.45, 0.72)
log(σ)	0.223	0.0271	8.23	< 0.001	

*Reference levels considered in the dummy variables, s.e.= standard error, R_{MT} = ratios of median survival times and *CI* = confidence interval.

According to the estimates obtained from the model, female patients at clinical staging I with localized tumor and underwent surgery, presented the highest probability to survive longer. For instance, the median survival time of female patients was $\exp(0.173) = 1.2$ times greater than of the male patients. Moreover, patients diagnosed with the disease at a younger age were more likely to survive longer. For example, the median survival time of patients 40 years-old at the diagnosis was ≈ 1.3 times greater of those patients 60 years-old at the diagnosis ($\exp(-0.012(40 - 60))$). Also, the median survival time of patients diagnosed with localized cancer was $1/\exp(-0.785) = 2.2$ times greater of those diagnosed with metastasis. This time has also declined as the clinical staging became more advanced.

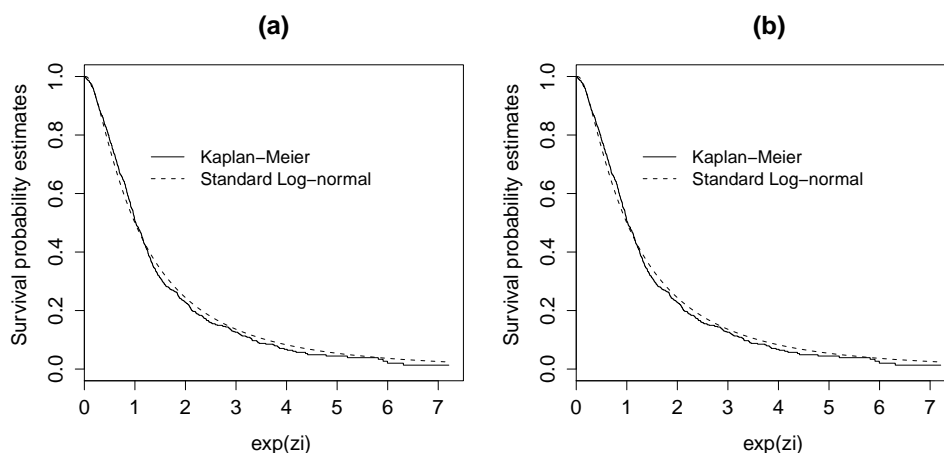


Figure 4 - Analysis of the standardized residuals associated with the log-normal models fitted to the survival data of patients diagnosed with a) esophageal cancer and b) stomach cancer.

Surgery was the treatment that presented the highest probability to survive longer, followed by surgery combined with adjuvant therapies. Furthermore, radiotherapy, chemotherapy and radiotherapy combined with chemotherapy were the treatments presenting the lowest probability to survive longer. Actually, patients submitted to these therapies showed no significant differences with respect to their survival time (estimates near to -0.5 for all them).

In addition to the results discussed, the expression (1) of the log-normal regression model, allow us to estimate the respective probability of any patient surviving t days. For instance, a male patient aged 50 years who was diagnosed with localized stomach cancer at clinical staging II and that underwent surgery, would have an estimated probability to survive five years of $S(\widehat{1825} | \mathbf{x}_i) = 0.47$. If this patient was, however, diagnosed with esophageal rather than stomach cancer, such probability would be 0.24.

Concluding remarks

Survival of Brazilian patients with esophageal or stomach cancer were analyzed in this paper based on data recorded during a period of 20 years. From this 20-year study period, we have shown that stomach cancer seems to be less aggressive than esophageal cancer since patients with stomach cancer had longer survival. In agreement with other studies that reported higher frequency of these cancers in men (e.g., Thuler et al., 2006; Terciotti Jr et al., 2009; Butte et al., 2008), we have

also found that gender had influence on patient survival for either stomach and esophageal cancer. For patients with esophageal cancer there was a ratio of 2.8 men for each woman and 2.6 for those with stomach cancer.

For both cancers, advanced clinical stage at diagnosis was the main cause of poor survival. A gradient of severity was also observed from the localized to the metastatic state. Age had no significant influence on survival of patients with esophageal cancer, while for those with stomach cancer the prognosis was better for young people. Furthermore, year of diagnosis was not significantly associated with patient survival for either gastric or esophageal cancer, suggesting no meaningful change in survival during the 20-year study period even with the advances in the quality of surgical techniques and other medical management that have been occurred in the past decade. This conclusion is in agreement with that presented by Crane et al. (2008) who analyzed a population-based study of cases of gastric and esophageal adenocarcinoma considered by them as representative of the white U.S. population. Patients in our study are mostly European descendants.

Regarding the overall five-year survival rate, it was estimated at 21% for patients diagnosed with stomach cancer against 11% for those diagnosed with esophageal cancer. In general, these estimates are in agreement with those reported abroad (Akoh and Macintyre, 1992; Braghetto et al., 2000; Butte et al., 2008). The corresponding estimates of the overall ten-year survival rate in our study were 12% and 6%, respectively.

Overall, the survival analysis performed in this article have confirmed the poor prognosis of both esophageal and stomach cancers, as well as that diagnosis and treatment of these cancers at an earlier stage remains the key to increase the survival of these patients. Intensify efforts at prevention and early diagnosis seems therefore crucial to change such prognosis.

GIOLO, S. R.; FLORES, B. I. O; BARSZCZ, P. K.; ORLANDI, D. Sobrevida de pacientes brasileiros diagnosticados com neoplasias malignas no sistema digestivo. *Rev. Bras. Biom.*, São Paulo, v.30, n.4, p.476-491, 2012.

- RESUMO: Análise de dados de pacientes diagnosticados com neoplasias malignas pode ser útil para identificar fatores afetando suas sobrevidas, bem como auxiliar os médicos na escolha de tratamentos e medidas paliativas. Nesse contexto, o modelo de regressão log-normal foi utilizado nesse artigo para analisar a sobrevida de 1.232 pacientes diagnosticados com câncer de esôfago e 981 diagnosticados com câncer de estômago. Esses pacientes foram admitidos entre 1990 e 2004 em um centro de tratamento de câncer localizado no Brasil, sendo acompanhados até dezembro de 2009. Fatores que apresentaram um papel importante na sobrevida desses pacientes foram: sexo, idade, estadiamento clínico, extensão da doença e tratamento. Mesmo com os avanços importantes ocorridos no tratamento desses cânceres ao longo das últimas décadas, nossos resultados confirmaram um prognóstico pobre para ambos, em particular quando estes são diagnosticados em estágios avançados.
- PALAVRAS-CHAVE: Câncer de esôfago; câncer de estômago; modelo log-normal, análise de sobrevida.

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Received in 21.09.2012.

Approved after revised in 26.05.2013.