Abstract
Objectives: Differences in mortality rates within Europe might be partly due to the quality of mortality statistics. The present article summarizes the available data on the quality of cancer death certification in Spain. A short description of the temporal distribution of the proportion of deaths due to ill-defined tumors in Spain –an indirect indicator of the quality of cancer death certification– is also provided.

Methods: Relevant studies were identified from electronic databases (MEDLINE, EMBASE, IME and IBECS) and from manual searches of the references contained in the articles retrieved. Quality data on death certificates for all tumors and for each specific cancer location were summarized, and all main cancer sites were classified according to their pooled accuracy indicators. Trends for the percentage of deaths due to ill-defined tumors and conditions were studied for the period from 1980 to 2002.

Results: In Spain, deaths from cancer as a whole and leading cancer sites (lung, colon-rectum, prostate, stomach, pancreas, female breast, uterus, brain, leukemia, lymphomas and myeloma) were well-certified. However, other frequent locations, such as the larynx, esophagus and liver were overcertified, while deaths from bladder, kidney and ovarian cancer were undercertified. The percentage of deaths due to ill-defined tumors and causes was regularly higher in females and decreased in both sexes during the study period. However, the recent introduction of the International Classification of Diseases (ICD)-10 has reversed this trend.

Conclusions: Spanish death certificates can be considered as accurate and useful to estimate the burden of cancer, though certification of some frequent sites should be improved. The possible effect of the introduction of the ICD-10 requires careful surveillance.


Resumen
Objetivos: Parte de las diferencias en tasas de mortalidad por cáncer entre países europeos podrían deberse a diferencias de calidad en las estadísticas de mortalidad. Nuestro objetivo es sintetizar la información cuantitativa que hay acerca de la calidad de los certificados de defunción por cáncer en España, y se añade una somera descripción de la evolución temporal de la proporción de defunciones por tumores mal definidos, indicador indirecto de calidad.

Métodos: Se identificaron los estudios relevantes mediante búsquedas en bases de datos electrónicas (MEDLINE, IME, EMBASE e IBECS), y posteriormente se añadieron referencias presentes en los artículos encontrados. Se extrajo la información acerca de calidad de certificación para cáncer en conjunto y para las principales localizaciones tumorales, y se clasificaron los tumores según sus indicadores de calidad. Se estudió también la tendencia del porcentaje de muertes mal definidas o tumores mal definidos entre 1980-2002.

Resultados: En España, el cáncer en conjunto y los principales localizaciones –pulmón, colon-recto, próstata, estómago, páncreas, mama, útero, cerebro, leucemia, linfomas y mieloma– están bien certificados. Sin embargo, otras localizaciones como laringe, hígado y esófago están sobrecertificadas, mientras que el cáncer de vejiga, riñón y ovario están infracertificados. Los porcentajes de muertes por tumores o condiciones mal definidas, mayores en mujeres, han disminuido en el período estudiado, aunque la introducción de la CIE-10 ha invertido esta tendencia.

Conclusiones: En general, los certificados de cáncer pueden considerarse válidos y útiles para estimar el impacto del cáncer en España, aunque la certificación de algunas localizaciones importantes podría mejorar. Debería estudiar-se el posible efecto de la introducción de la CIE-10.

Background

One of the most usual approaches to studying the situation of cancer worldwide is to analyse the geographic distribution of mortality rates and their trends. Information on the quality of cancer mortality data is thus essential for interpreting differences in mortality statistics.

In Spain, mortality represents the only comprehensive and homogeneous source of information on cancer for the whole country. The source of mortality statistics is the medical death certificate (DC), a compulsory administrative document completed by the practitioner who certifies the death. This certificate is subsequently transcribed onto a second document, the Statistical Bulletin of Death (SBD), and both are sent to the Municipal Civil Registry. Usually, the Civil Registry forwards the SBDs to the regional offices of the National Statistical Institute (Instituto Nacional de Estadística [INE]) on a monthly basis, where all items except cause of death are digitally recorded. When the data have been duly screened to detect errors and ensure quality control, the underlying causes of death (Causa básica de defunción) are coded at the Regional Authority Mortality Registries in accordance with International Classification of Diseases (ICD) guidelines. National coding protocols have been established to guarantee homogeneity of data.

Specific methods have also been implemented to validate accuracy systematically. Digital data files are then sent to the INE head office, which releases them once they have been rendered anonymous.

Quantitative data that would enable to assess the quality of cancer death certificates in Spain are relatively scarce. Several studies have addressed this topic, but all refer to areas of the country or to specific populations, and some have been published in local epidemiological bulletins or in symposium proceedings, which are not easily accessible. In this paper, we sought to synthesize information derived from these studies and to complement such data with a short description of the temporal distribution of the proportion of deaths due to ill-defined tumours in Spain, as an indirect indicator of the quality of cancer death certification.

Methods

For review purposes, DC and SBD were deemed to be death certificates, as a very high concordance between both documents has been reported. Studies into the quality of cancer death certification in Spain were identified through: 1) a MEDLINE and EMBASE search using broad search criteria (January 1966 to January 2006); 2) a similar search in Spanish bibliographical databases, the Spanish Medical Index (Índice Médico Español [IME]), and IBECS; and 3) references in identified papers. In two studies, only abstracts of poster presentations at scientific meetings were published. In these cases, quality-indicator data presented in the poster were specifically searched for.

Studies were considered eligible if they reported quantitative estimates on the accuracy of death certificates containing any mention of cancer. In these studies, cancer death certificates were compared against a second source of information, mainly comprising clinical or anatomo-pathological reports (which were taken as the «gold standard»). Agreement between both sources was measured using detection and confirmation rates.

According to Percy et al. (1996), the detection rate (DR) or sensitivity for a specific site is defined as the proportion of hospital diagnoses (available clinical/anatomo-pathological information) with cancer of a certain site, with a death certificate where this disease is considered to be the basic cause of death, whereas the confirmation rate (CR) or positive predictive value is the proportion of cancer deaths in which the underlying cause specified in the death certificate is confirmed by hospital diagnosis.

DRs and CRs can be computed as: a) site-specific cancer rates at three digits of the ICD, that is considering an indicator per cancer-site; b) all-site three-digit rates, an overall indicator for cancer where the rates’ numerator contains all cancer cases (ICD-9 codes 140-208) in which the site specified in the death certificate and gold standard agree; and c) all-tumour rates, also an overall indicator where the rates’ numerator includes all cases that just mention «cancer» in both the death certificate and gold standard, even though there might be site misclassification. These figures are logically expected to be higher than overall comparisons at a three-digit level. A graphical scheme that might help understand these concepts is shown in figure 1.

Identified papers were classified into three main categories:

I. Studies focusing on all-cause death certificates, which provide accurate detection and confirmation rates (fig. 1).

II. Studies based solely on death certificates that mention cancer. These could be subdivided into two groups:

a. Studies with an additional source of information on \( a_i \) or \( b_i \) (fig. 1) that allows them to estimate accurate detection and confirmation rates. In some cases, these data were not considered for the purpose of calculating site-specific cancer rates, thereby leading to overestimated rates.
b. Studies without information on cancer deaths not certified as such, or on non-cancer cases erroneously certified as cancer (c_g or c_b). This rules out the possibility of computing all-tumour or three-digit agreement detection rates, and means that site-specific detection rates and confirmation rates are likely to be overestimated (fig. 1).

In some cases\(^4,7,8\), it was possible to find information on global false positives within the text of the paper. We used these data to calculate unbiased all-tumour confirmation rates.

III. Necropsy-based studies. Since necropsies are relatively scarce in this country\(^9\), the main problem with these studies is external validity, as they tend to focus on very specific populations.

Many of the detection and /or confirmation rates offered in the summary tables were directly taken from the selected studies, though, where possible, the tables were completed by computing DRS and CRs using data provided in the papers.

In a second stage, a pooled CR and DR was calculated for each specific cancer location using data from all studies that had covered that location, and then all main cancer sites were classified according to Percy’s criteria, the bench-mark for these types of studies\(^5\). Finally, as a complementary approach, we calculated the percentage of deaths due to ill-defined tumour versus all-tumour deaths and the percentage of deaths of ill-defined conditions versus all-cause deaths for the period 1980-2002, using whole country mortality figures supplied by the INE.

Results

Published studies on quality of cancer death certificates in Spain

A total of 14 studies providing quantitative data on quality of cancer death certification in Spain were found. The main characteristics of these studies, their classification according to the above criteria and, where available, all-tumour (ICD-9 codes 140-208) and all-site three-digit detection and confirmation rates are shown in table 1. In addition, figure 2 depicts the geographical location of the respective study populations.

Six of these studies belonged to categories I and II(a)\(^3,6,10-14\), those furnishing the most accurate estimators, with detection rates ranging from 75.2-100% for all tumours as a whole and 64.8-100% for all-site three-digit rates. On average, confirmation rates were higher than detection rates, ranging from 91.5-99.3% for all-tumour and 68.2-80.8% for all-site three-digit rates.

Another five studies were classified as category II(b)\(^7,8,15-18\). In general, they supplied data on all-tumour and all-site three-digit confirmation rates. Yet, with two exceptions\(^4,8\), these studies failed to consider global false positives when estimating three-digit confirmation rates, an approach that implies a certain overestimation of the agreement. Where possible, therefore, we calculated a
corrected confirmation rate by including global false positives in the denominator. Only one study\(^4\) had adopted this approach and, in this case, the «biased» confirmation rate (excluding global false positives) was reckoned for comparison purposes. Both «biased» – denoted by «*» – and corrected confirmation rates are shown in table 1. On average, biased confirmation rates were three points higher than corrected rates. In these stu-

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**Table 1A. Quality of cancer death certification in Spain. Characteristics and classification of published studies sorted by publication year**

<table>
<thead>
<tr>
<th>Study category</th>
<th>Author</th>
<th>Geographic location</th>
<th>Institution</th>
<th>Period analysed</th>
<th>Death certificates or SBD (All cases/cancer)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>García-Benavides, 1986(^a), 1989(^b)</td>
<td>Valencia (city)</td>
<td>University of Alicante</td>
<td>1984</td>
<td>1,060/279</td>
</tr>
<tr>
<td>I</td>
<td>Pañella, 1989(^c)</td>
<td>Barcelona (city)</td>
<td>Municipal Institute of Health</td>
<td>1985</td>
<td>1,480/190(^d)</td>
</tr>
<tr>
<td>I</td>
<td>Ruiz Liso, 1989(^e)</td>
<td>Soria (province)</td>
<td>Provincial Hospital</td>
<td>1985</td>
<td>993/309</td>
</tr>
<tr>
<td>I</td>
<td>Giménez, 2002(^f)</td>
<td>a) National</td>
<td>CISATER</td>
<td>1981-1995</td>
<td>1,485/294</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) National</td>
<td>CISATER</td>
<td>1987-1998</td>
<td>773/224</td>
</tr>
<tr>
<td>I(a)</td>
<td>Caffaro, 1995</td>
<td>Island of Majorca</td>
<td>Cancer Registry</td>
<td>1989</td>
<td>-/1,250</td>
</tr>
<tr>
<td>I(a)</td>
<td>Sánchez-Garrido, 1996(^g)</td>
<td>a) National</td>
<td>University Hospital, Municipal Institute of Health</td>
<td>1986-1989</td>
<td>-/244</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b) National</td>
<td>Cancer Registry</td>
<td>1989</td>
<td>-/244</td>
</tr>
<tr>
<td>I(b)</td>
<td>Bosch, 1981(^h), 1983(^i)</td>
<td>Barcelona (city)</td>
<td>Hospital, Municipal Institute of Health</td>
<td>1979</td>
<td>-/2,940</td>
</tr>
<tr>
<td>I(b)</td>
<td>Navarro, 1984(^j)</td>
<td>Murcia (province)</td>
<td>Public Health Authority, Cancer Registry</td>
<td>May 1981-Oct 1983</td>
<td>-/2,500</td>
</tr>
<tr>
<td>I(b)</td>
<td>DGA, 1988(^k)</td>
<td>Zaragoza (city)</td>
<td>Cancer Registry</td>
<td>1983</td>
<td>-/3,366</td>
</tr>
<tr>
<td>I(b)</td>
<td>Izazuriaga, 1994(^l)</td>
<td>Euskadi (Basque Country) (region)</td>
<td>Cancer Registry</td>
<td>1989</td>
<td>-/3,940</td>
</tr>
<tr>
<td>I(b)</td>
<td>Martínez, 2000(^m)</td>
<td>Granada (province)</td>
<td>Cancer Registry</td>
<td>1991-1994</td>
<td>-/4,772</td>
</tr>
<tr>
<td>I(b)</td>
<td>Cirera, 2002</td>
<td>Murcia (province)</td>
<td>Cancer Registry</td>
<td>1992</td>
<td>-/1,658</td>
</tr>
<tr>
<td>III</td>
<td>Castellón, 1989(^p)</td>
<td>Valencia (region)</td>
<td>Public Health Authority</td>
<td>1985</td>
<td>90/19</td>
</tr>
</tbody>
</table>

\(^a\) The study uses SBD.
Pérez-Gómez B et al. Accuracy of cancer death certificates in Spain: a summary of available information

Table 1B. Quality of cancer death certification in Spain. Characteristics and classification of published studies sorted by publication year

<table>
<thead>
<tr>
<th>Author</th>
<th>Cancer DC with</th>
<th>Cancer deaths detected only</th>
<th>CR (%)</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>García-Renañez, 1986; 1989</td>
<td>279</td>
<td>30 (revised DC without mention of cancer)</td>
<td>42.1(3D)</td>
<td>Studies all DC of this period</td>
</tr>
<tr>
<td>Padilla, 1989</td>
<td>154</td>
<td>36 (revised SBD without mention of cancer)</td>
<td>79.5(3D)</td>
<td>Studies all DC of this period</td>
</tr>
<tr>
<td>Ruiz-Laso, 1989</td>
<td>203</td>
<td>0</td>
<td>100(3D)</td>
<td>Studies all DC of this period</td>
</tr>
<tr>
<td>Giménez, 2000*</td>
<td>91 (clinical follow-up)</td>
<td>75.2(3D)</td>
<td>97.5(3D)</td>
<td>No additional cases found</td>
</tr>
<tr>
<td>Calzón, 1999</td>
<td>1,173</td>
<td>65 (Cancer registry)</td>
<td>94.7(3D)</td>
<td>Excludes multiple tumours</td>
</tr>
<tr>
<td>Sánchez Gamito, 1999</td>
<td>61 (Cancer registry)</td>
<td>93.3(3D)</td>
<td>73.0(3D)</td>
<td>Excludes multiple tumours</td>
</tr>
<tr>
<td>Bosch, 1981; 1982*</td>
<td>1,057</td>
<td>Not searched</td>
<td>61.4(3D)*</td>
<td>Only gynaecological cancer</td>
</tr>
<tr>
<td>Navarro, 1984*</td>
<td>646</td>
<td>Not searched</td>
<td>64.4(3D)*</td>
<td>Excludes ill-defined &amp; multiple tumours</td>
</tr>
<tr>
<td>DGA, 1988**</td>
<td>685</td>
<td>Not searched</td>
<td>73.1(3D)*</td>
<td>Excludes multiple tumours, in situ, skin non-melanoma and non-residents in this region</td>
</tr>
<tr>
<td>Zarzagarza, 1994*</td>
<td>3,296</td>
<td>Not searched</td>
<td>74.1(3D)*</td>
<td>Excludes multiple tumours</td>
</tr>
<tr>
<td>Martínez, 2002</td>
<td>4,231</td>
<td>Not searched</td>
<td>74.0(3D)</td>
<td>Excludes multiple tumours</td>
</tr>
<tr>
<td>Cirera, 2002</td>
<td>1,271</td>
<td>Not searched</td>
<td>74.0(3D)</td>
<td>Excludes multiple tumours</td>
</tr>
<tr>
<td>Nava, 1985, 1986**</td>
<td>7</td>
<td>6 (cancer deaths only detected by necropsy)</td>
<td>50.0(3D)</td>
<td>Necropsy-based</td>
</tr>
<tr>
<td>Carballal, 1989*</td>
<td>19</td>
<td>5 (cancer deaths only detected by necropsy)</td>
<td>42.1(3D)</td>
<td>Necropsy-based</td>
</tr>
</tbody>
</table>

CR: Confirmation rate; CR: Detection rate; G: all-tumour agreement rates (ICD-9 codes 140-208); 3D: all-site three-digit agreement rates.

* only those death certificate (DC) / Statistical Bulletin of Death (SBD) that really corresponded to malignant tumours used as denominator.

The results were slightly worse than others, but it should be borne in mind that in Spain most autopsies are restricted to cases with uncertain diagnosis.

Table 2 summarises available information in Spain on detection and confirmation rates for malignant neoplasms by the main specific locations. The data, sorted by the period analysed, revealed that in the interim between the early 1980’s and the most recent study (1992 data), the quality of certification had improved. Highest indices were found for cancer of the stomach, colon and rectum, pancreas, lung, melanoma, female breast, brain and haematological tumours. In contrast, other sites, such as ill-defined tumours and non-melanoma skin cancer, displayed lower rates of agreement.

Furthermore, in order to have a brief overview of the quality of cancer certification for specific sites, pooled estimators were calculated to classify the accuracy of death certification for specific cancers according to Percy’s criteria, which depend on detection and confirmation rates (table 3).

Figure 3 shows the trend in the percentage which ill-defined tumours and ill-defined causes represent of all-cancer and all-cause deaths, respectively, over the calendar period 1980-2002, in both sexes. During the 1980’s, Regional Mortality Registries became respon-
Table 2. Spanish cancer-death-certificate detection and confirmation rates by site

<table>
<thead>
<tr>
<th>Location</th>
<th>ICD-9 codes</th>
<th>Detection Rate (DR)</th>
<th>Confirmation Rate (CR)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Murcia 1992 (Cim 2002)</td>
<td>140-149</td>
<td>58.6 81.1 55.5 89.2 67.5 87.7 57.8 92.9</td>
<td>100.0 100.0 60.0 75.0 57.1 80.0 41.4 57.1</td>
</tr>
<tr>
<td>Granada 91-94 (Martín, 2000)</td>
<td>150</td>
<td>95.2 69.0 79.4 72.3 90.1 85.5 92.9 76.5</td>
<td>75.0 100.0 85.7 75.0 84.6 68.7 86.4 76.0</td>
</tr>
<tr>
<td>Mallorca 1989 (Balbo, Barque)</td>
<td>153</td>
<td>112.0 79.4 79.4 72.3 90.1 85.5 92.9 76.5</td>
<td>57.0 100.0 85.7 75.0 84.6 68.7 86.4 76.0</td>
</tr>
<tr>
<td>Barcelona 1998 (Sanz)</td>
<td>156</td>
<td>48.6 97.2 48.6 64.4 62.6 77.7 51.5 82.9</td>
<td>33.4 50.0 66.6 66.7 55.6 83.3</td>
</tr>
<tr>
<td>Girona 1984 (Cirera, Martínez, Basque)</td>
<td>159</td>
<td>82.1 90.9 89.9 47.5 90.6 47.5 80.7 47.1</td>
<td>66.6 14.3 53.8 38.9 85.7 37.5 53.3 25.6</td>
</tr>
<tr>
<td>Zaragoza 1981 (Cáffaro, Sánchez, Pañella, Ruiz Liso, Benavides, DGA, Navarro, 2002)</td>
<td>161</td>
<td>36.3 62.5 81.4 64.2 83.5 85.0 63.0</td>
<td>100.0 100.0 80.0 80.0 96.4 79.4 75.0 65.9</td>
</tr>
<tr>
<td>Valencia 1984 (García, Benavides, 1986, 1990)</td>
<td>162</td>
<td>93.8 89.8 91.6 85.9 93.7 92.4 95.4 95.4</td>
<td>67.6 85.5 100.0 94.8 84.6 91.7 93.2 91.2 93.2 86.6</td>
</tr>
<tr>
<td>Madrid 1972-1973</td>
<td>163</td>
<td>66.7 80.0 59.3 80.0</td>
<td>22.2 100.0 50.0 50.0 44.4 85.7</td>
</tr>
<tr>
<td>Murcia 1981 (Navarro)</td>
<td>172</td>
<td>59.9 83.3 76.9 100 76.7 88.9</td>
<td>50.0 50.0 44.4 85.7</td>
</tr>
<tr>
<td>Others</td>
<td>173</td>
<td>46.2 75.0 46.2 60.0</td>
<td>44.0 91.7 51.4 50.0</td>
</tr>
<tr>
<td>Brazil</td>
<td>174</td>
<td>92.1 81.7 87.9 98.6 92.2 98.7 91.7 100</td>
<td>94.1 88.9 100.0 88.0 95.7 97.5 96.7 98.6 97.0 0.00</td>
</tr>
<tr>
<td>Uterus</td>
<td>175,180,182</td>
<td>78.0 86.7 76.0 81.4 73.7 90.3 86.0 88.0 93.0 82.0</td>
<td>83.3 62.5 62.5 86.2 75.9 62.5</td>
</tr>
<tr>
<td>Cervix</td>
<td>178</td>
<td>51.7 88.2 57.6 57.1 50.0 59.8 68.0 94.4 43.2 86.4</td>
<td>100.0 50.0 75.0 100.0 0.0 0.0 25.0 50.0</td>
</tr>
<tr>
<td>Corpus</td>
<td>180</td>
<td>50.0 83.3 89.9 89.5 85.5 87.5 85.7 84.9 82.8</td>
<td>100.0 100.0 71.3 33.3 14.3 33.3</td>
</tr>
<tr>
<td>Ovary</td>
<td>181</td>
<td>48.6 80.2 70.1 50.1 71.2 78.1 71.4 71.4 83.7 77.9</td>
<td>100.0 100.0 36.4 44.4 58.3 87.5</td>
</tr>
<tr>
<td>Prostate</td>
<td>182</td>
<td>93.2 84.6 87.6 81.3 90.8 91.4 89.5 93.2 94.1 85.5</td>
<td>90.9 76.0 68.8 49.3 88.2 65.2 91.0 90.0 33.3</td>
</tr>
<tr>
<td>Other genit-al</td>
<td>183-187</td>
<td>0.0 0.0 70.0 70.0 77.8 100.0 50.0 100.0</td>
<td>100.0 0.00</td>
</tr>
<tr>
<td>Testicular</td>
<td>188</td>
<td>0.0 0.0 70.0 70.0 77.8 100.0 50.0 100.0</td>
<td>100.0 0.00</td>
</tr>
<tr>
<td>Bladder</td>
<td>189</td>
<td>77.9 91.4 76.4 90.2 87.3 88.8 74.4 91.4</td>
<td>100.0 77.8 50.0 70.0 63.8 99.0 58.8 100.0</td>
</tr>
<tr>
<td>Kidney</td>
<td>190</td>
<td>75.0 80.0 79.0 84.5 88.8 92.1 85.8 88.8</td>
<td>100.0 68.7 70.0 77.8 86.7 25.0</td>
</tr>
<tr>
<td>Brain</td>
<td>191</td>
<td>96.2 92.6 95.5 83.6 94.4 87.9 100.0 84.4</td>
<td>100.0 77.7 91.7 78.6</td>
</tr>
<tr>
<td>Endocrine Glands</td>
<td>193-194</td>
<td>100.0 71.4 75.0 75.0 73.7 100.0 100.0</td>
<td>100.0 80.0</td>
</tr>
<tr>
<td>Thyroid</td>
<td>195</td>
<td>100.0 75.0 64.7 79.6 88.0 100.0</td>
<td>100.0 100.0</td>
</tr>
<tr>
<td>Ill-defined tumours</td>
<td>196-199</td>
<td>58.2 50.4 50.6 30.0 56.5 51.7 52.6 42.4</td>
<td>31.6 30.0 5.8 23.1</td>
</tr>
<tr>
<td>Lymphomas</td>
<td>200-202</td>
<td>90.2 83.0 87.0 77.7 85.7 91.3</td>
<td>100.0 100.0 86.7 52.9 62.5 79.6 50.0 50.0</td>
</tr>
<tr>
<td>Hodgkin</td>
<td>203</td>
<td>50.0 93.0</td>
<td>75.0 85.7 100.0 42.0</td>
</tr>
<tr>
<td>Others</td>
<td>204-209</td>
<td>81.6 75.6</td>
<td>71.9 85.3 84.8 90.3</td>
</tr>
<tr>
<td>Multiple Myeloma</td>
<td>210</td>
<td>100.0 94.4</td>
<td>100.0 52.3 81.3 92.9</td>
</tr>
<tr>
<td>Leukaemia</td>
<td>211-212</td>
<td>52.9 96.2 54.6 96.2 86.1 98.3 100.0 100.0 100.0 100.0</td>
<td></td>
</tr>
</tbody>
</table>

Note: CR: confirmation rate; DR: detection rate. Tumours (ICD 200-203). Only lymphoid cases were found (ICD 204). Haematopoietic and reticular system (ICD-O 169).

Rates from reviewed studies, though in some cases Detection Rates (DR) and Confirmation Rates (CR) were calculated with data supplied in the papers.
Table 3. Accuracy of death certification for specific cancers in Spain according to Percy’s criteria (Percy 1981). Pooled analysis

<table>
<thead>
<tr>
<th>Location</th>
<th>ICD-9 DR CR Location</th>
<th>ICD-9 DR CR Location</th>
<th>ICD-9 DR CR Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stomach</td>
<td>151 83 89</td>
<td>Oesophagus 150 87 78</td>
<td>Mouth &amp; pharynx 140-149 59 85</td>
</tr>
<tr>
<td>Colon-rectum 153-154 83 90</td>
<td>Liver 155 85 45</td>
<td>Rectum 154 54 82</td>
<td>Gallbladder 156 58 79</td>
</tr>
<tr>
<td>Pancreas 157 84 80</td>
<td>Larynx 161 83 67</td>
<td>Skin 172-173 54 87</td>
<td>Corpus uteris 162 42 76</td>
</tr>
<tr>
<td>Lung 162 52 91</td>
<td>Melanoma 172 78 91</td>
<td>Ill-defined tumours 156-199 53 30</td>
<td></td>
</tr>
<tr>
<td>Breast 174 50 98</td>
<td>Skin (non-melanoma) 173 42 80</td>
<td>L. Hodgkin 201 69 69</td>
<td></td>
</tr>
<tr>
<td>Uterus 179,180,182 82 83</td>
<td>Cervix uteris 180 51 91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prostate 185 69 82</td>
<td>Ovary 183 74 81</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brain 191 56 85</td>
<td>Other genital-δ 186-187 69 82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lymphomas 200-202 86 80</td>
<td>Testicular 186 78 88</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Multiple Myeloma 203 96 94</td>
<td>Bladder 188 76 91</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leukaemia 204-208 99 93</td>
<td>Kidney 189 76 83</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endocrine glands 150-194 79 83</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Thyroid gland 150 76 89</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lymphomas, others 200-202 76 83</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

CR: confirmation rate; DR: detection rate.

Discussion

Though quality at a national level has not been studied, available data suggest that, overall, cancer death certificates in Spain possess an accuracy comparable to that reported for other industrialised countries.

Indirect estimations such as the proportion of ill-defined causes in Spain show similar percentages to those registered by other developed countries.

The first Spanish study to address death certificate reliability was published in 1981. Specifically focused on cancer death certificates, this study solely covered the Barcelona metropolitan area. Several authors...
subsequently studied the quality of death certificates in other parts of the country. In this paper, we summarised all available information to provide a global view of the quality of Spanish cancer-mortality statistics.

In Spain, published quality estimators are basically drawn from regional studies, many of which are sponsored or undertaken by Cancer Registries. Accordingly, it should be borne in mind that, despite the existence of national coding protocols, differing quality indicators for the country, such as our pooled estimators, might also be problematic, since decentralisation of the coding process could cause inter-regional variability, and there are huge areas of the country where death certification quality studies have not been conducted (fig. 2). Onlín Giménez et al., in their study on a toxic-oil poisoned cohort, provided national data, though their results could also be misleading as they refer to a cohort of sick people, subjected to a thorough follow-up over time. The progressive increase in the number of Cancer Registries in the country might go some way towards having more representative data about quality of cancer death certification in Spain in the future. Nevertheless, results from the different studies were quite similar for most cancer sites.

Compared to other causes of death, cancer (ICD 140-208) seems to be well certified in Spain, with detection rates being as much as 9 points higher for all tumours than for all causes together, and confirmation rates over 20 points higher than for all causes11,12, which could be due to the fact that cancer is usually a well-characterised diagnosis, and in most cases has histological confirmation.

All-tumour detection rates ranged from 79.9 to 100 respectively. Nevertheless, it should be noted that colon and rectal cancers are respectively ill-certified, since decentralisation of the coding process could cause problematic locations raised it to 83%. A comparable increase was previously described in the USA4 (4%) and in Ontario6 (8%). Analysis of specific anatomic locations shows that, in general, the main leading cancer sites are well certified. Thus, lung, colon-rectum (ICD 153-154), prostate, stomach, pancreas, female breast, uterus (ICD 179-180,185) and brain cancer, as well as leukaemia, lymphomas, myeloma belong to this category. Together, they represented around 69% of all cancer deaths registered in Spain in 200231. Nonetheless, it should be noted that colon and rectal cancers are respectively ill and undercertified unless they are considered together, since mutual misclassification of the two sites has been reported 13,14. A similar situation can be observed with respect to uterus. Overall, this location has good accuracy rates, but cervix and corpus uterus are under –and ill– certified, respectively. Mortality due to uterus cancer in Spain registered a steady decrease since 1976, contrasting with the slightly increasing trend in cervix mortality15, which has been explained mainly as a consequence of a reassessment of cases previously coded as «uterus non-specified»16. Nevertheless, if uterus is regarded as a single category, its certification has improved with time and, in more recent studies, achieves acceptable figures. Some other frequent locations, such as larynx, bladder or ovary, which rank among the ten leading causes of cancer death in Spain, evade problems in certification. A certain degree of overreporting has been described for laryngeal cancer, due to misclassification of head and neck tumours17,18. Similarly, there is certain measurement of urinary bladder cancer, erroneously certified under this category.

As expected, when site misclassification was taken into account, agreement estimates were lower. All-site three-digit detection rates from categories I and II(a) studies range from 64.8 to 100 and confirmation rates over 20 points higher than for all causes11,12, while others have viewed tumours as being slightly underreported10,16. However, the percentage of underreporting in Spain, as estimated by García-Benítez et al.19 and Calzado et al.20, seems to be around 5-6%, which is comparable to international figures20,23,24. Hence, global cancer mortality figures can be considered accurate and useful for estimating the burden of this group of diseases.

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hors have reported undernotification of skin cancers due to lack of information on their anatomic location, thereby implying their inclusion as ill-defined and unspecified tumours (ICD-9 195, 199).

Accuracy of ovary-neoplasm certification seems to vary widely among studies, though it can be regarded as uncertain according to pooled estimates. While some reported cases of death due to ovarian cancer were really due to abdominal or uterine neoplasms, in some studies «unspecified uterus tumours» would appear to include some ovarian cancers as well as tumours of the cervix and endometrium.

III-defined tumours were badly certified according to Percy's criteria. Cirera and Navarro reported there was clinical information that would allow for almost half of these tumours to be included in other categories. The selfsame problem has been described in other countries, such as Brazil.

Our results show that all cancer sites classified as well certified in Spain have been reported as such in the USA by Percy et al. However, this author also encountered good agreement rates for esophagus, bladder, gallbladder, thyroid gland and kidney, locations that did not display a good standard in Spanish studies. In Ontario, Canada, Reynolds similarly observed good DRs and CRs for all those neoplasms classified as well-certified in Spain, with the exception of pancreas, and also found high rates for cervix uterus, bladder, kidney, ovary and endocrine glands. In France, Laplanche et al. reported CRs of over 80% for breast, colon-rectum, lung and pancreas, values similar to Spanish figures. In contrast, they found CRs of under 80% for head and neck, stomach, cervix uterus, and ovary-tumours. In Italy, Stomach cancer was also well classified in Brazil and Italy. In international comparisons, however, a relevant factor to be considered are differences in international coding practice, since divergences up to 30% have been described by Percy and Muir among western countries using the ICD-9.

With respect to accuracy of certification, Percy mentioned the influence of several factors such as age, sex, geographic area, presence of an autopsy or place of death. In Spanish studies, a lower quality has been reported for older ages and for women. These sex-related differences are reflected in the percentage of ill-defined tumours and ill-defined causes, which are regularly higher in females and could in part be due, both to gynaecological neoplasms and to the older age of women. Insofar as place of death is concerned, a lower quality of death certification has been associated with death at home, though other authors have failed to find any difference. Finally, the quality of certification has been shown to be slightly lower in rural areas.

As Navarro et al. points out, clinical information is needed to validate death certificates, thus implying the exclusion of those cases where this information is not available. Death certificates lacking complementary clinical or anatomopathological data could be of worse quality, as they probably include more home deaths. Navarro found that death certificates excluded for this reason belonged to subjects who were, on average, seven years older than those included in her study. All this may well lead to overestimation of the quality reported in many studies.

Several strategies have been proposed to motivate and improve physicians’ certification such as a periodic assessment of coding practices along with the education and motivation of medical students and physicians. In Spain, several Regional Health Authorities implemented specific workshops that showed their efficacy in enhancing death certificate quality indicators. Yet, these interventions are questioned by Swift’s study, which failed to find significant changes in the state of certification after the introduction of formal education into the medical syllabus.

A further point of discussion is the effect of the introduction of the ICD-10 on the quality of mortality data. To date, we have been unable to find any validation study in Spain covering the ICD-10 coding period. In 1999, Ruiz et al. compared ICD-9 and ICD-10 coding in a huge sample of Spanish death certificates. They reported that, whereas ill-defined condition figures increased almost 14% with the use of this latest version, neoplasms seemed quite stable. In contrast, our data indicate that the ICD-10 effect might be greater than thought, and that it has also affected tumours coding. This could suggest a worsening in the quality of data, and careful surveillance is thus called for.

In conclusion, the quality of cancer death certification in Spain for all tumours and all main sites has improved over the last two decades and can be considered comparable to internationally published data. Thus, mortality data constitute a valid indicator to estimate the burden of cancer. However, for some locations, such as the oesophagus or bladder, death certificate information should be approached with caution. Misclassification may generate problems for studying mortality trends and planning future needs. It should be noted that, in general, most available information on the quality of death certification reflects the situation from 1970 to 1990, when the ICD-9 was in use. The relatively recent introduction of the ICD-10 may have affected quality indicators and should thus be carefully monitored. Finally, our results point to the need to improve death certification in the case of Spanish women.

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references
1. Instituto Nacional de Estadística. Manual de causas de de-
2. Garrucho G, Almazàn M, Madrazo M, Sánchez J, Valtuellerb e H, Infesta JA. Anàlisis de la concordancia de los datos re-
cogidos en el certificado médico de defunción y el boletín està
dístico de defunción. Rev Sanid Hig Publica. 1990;64:
63-72.
de las causas de muerte en la cohorte del síndrome del azoi-
toxico. Validación de los certificados oficiales de defunción.
Gac Sanit. 2002;16:118.
4. Izarzeguza I, Sastre B, Ibarrola T. Validez del boletín esta-
dístico de defunción en la Comunidad Autónoma del País
 Vasco. Resultados preliminares. Granada: XIX Reunión del
groupe p/Epidemiology et l’enregistrement du cancer dans
les pays du langue latine; 1994.
5. Percy C, Stanek EII, Glöckler L. Accuracy of cancer death
 certificates and its effect on cancer mortality statistics. Am J
6. Caffaro M, Garau I, Cabeza E, Franch P, Obrador A. Validez
 de los certificados de defunción por cáncer en Mallorca.
7. Corra L, Navarro C. Validez de la certificación de la muerte
por cáncer en la Comunidad de Murcia. Oncología. 2002;
25:264-72.
8. Martínez C, Sánchez MJ, Rodríguez M, Alamino FJ, Medi-
nan MJ. Exactitud del diagnóstico de cáncer en los certifica-
tos de defunción de la provincia de Granada. Revista de On-
9. Carballeira Rocca C, Vázquez Fernández E, Brana Rey N,
López Rois F, Loureiro Santamaria C, Hervada Vidal J. Apro-
ximación a la calidad de las estadísticas de mortalidad. Gal-
10. García-Benavides F, Fiabilidad de las estadísticas de mor-
talidad. Valencia: Conselleria de Sanitat i Consum. Genera-
litat Valenciana. Monografies Sanitàries. Serie A. N.
10; 1991.
12. Parrella H, Bonet C, Rodríguez R, Roca J. Validación de
1989;92:129-34.
13. Ruiz Liso JM, Sanz Arequeta JM, Altuna Torres J, Dodeiro de
Solano S, García Pérez MA. Valoración histopatológica de los
14. Sánchez Garindo MV, Izquierdo Fort A, Beltrán Fabregat M,
Bosch José FX. Tendencias temporales de la mortalidad por cáncer de cóncav en Cataluña 1975-1992: Anàlisis del Boletín Estadístic de Defunción y del
Registro de Cáncer de Girona. Gac Sanit. 1996;10:
67-72.
15. Bosch José FX, García González A, Orta Buá J. Mortalidad
por tumores malignos en la ciudad de Barcelona. Rev Sanid
Hig Publica. 1990;64:63-72.
16. Bosch FX, García A, Orta J, Juvent J, Campredon A, Pu-
marola A. The accuracy of medical certification of cancer

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dís information.

Pérez-Gómez B et al. Accuracy of cancer death certificates in Spain: a summary of available information

Deaths and of cancer diagnosis in the municipal area of Bar-
17. Navarro Sánchez C, Sánchez Sánchez JA, Molina Hán JA.
Validez del Boletín Estadístico de Defunción como fuente de
datos en las estadísticas sobre el cáncer. Un estudio preli-
18. Diputación General de Aragón: Exámen de los certificados
de defunción por cáncer en Zaragoza. Bol Epidemiol Aragón;
19. Navarro Caballero JM, Huguet Recasens M, Carnasco MA. Cer-
ificado médico de defunción: su fiabilidad. Rev Sanid Hig Pu-
bl. 1986;60:85-94.
20. Laplanche A. Quality of death certificates in cases of cancer
21. Reynolds DL, Nguyen VC, Clarke E. Reliability of cancer mor-
tality statistics in Ontario: a comparison of incident and death
22. Regidor E, Rodríguez C, Ronda E, Gutiérrez JL, Redondo JL.
La calidad de la causa básica de muerte del Boletín Estadís-
23. Griffith GW. Cancer surveillance with particular reference to
24. Puffer RR, Griffith GW. Patterns of urban mortality. Report of
the Inter-American investigation of mortality. Pan American
Mortalidad por cáncer y otras causas en España en 2002. Área
de Epidemiología Ambiental y Cáncer. Centro Nacio-
nal de Epidemiología. ISCIII. [Actualizado 2005; citado 9-
8-2005]. Disponible en: http://cne.isciii.es/hidro/can-
26. López-Abente G, Prollin M, Aragonés N, Pérez-Gómez B, Her-
nández V, Lope V, et al. Plan Integral del Cáncer. Situación
del cáncer en España. Madrid: Ministerio de Sanidad y Con-
sumo; 2003.
27. Percy C, Reis LS, Van Holten WD. The accuracy of c anc
cancer as the underlying cause of death on death certificates.
28. Monteiro GT, Kolffman RJ, Kolffman S. Reliability and accu-

cracy of reported causes of death from cancer. I. Reliability of
all cancer reported in the State of Rio de Janeiro, Brazil. Cad
29. Monteiro GT, Kolffman R, Kolffman S. Reliability and accuracy
of reported causes of death from cancer. II. Accuracy of
stomach cancer reported in the municipality of Rio de Ja-
neiro Country, Brazil. Cad Saud Publica. 1997;13 Suppl 1:
13-65.
30. Barchielli A, De Angelis R, Lova R. Use of mortality statis-
tics for the study of the distribution of digestive system tumors:
characteristics and quality of the data. Ann Ist Super Sani-
31. Percy C, Myr C. The international comparability of cancer mor-
tality data. Results of an international death certificate study.
32. Cirera L, Martínez C, Contreras J, Navarro C. Aprendizaje
aplicada a la codificación de la causa de muerte en Espa-

Gac Sanit. 2006;20(Supl 3):42-51