Regional analysis of old-age mortality in the Northern Netherlands

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Abstract

Objective: The objective of this thesis is to describe to what extent there are differences in old age mortality by region in the Northern Netherlands and to see whether these differences can be explained by differences in cause of death. **Methods**: Data on the population and (cause specific) mortality specified by ages, sex, year and region available from database Statline from Statistics Netherlands was used. Regional differences in old age mortality in the Northern Netherlands were measured using the life expectancy at age 80 estimated from life tables. Additionally the age standardized mortality rate 80+ per region was calculated. The cause of death analysis was done using the age and cause specific mortality rate 80+ and the decomposition technique from Arriaga. Z-scores and ArcGIS were used to further analyze the results. **Results:** The municipalities Bolsward, Grootegast and Winsum show higher levels of old age mortality. Lower old age mortality for females are found in Het Bildt, De Marne and Marum, for males this is Leeuwarderadeel. At Corop level East Groningen shows high levels of odl age mortality, while it is low for Region Delfzijl and Northern and South-west Drenthe. The cause specific mortality rates largely follows the same pattern as the all cause mortality rates. The eastern parts of Groningen showed clustering of lung cancer for females and of cardiovascular diseases for males. Region Delfzijl showed remarkably low mortality rates for mental disorders and external causes of death. The causes having most influence on the life expectancy in both a positive and negative way are lung and other cancers, cardiovascular diseases and other causes. For females mental disorders is also influential. **Conclusion:** There are regional differences in old age mortality in the Northern Netherlands. Mainly responsible for the regional differences were cardiovascular diseases, lung and other cancers and other causes.

Keywords: old age mortality, Northern Netherlands, regional differences, cause-specific mortality, decomposition.

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1. Introduction

1.1 Background

The life expectancy in Europe was only 45 at the beginning of the 20th century. In 1950 it already rose till 62, mainly due to reduced infant mortality and reduced mortality from infectious diseases. From the 1960s on further reductions in child mortality became almost impossible and gains in life expectancy shifted to higher ages. Cardiovascular diseases and cancer became the main causes of death. However due to the cardiovascular revolution, which led to large declines in cardiovascular mortality, the mortality at older ages could still decline (Vallin, Meslé and Valkomen, 2001).

In the Netherlands, the mortality during the first part of the 20th century also declined primarily due to decreasing child mortality. The mortality for females decreased steadily from 1950 onward, and from 1970 for males, leading to a bridge in life expectancy between men and women.
The life expectancy in the Netherlands is recently stagnating, especially for the higher ages.
In 1960 women in the Netherlands had one of the highest life expectancies in Europe. They held this position till the 1980s, when the increase in life expectancy slowed down.
So although Dutch life expectancy is still increasing, this increase is small compared to other European countries (Van der Wil, Achterberg and Kramers, 2001).

The stagnation of the life expectancy poses the question whether some countries reached the maximum possible life expectancy or whether the life expectancy will be able to increase even further. There are two stances in this matter, 'the limited-lifespan paradigm' and 'the mortality-reduction paradigm'. According to the limited-lifespan paradigm the life expectancy will not increase much further due to biological and social barriers, while according to the mortality reduction paradigm it will be possible to postpone mortality till even higher ages in the future (Nusselder and Mackenbach, 2000). Still this debate remains inconclusive, but it will have important implications for future policies (Olhansky and Carnes, 1994).

The life expectancy at birth increased till 78 for males and 82 for females in 2008 (Statistics Netherlands, 2009b). However, not in all regions this life expectancy is reached and regional differences in mortality at older ages persist. In this study, old age mortality within the Northern Netherlands will be studied to discover possible differences in mortality and life expectancy and how this will be related to differences in cause of death. This can contribute to further understanding of the factors determining regional patterns of mortality. This can be useful in other demographic studies, but also for epidemiology, since the differences in mortality can also be related to differences in causes of death. The study of regional mortality differences among elderly is an important source to gain insight in the potential role of behaviour, environment and health care factors. By showing which areas have relative high old age mortality it is shown where improvements are needed. So the outcomes of this study can be useful for health programmes to improve the health needs of the elderly and to prevent risk factors that could lead to disability or mortality in the future. By showing which regions lack behind in life expectancy and which causes of death are most responsible for this, health care and related policies can be improved and aimed more specifically at certain regions and causes of death. This way inequality in life expectancy and health care between regions can be solved and prevented.

1.2 Research

The objective of this thesis is to describe to what extent there are differences in old age mortality by region in the Northern Netherlands and to see whether these differences can be explained by differences in cause of death.

The main research question related to this objective is:
'What are the regional differences in old age mortality in the Northern Netherlands, and which causes of death contribute to the difference?'.
To answer the main question the following sub questions will be used:

1. What regions in the Northern Netherlands show relatively high or low old age mortality?
2. To what extend do the areas of relatively high vs. relatively low old age mortality cluster?
3. What are the regional differences in age and cause specific mortality rates?
4. How can the differences in life expectancy be explained by differences in cause of death between regions?

1.3 Structure

To come to an answer on the research questions, this thesis uses the following structure. The underlying theories, a literature review of relevant studies and the related conceptual framework and hypothesizes will be discussed in the coming chapter. Chapter three will describe the data and methods used, and will go further into the statistical and spatial analysis of the results.
The fourth chapter is used to describe the results, and will provide an answer to the research questions. Finally, the conclusion summarizes the results and discusses the findings, ending with the recommendations.

2. Theory and literature review

2.1 Theory

2.1.1 Demographic transition theory

The transition in overall mortality can be described by the demographic transition. Societies started with a stable situation of high fertility and high mortality. Then mortality started to decline due to improvements in nutrition, hygiene and housing and recession of diseases. Meanwhile the fertility stayed at a high point, leading to high population growth. It is in the third phase of the demographic transition, when the birth rate also begins to fall, combined with a further decline in death rates, though at a lower pace. Most countries are still in the second or third phase, but some developed countries already entered the fourth stage, characterized by equal birth and death rates and zero population growth (Kirk, 1996).

2.1.2 Epidemiologic transition theory

The demographic transition results in changes in mortality, fertility, health and disease explained by the epidemiological transition theory.
Mortality is a central part of this theory, and Omran (1971) states 'mortality is a fundamental factor in population dynamics'. The theory describes the decline in mortality, accompanied by a different pattern of diseases whereby communicable diseases and malnutrition are replaced by non-communicable diseases and ageing. The biggest influence on the mortality decline came from children and young females, since the health improvements were most beneficial to those groups. As a result, infant mortality became low, while a greater amount of deaths occurred at older ages (Omran, 1998).
Originally the epidemiologic transition theory had only three stages, which are:

1. *The age of Pestilence and Famine*:
   During this period, mortality and fertility are both high, leading to a stable population. The life expectancy during this stage is low and varies between 20 and 40 years (Omran, 1971). Most deaths can be attributed to infectious diseases and malnutrition. The living conditions during this age were poor, with poor sanitations and an indigenous health system (Omran, 1998).
2. *The age of Receding Pandemics*:
   Mortality started to decline and epidemics became less frequent. Fertility remained stable at a high level, leading to rapid population growth.
   The life expectancy increased till about 40 till 50 years. Communicable diseases were still the main cause of death, although later during this stage non-communicable diseases were also on the rise. Though there were little improvements in health care, better sanitation and housing improved the living conditions (Omran, 1998).
3. *The age of Degenerative and Man-made diseases:*
   Mortality continued to decline and remained stable at a low level, resulting in a life expectancy up to 75 years. This was made possible by major improvements in health care and improvements in the living conditions and sanitation. Cardiovascular diseases, cancer and man-made diseases became the leading causes of death during this stage (Omran, 1998).

It was expected mortality would not decrease much further in countries at the end of the transition and also life expectancy of the elderly would stabilize (Omran, 1971).
These assumptions turned out to be untrue, since mortality at old ages did decline even further, leading to a revision of the theory and the adding of an additional fourth and possible future fifth stage (Omran 1998).

4. *The age of declining cardiovascular mortality, ageing, lifestyles modifications, emerging and resurgent diseases:*
   During this stage a shift occurs from the situation of low longevity and a small proportion of the population at old ages to a situation with long longevity and a large part of the population at the old ages (Mertens, 1994). These changes were accompanied with a change in cause of death. Mortality from circulator diseases declined, which was an important factor in the decline of old age mortality. This decline was made possible by a healthier life style, medical breakthrough and treatment of risk conditions (Omran, 1998). Still the predominant causes of death of this phase are cardiovascular diseases and cancer, though also the prevalence of new and resurgent diseases and external causes of death is rising (Omran, 1998). Since both mortality and fertility arrive at a low level, some countries may experience population decline (Omran 1998).
5. *The age of aspired quality of life with paradoxical longevity and persistent inequities*:
   During this possible future stage further prolongation of life will be made possible by controlling more diseases and living a healthy life style. This way the life expectancy can increase till above 90 years. Though mortality from now leading diseases can be reduced during this state, mortality from stress and man-diseases will rise and new diseases will appear. This further longevity is paradoxical since a longer life most likely would also mean living longer with morbidity, which will also have an impact on the costs of health care. It will also lead to increasing inequities between and within countries (Omran, 1998).

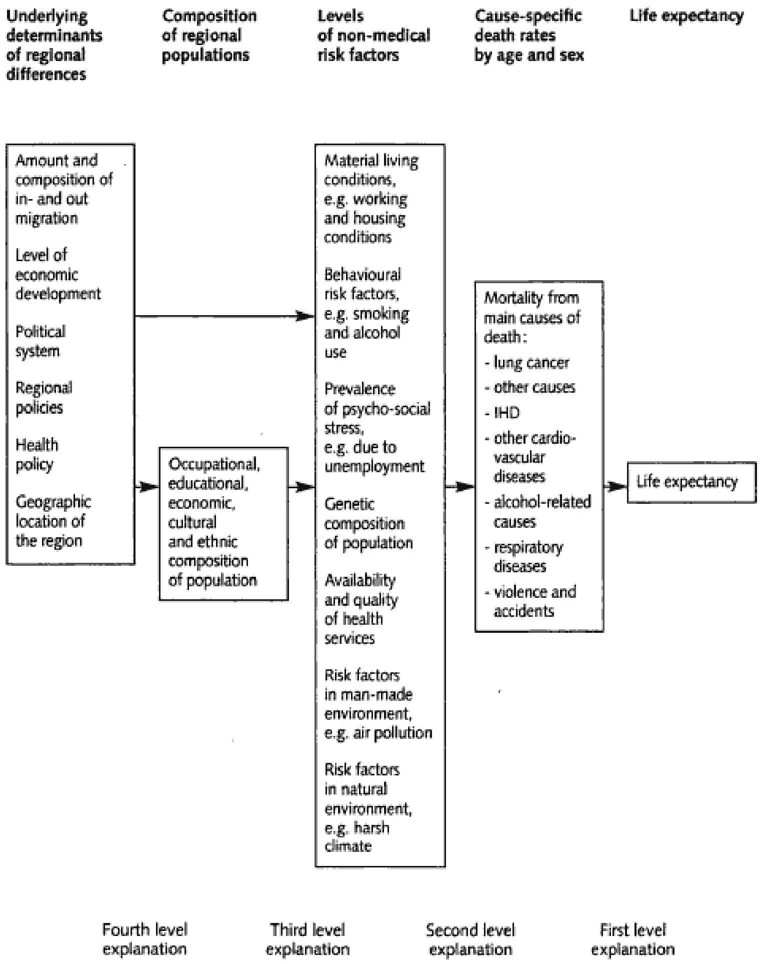
Though the epidemiologic transition is a good explanation of the trends in health of most countries, not all countries are able to go through all stages of the transition. There are still countries (mostly African) that are still in the second phase, but at the same time have to deal with new or resurgent diseases (like the AIDS epidemic) (Vallin and Meslé, 2004).
This is one of the things that was not expected when the theory was developed, since it was assumed all countries would go through all stages and converge in the end.
Still, the increase in life expectancy during the 70s is the biggest contradiction of the theory.
Though this development has been incorporated in the theory by adding a fourth stage, Vallin and Meslé (2004) state it is not appropriate to see these developments simply as a fourth stage of the transition theory. They rather see the epidemiologic transition theory as a component of a broader theory of health transition. During this transition, countries experience successive stages of divergence and convergence in their health status.

2.1.3 Framework for determinants of regional differences in mortality

Vallin, Meslé and Valkomen (2001) tried to explain which factors causes regional variation in life expectancy. Based on several studies they developed a framework of factors important in explaining differences in regional life expectancy. A figure of the framework is shown in figure 2.1. At the first level of explanation, regional differences can be explained by differences in mortality from specific causes of death. Mortality due to specific causes can in turn be explained by non-medical risk factors. These constitute of mainly health-related behaviour and geographical characteristics. Regional differences in the prevalence of risk behaviour like smoking, drinking and unhealthy diet are large factors in explaining regional variation in mortality.
Next to that there are also region specific factors that have an influence, like climate and environmental factors. Another important regional aspect is the quality and availability of health care. When looking at the third level of explanation, factors causing differences in risk factors are identified. Differences in living conditions, life style and stress are influenced by the characteristics of the population. These characteristics could be the level of education, occupation and ethnic composition of the region, but also culture and religion can be important determinants of health behaviour.

The fourth explanatory level shows major factors shaping the region over time, like the level of economic development, politics and policies.
Though these are some important factors contribution to regional differences in life expectancy, they state the factors can differ widely among countries and should be specified according to the country's context.

Figure 2.1 Framework for explaining differences in regional life expectancies



Source: Vallin, Meslé and Valkomen, 2001, p 193.

2.2 Literature review

2.2.1 Earlier studies on old age mortality

Earlier studies on differences in old age mortality between countries in Europe show some convergence, whereby all countries experienced a decline in old age mortality. There however seem to be differences in the pace of decline and periods of stagnation. (Janssen et al, 2004; Spijker, 2004), which seems to be consistent with the successive stages of divergence and convergence in the health transition proposed by Vallin and Mesle (2004).

During the 60s and 70s, most industrialized countries experienced declining mortality at old ages and a rise in life expectancy, leading to a situation of convergence.
Though the life expectancy of elderly is still increasing in most countries, this is not the case in some countries, suggesting a trend towards divergence.

A study by Janssen, Mackenbach and Kunst (2004) compared the trends in old age mortality in seven European countries. Since the 1950s mortality at old age is declining, though with differences in the pace of decline. This study observed stagnation in old age mortality for Denmark and the Netherlands from the 1980s on, stagnation was also observed for Norwegian males. This trend continued during the 1990s. They looked at the role of cause of death and smoking in this trend. Though the role of smoking seemed only small, mortality due to cardiovascular diseases did show differences between countries. It were the countries experiencing stagnation that also experienced the highest mortality level from cardiovascular diseases. Also mortality from smoking related diseases increased most in Denmark and the Netherlands. All countries, except France, showed an increase in mortality due to 'other causes'. Also this increase is largest for Denmark and the Netherlands, and increases especially during the 1990s.

Nusselder and Mackenbach (2000) describe the trends in life expectancy at age 60 and 85 in the Netherlands over time. They estimated life expectancies at age 60 and 85 by sex using life tables and also explained the contributions of age groups and causes of death using age and cause-specific mortality data. They found that in the 1970s all age groups contributed positively to the increase in life expectancy of elderly. However, in the 1980s the oldest age groups started to contribute negatively, leading to stagnation in the life expectancy. When looking at influences of cause of death, the reductions in cardiovascular diseases became smaller, while mortality from COPD, mental disorders, diabetes and cancers increased. They concluded the Netherlands is the only low-mortality with a stagnating life expectancy, though mortality at older age in Norway also slightly increased. Factors like influenza epidemics, smoking, and the policy on euthanasia could be an explanation for the stagnation.

Meslé and Vallin (2006) compare the trends in female life expectancy at old ages (65+) in the United States and the Netherlands (both experiencing a slowdown of improvements in life expectancy at old ages), against the trends in France and Japan. Two periods are compared together with the age component of the changes in each period. They also looked at which causes of death were responsible for the changes in life expectancy.
The research showed that all four countries experience mortality declines till the 1980s, mainly due to a decline in cardiovascular diseases. However, after the 1980s the increase in life expectancy for the Netherlands and United States began to slow down, while other countries still showed an increasing life expectancy. The main reason for this stagnation is the contribution made by other causes. In most countries mortality due to other causes declined, which reinforced the positive effect of declining cardiovascular diseases on the life expectancy.

However in the Netherlands, United States and Denmark, mortality due to other causes increased, cancelling out the positive improvements to the life expectancy by declines in cardiovascular diseases. They explain the divergence between countries by inaccuracies in the data, and by differences in health of elderly or health care, though they state this is unlikely since health care systems in low mortality countries are of comparable quality.

Janssen et al. (2003) did a study on the mortality decline in the Netherlands, and which factors contributed to it. They name smoking as an important reasons for the mortality stagnation, but when controlling for smoking-related mortality, it turned out to be one of many explaining factors. Another explanation could be that further improvements in mortality at old age are no longer possible. The stagnating countries could have reached a level where mortality can no longer decline and the limit to life expectancy is reached. Still, there are countries with the same low levels of mortality, but where further declines in mortality at older ages are realized.
Other explaining factors could be an increasing proportion of frail people at older ages, or changes in medical and social services. End-of-life-decisions and euthanasia are more commonly practiced in the Netherlands, but these have only a small negative effect on life expectancy.
So far there have not been explanations that are typical for the Netherlands, or the other countries experiencing stagnating declines in old age mortality. Therefore it cannot be certain the mortality declines at old ages occurring in most low-mortality countries will continue in the future.

2.2.2 Regional differences old age mortality

Caselli and Lipsi (2006) study the survival differences among elderly 80+ in Sardinian provinces and compared to Italy. The life expectancy at Sardinia is high compared to Italy, and the island has many centenarians. They find clear differences in life expectancy 80+ for the different provinces. They also looked at differences at a municipality level, using the Standardized Mortality Ratio (SMR) for age 80 and over. From this more detailed research it could be concluded that even though some provinces showed high life expectancies, there were large differences in life expectancy at municipality level. Especially municipalities in the south-east of Sardinia showed low mortality for age 80 and over, while municipalities in the west a high mortality. The low mortality at age 80 found in some provinces coincided with the high number of centenarians. So the low levels of mortality could be an explanation for the relatively high number of centenarians at Sardinia. The research further showed Sardinians have a lower mortality from cardiovascular diseases than Italians. This could indicate there is a genetic or environmental factor which causes the Sardinians to live longer.

The study by Vallin, Meslé and Valkomen, (2001) studied mortality differences among subgroups in the population, one of them was region. They study whether regional differences in life expectancy have increased or decreased since the 1970s. From the data it was obvious there are regional mortality differences in all countries. Several zones of high mortality crossing national borders were found in Europe, for example a zone consisting of northern France, southern Belgium, western Germany and Luxembourg and a zone in the north of the United kingdom, including Scotland and parts of Ireland.
When looking at regional differences in life expectancy within countries, there are often clusters of regions with high or low life expectancy. They also found, though the levels of mortality have changed, the regional differences within countries have been stable since the 1960s. However, the differences between men and women decreased over time in most countries.

2.2.3 Determinants of old age mortality

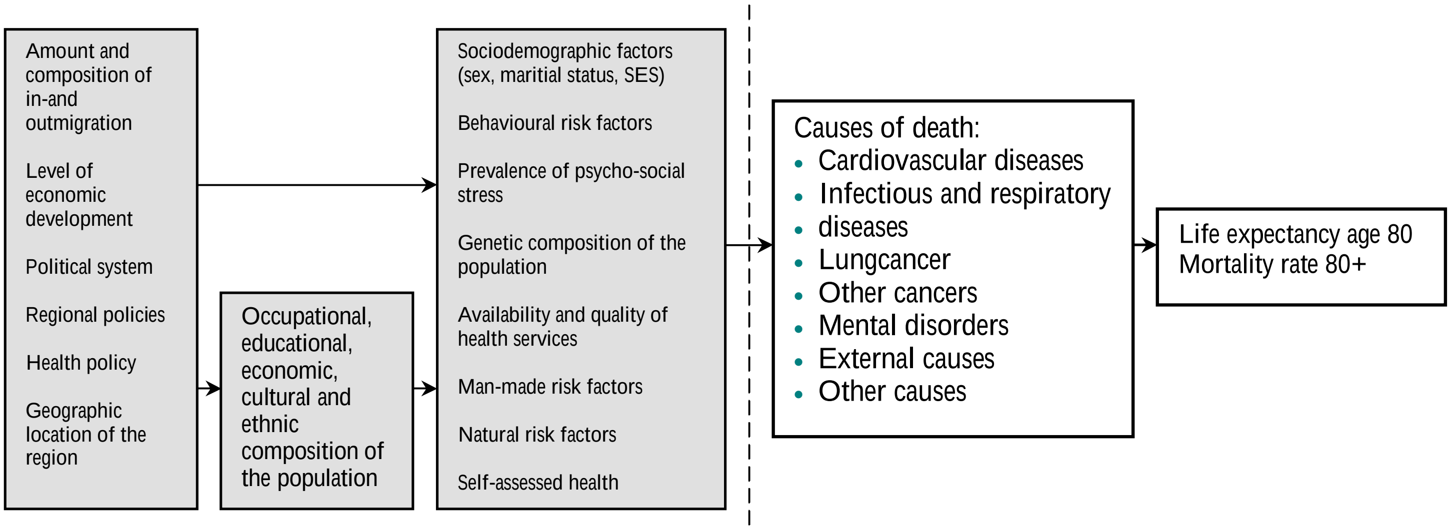
Zimmer, Martin and Lin (2003) look at determinants of old age mortality in Taiwan.
They identify three possible individual-level characteristics that can cause old age mortality to vary. The first are socio-demographic characteristics, like sex, marital status and socio-economic status. Women and married people tend to live longer, just like people with a higher socio-economic status. Secondly there are health disadvantages starting already early in life. This can be environmental pollution, poverty, high risk behaviour or limited access to health care. Disadvantages can be through disease or environmental pollution, limited access to health care, poverty or having a high risk occupation. For example smoking does have a positive relation to mortality. Finally, there is growing evidence that self assessment of health is a good prediction of mortality. Limitations and disability can be indications of mortality in the future. Next to these characteristics, access to health care is another important determinant of mortality.

Between 1980 and 2000, the life expectancy at birth increased with almost four years for both sexes. During this period the gains were faster for males, but still males experience a higher level of mortality than females. Also among elderly the gender gap remains visible (Meslé and Vallin, 2006). There are various explanations for this gender gap. One is the biological explanation, saying that differences in life expectancy are caused by genetic, auto-immune and hormonal differences between men and women. However it is believed biological factors are not the main explanation, since the gender gap is so persistent over time and over countries (Liang et al. 2003). Another explanation is the behavioural one, which emphasizes the influences of risk and health behaviour. Men tend to engage more in high risk behaviour, of which smoking is the most important (Jacobsen et al. 2008). Finally social development and the relative status of women are believed to have an influence on the differences in mortality (Liang et al. 2003).
Also socioeconomic status can have an influence on life expectancy. Several studies showed mortality is higher for people with a low economic status, compared to people with a high socioeconomic status. This inequality in mortality due to socioeconomic status is also visible among elderly, though the inequalities tend to decrease with increasing age (Huisman et al, 2004).

2.3 Conceptual model

The conceptual model shown in figure 2.2 shows the concepts that will be discusses in this research.

Figure 2.2 Conceptual model



Based on: Vallin, Meslé and Valkomen, 2001.

In context of the framework for explaining differences in regional life expectancies by Vallin, Meslé and Valkomen (2001) (figure 2.1) this research will only discuss the first level of explanation. At this level of explanations regional differences in life expectancy can be explained by differences in mortality from specific causes of death. This research will try too look whether regional mortality differences among elderly can be explained by differences in cause of death.

Though most background factors are relevant to elderly some are not, so based on literature the model was adapted to better fit the highest age groups. The material situation for example, is not much related to the situation of the elderly, since this group usually does not experience bad living conditions. The original model also does not include marital status, while Zimmer, Martin and Lin (2003) showed this is also important in explaining old age mortality.
Psychosocial stress, which is often caused by occupation and a hectic life style, is mainly related to people in the labour fource (Vallin et al, 2001). However, at older ages loneliness and depression can lead to stress, so this factors still plays a role (Kahn, Hessling and Russel, 2003).
There is also some debate to what extend social economic status can be used to explain differences in old age mortality. Occupation is difficult to use for people who are pensioned, and also the differences in education are skewed (Spijker, 2004). However, as Huisman et al (2004) already stated, socio-economic status can lead to mortality differences among elderly, though the differences decrease with age. Studies in Finland also showed that differences in occupation and education are partly responsible for regional differences in old age mortality (Mertens, 1994).

2.4 Hypothesizes

Based on previous studies on old age mortality and regional differences in mortality some hypothesizes for this study can be made.
From the study of Vallin, Meslé and Valkomen, (2001) it became clear mortality differences occur in all countries. So it could be expected it is also shown within the Netherlands. They also found that these regions with relatively high or low life expectancies often cluster.
At municipality level the differences will probably be larger than at Corop level, since the study of Caselli and Lipsi (2006) showed that mortality differences were larger at lower levels of analysis.
Studies on old age mortality showed that regions experiencing stagnating mortality declines often show higher levels of mortality due to cardiovascular diseases. Caselli and Lipsi (2006) also found this in their study, and lower mortality levels from cardiovascular diseases were one of the explanations for longer longevity of Sardinians.
When analyzing which causes of death are responsible for the regional variation in old age mortality, it is therefore likely that cardiovascular diseases will have a high influence. Especially regions with lower levels of old age mortality will have less mortality from cardiovascular diseases.

Though the background factors will not be studied, some assumptions can be made about them.
Females usually have a higher life expectancy compared to males, which is confirmed in several studies (Meslé and Vallin, 2006). So also in this study a difference in life expectancy between males and females can be expected.
This research will not explore socio-economic status, but some regions are known to have a lower socio-economic status (for example the eastern parts of Groningen). Since there is a relation between socio-economic status and mortality, also at older ages, there is a high chance these regions will show a higher level of old age mortality.

To summarize the hypothesizes, these will be the expected results of the study:

- Regional variation in life expectancy at age 80 will be visible.
- Regions with relatively high or low life expectancy will be clustered.
- Municipalities will show a more diverse pattern than Corop regions.
- Regions with a higher life expectancy will have lower mortality from cardiovascular diseases.
- Females will have a higher life expectancy than males.
- Regions with a lower socio-economic status (like the Eastern part of Groningen) will show relatively high levels of mortality.

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3. Data and methods

3.1 Study design

The objective of this study is to describe the differences in life expectancy between regions in the Northern Netherlands and to see whether these differences can be explained by differences in cause of death. This will be done by conducting a quantitative cross-sectional study, based on existing data sets. The main part of the research will be descriptive in nature, though the last research question (how differences in life expectancy can be explained by causes of death) is more explanatory.

The data used comes from Statistics Netherlands. The objective of Statistic Netherlands is to collect and process data to make statistics used in practice, by policymakers and for scientific research (Statistics Netherlands, 2010a). The data is derived from population registers kept at municipality level where all vital events of the inhabitants are recorded. The data from these population registers are seen as reliable (Nusselder and Mackenbach, 2000).

3.1.1 Study area

In the Nomenclature of Territorial units for Statistics (NUTS), the Netherlands are divided into three hierarchical levels. The NUTS is a 'European measure to provide territorial units for the production of regional statistics' (p9). It divides countries into three hierarchical administrative units, based on the size of the regions. At a more detailed level, there are Local Administrative units (LAU), which are districts and municipalities and are not part of the NUTS regulation (European Commission, 2007).

The Netherlands is divided into the following NUTS regions:

- NUTS 1: 1 countyparts
- NUTS 2: 12 provinces
- NUTS 3: 40 COROP regions
- LAU 1: -
- LAU 2: 443 municipalities

(European Commission, 2007)

In this context, the study area consists of three NUTS 2 regions: the provinces of Groningen, Friesland and Drenthe. Furthermore on NUTS 3 level, the area has 9 Corop regions, and 68 municipalities which are part of the Local Administrative Units. For a map and overview of the Corop regions and municipalities in the Northern Netherlands, see figure 3.1, table 3.1 and table 3.2.

The Northern Netherlands has 1.7 million inhabitants, which is one tenth of the inhabitants of the Netherlands, while the area is as large as one quarter of the Netherlands.

The Netherlands as a whole won't experience population decline until 2025, but the Northern Netherlands is one of the areas where population decline is already present. Especially the Northern and Eastern parts of Groningen have to deal with major decline, but in the future (before 2025) population decline will also be present in the East of Drenthe, the North and West of Friesland and further decline is predicted in the North and East of Groningen.

The population decline also influences the age composition of the North, leading to an increasing ageing of the population (Ministry of Transport, Public Works and Water Management, 2009).

Figure 3.1 Map of municipalities in the Northern Netherlands

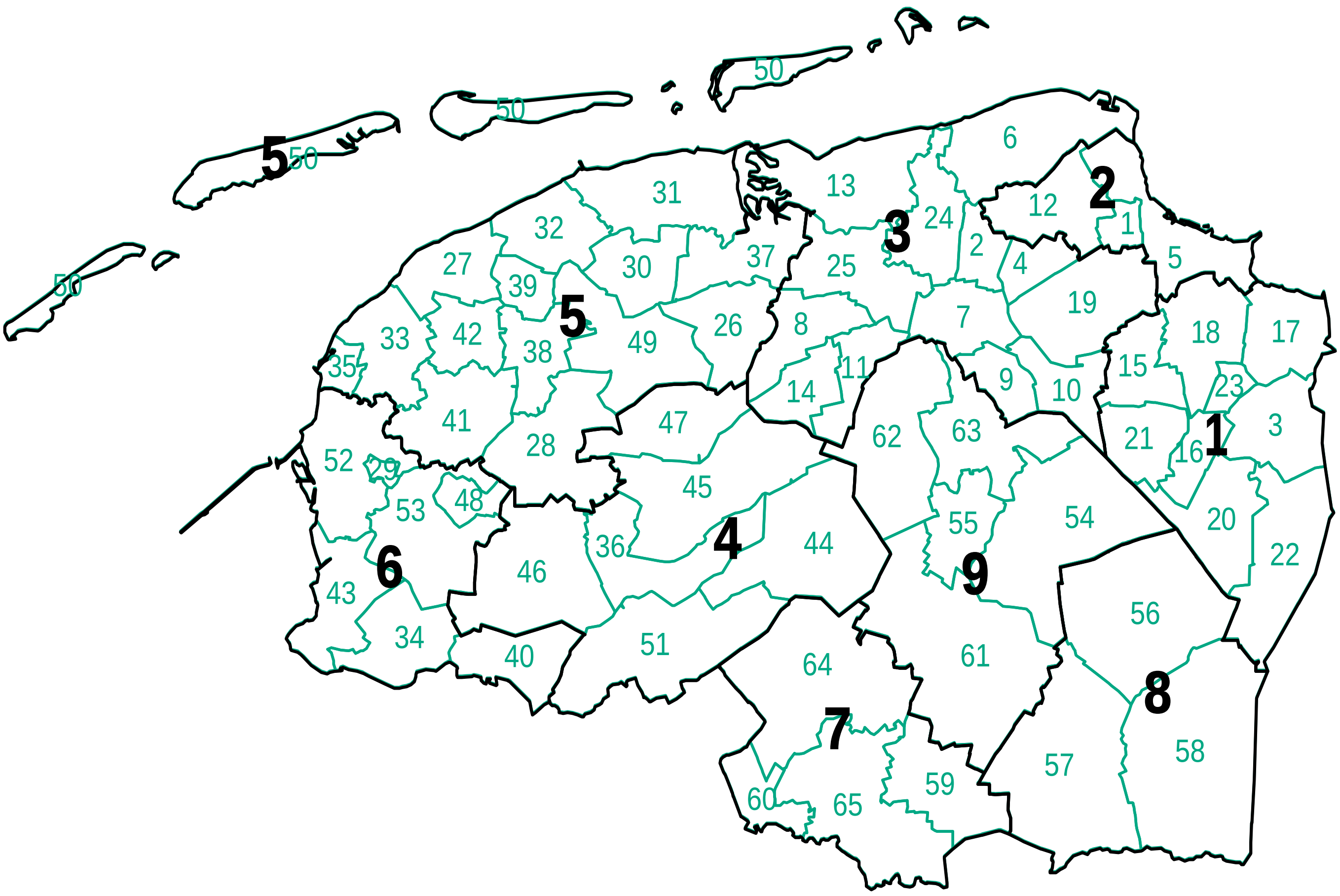


Table 3.1 Population size and percentage population 80+ in the Netherlands and Northern Netherlands

Region	Population size	Percentage 80+
Netherlands	16,332,232	3.6%
Northern Netherlands	1,701,568	4.0%

Table 3.2 Population size and percentage population 80+ in COROP regions in the Northern Netherlands

	Corop region	Population size	Percentage 80+
1	East Groningen	153939	4.6%
2	Region Delfzijl	512355	4.6%
3	Groningen Other	368940	3.8%
4	South-east Friesland	206193	4.1%
5	Northern Friesland	33110	3.8%
6	South-west Friesland	105238	3.8%
7	South-west Drenthe	127888	4.2%
8	South-east Drenthe	171101	3.9%
9	Northern Drenthe	185930	4.2%

Table 3.3 Population and percentage population 80+ in municipalities in the Northern Netherlands

	Municipality	Population size	Percentage 80+		municipality	Population size	Percentage 80+
1	Appingedam	12292	5.4%	34	Gaasterlân-Sleat	10240	4.9%
2	Bedum	10675	3.4%	35	Harlingen	15694	4.3%
3	Bellingwedde	9630	4.8%	36	Heerenveen	42801	5.0%
4	Ten Boer	7211	3.4%	37	Kollumerland en Nieuwkruisland	13114	3.2%
5	Delfzijl	28042	4.5%	38	Leeuwarden	92025	4.3%
6	Eemsmond	16724	4.4%	39	Leeuwarderadeel	10486	2.9%
7	Groningen	180923	3.4%	40	Lemsterland	13403	2.9%
8	Grootegast	12088	3.1%	41	Littenseradiel	10852	3.1%
9	Haren	18961	7.5%	42	Menaldumadeel	13877	3.1%
10	Hoogezand-Sappemeer	34338	3.9%	43	Nijefurd	10933	4.3%
11	Leek	19282	3.5%	44	Ooststellingwerf	26384	4.2%
12	Loppersum	10901	4.1%	45	Opsterland	29552	3.7%
13	De Marne	11014	4.4%	46	Skarsterlân	27078	3.8%
14	Marum	10169	3.2%	47	Smallingerland	54652	3.6%
15	Menterwolde	12576	3.1%	48	Sneek	33019	4.1%
16	Pekela	13378	4.0%	49	Tytsjerksteradiel	32137	4.0%
17	Reiderland	7000	4.5%	50	Waddeneilanden	2063	4.2%
18	Scheemda	14192	3.9%	51	Weststellingwerf	25726	4.6%
19	Slochteren	15103	3.6%	52	Wûnseradiel	11893	3.1%
20	Stadskanaal	33920	4.5%	53	Wymbritseradiel	16224	2.6%
21	Veendam	28177	4.8%	54	Aa en Hunze	25443	4.3%
22	Vlagtwedde	16607	5.0%	55	Assen	63588	3.9%
23	Winschoten	18459	6.0%	56	Borger-Odoorn	26298	3.7%
24	Winsum	14105	3.4%	57	Coevorden	36095	4.2%
25	Zuidhorn	18347	3.4%	58	Emmen	108709	3.9%
26	Achtkarspelen	28149	3.1%	59	Hoogeveen	54110	3.9%
27	Het Bildt	10965	3.4%	60	Meppel	30842	4.2%
28	Boarnsterhim	19226	3.4%	61	Midden-Drenthe	33241	3.9%
29	Bolsward	9526	4.9%	62	Noordenveld	31621	4.3%
30	Dantumadiel	19571	4.1%	63	Tynaarlo	32037	5.0%
31	Dongeradeel	24942	3.8%	64	Westerveld	19209	4.9%
32	Ferwerderadiel	8942	3.5%	65	De Wolden	23727	4.2%
33	Franekeradeel	20804	4.0%				

3.1.2 Operationalization

There is discussion when someone can be considered old, since the elderly are no homogeneous group. Often age is used to define someone as being old, whereby the age of 65 is used as the start of elderly hood (Mertens, 1994).However, since the elderly are such a heterogeneous group and there is much difference between elderly of 65 and elderly of 80, often a distinction between the 'young' old and the 'old' old is made (Mertens, 1994). This study will focus on the 'old' old, consisting of people aged 80 and over. Old age mortality will be measured by looking at life expectancy at age 80 and the age specific crude death rate of people above age 80.

To measure the differences in life expectancy by region, municipalities are used as a geographical unit. Municipalities are administrative regions with clear defined boundaries. They consist of a village or town, or a group of villages or towns. People are assigned a municipality of residence when they live there or usually spend the night there (Statistics Netherlands, 2010b)
To measure the contribution of different causes of death to life expectancy a selection of causes of death will be made, so only relatively common diseases are used. Cause of death here means the primary cause of death, which is the disease or event that is the underlying cause of death, eventually leading to death. This is different from the secondary cause of death, which is often the consequence of the primary cause of death or other diseases contributing to death.

3.1.3 Ethical issues

The research will be conducted on municipality level and on such small scale identification of individuals in the data could be possible. To prevent this, the data is aggregated by age and period. The data on age specific mortality data is already rounded and Statistics Netherlands refused to give more specific information about deaths per age because of confidentiality reasons.

3.2 Data

Like mentioned before, the data used comes from the Statistics Netherlands. All data used in this thesis is gathered through their online database StatLine.
It should be stated this data only includes people registered in the population register. This means only the 'de jure' population is included, which includes inhabitants of The Netherlands, and people living in The Netherlands for more than four months. Excluded from this register are foreign people living in The Netherlands (like diplomats and NAVO military), and people staying in the Netherlands illegally (Statistics Netherlands, 2010b).
The data quality of the Netherlands is seen as good and reliable (Nusselder and Mackenbach, 2000). Before the data is published, it is checked on completeness and inconsistencies, and cause of death data is compared to the information on deaths from the population register. In 2008, 98.6 percent of the deaths had a known cause of death. Most of the missing cases were people who died abroad, while only a minor part were due to unclarified causes of death (Statistics Netherlands, 2010c).

For this research data on population and deaths for the municipalities and Corop regions in the Northern Netherlands were needed for the period 2004-2008. The data for a five year period is used so the numbers are high enough to ensure reliable results. Especially for municipalities mortality numbers are small which could bias the results. By summing them up over five years this is being avoided. During the study period, there were no changes in classification of the data, or in the borders of the regions used. The only change was in the name of the municipality Dongeradiel, which was changed in 2009. This means that data on the population for Dongeradeel was used for 2004-2008, and for Dongeradiel for the year 2009.

For both municipalities and Corop regions data on the population during 2004-2009 is used, according to sex and age group. The data was available for each age separate, or for five year age groups, both with 95 as the highest age group. The data for separate ages was used, so they could be summed to the required age groups during the analysis later on.
For information on mortality, data on age specific deaths during 2004 till 2008 was used.
Mortality data was also sex-specific, but only available in five year age groups, whereby the youngest age group was divided in 0 and 1-5, and 95 as highest age group. The deaths were recorded as deaths at age December, 31. For privacy reasons, the age specific numbers are randomly rounded till five- and tensomes. This means the summed age specific numbers are not equal to the total number of deaths (of which the accurate number is available). This also implies

that because of the rounding, some ages have higher or lower death rate than they should have. The consequence for the life expectancy is that the life expectancy could differ with a few months from what it should be which can be up to 6 months.
Cause of death data for municipalities was only available for a few categories and was not specified according to sex or age. Therefore age-specific mortality for Corop regions is used.
It should be stated Statistic Netherlands only publishes information about the primary cause of death, so the cause that eventually leads to death. Data on secondary causes of deaths (which contribute to death) is not available.

Information on cause of death for Corop regions was available for the age groups 0-50, 50-60, 60-65, 65-70, 75-80, 80-85, 90 and older. On Statline only a short list of causes (the so-called Beldo list) was available. From this list six main causes of death were selected. The causes and their codes of the International Classification of Diseases (ICD) are shown in table 3.3. The causes of death are classified according to the tenth revision of the ICD (ICD-10), which is used since 1996 (Statistics Netherlands, 2010c).

Table 3.4 List of causes of death and ICD codes.

Cause of death	ICD 10
Cardiovascular diseases	I00-I99
Infectious and respiratory diseases	A00-B99, J00-J99
Cancer of the lung	C33 and C34
Other neoplasms	C00-C32, C35-D48
Mental disorders	F00-F99
External causes of death	V01-Y89
Other causes of death	Other A00-Z99

Source: World Health Organization, 2007.

3.2.1 Outliers

When exploring the data it was discovered there were some outliers or exceptional cases which could influence the analysis. Especially the islands were extreme outliers, because for some the life expectancy was exceptionally high, especially for males. When looking at table 3.4 the islands, with the exception of Terschelling, show a much higher or lower life expectancy than could be expected. Also the total life expectancy for some islands is higher or lower than for males or females separately. A most likely explanation for these strange values could be that there are very few elderly on the islands, which can cause distortions in the life tables.
Also when a boxplot of municipalities is made (see appendix, figure 3.3) the islands are outliers.
It is most likely these deviating values are the result of very small number of deaths and people at older ages on the islands. Therefore it is decided to group the islands together, so more reliable numbers are created. As table 3.4 shows, combining the islands gives a more logical life expectancy.

Table 3.5 Life expectancy of the islands, compared to the Northern Netherlands.

	Males	Females	Total
Vlieland	5.55	8.93	9.97
Terschelling	6.67	9.68	8.53
Ameland	8.61	7.77	10.58
Schiermonnikoog	10.36	11.12	6.72
Northern Netherlands	7.39	10.89	8.48
Islands Combined	7.57	9.00	8.66

There were also two municipalities, Reiderland and Ferwerderadiel, which had a probability of dying above one for males at age 90-95. Although the life expectancy was within the normal range, a probability of dying above one is not possible. Both municipalities showed exceptionality high death rates, of about 0.5, which was not observed for the other municipalities. Then still, the probability of dying should not become higher than one.
Both municipalities are relatively small, and it is possible the chosen average person years lived in the interval is not suitable for this size. It is also possible the nax for this age interval is not suitable for males in the Northern Netherlands and men already die earlier in this age interval.
A solution to correct the probability of dying in these municipalities was to change the average person years lived in the interval from 2.1 to 1.85 for males in the age interval 90-95. To not bias the results, this was changed for males age 90-95 in all municipalities. The effect on the life expectancy was only 0.02 years so only a minor change.

3.3 Data analysis

There are several ways of measuring mortality. Mostly life expectancy is used, though sometimes age (and cause) specific death rates are also used. The advantage of life expectancy over mortality rates is that it is easy interpretable (Pollard, 1988), and is unaffected by the age distribution which makes comparisons over time or between populations possible (Nusselder and Mackenbach, 2000). For this thesis both life expectancy and the age standardized crude death rate will be used.

3.3.1 Measuring old age mortality

The level of old age mortality in a region is measured using two calculations. First life tables were calculated, from which the life expectancy at age 80 could be estimated. Second the age standardized mortality rate 80+ were used to give an indication of the mortality levels of the regions. First the construction of the life tables will be explained, followed by the calculation of the age standardized mortality rate 80+

3.3.1.1 Life tables

Instead of cohort life tables, period life tables were used, since otherwise assumptions had to be made about the cohorts that are not yet completed. To construct the life tables, sex and age specific data on the population for the years 2004-2009 were used, and data on deaths of the years 2004 till 2008 are used. For municipalities, the population data is available per year up till the age of 95, so this was used as the highest category. Data on mortality is available in five year age groups, again with 95 as the highest age group. The age specific mortality data is based on age of death at December 31, implying a life table based on average age at January 1 has to be used.
To construct this life table the following formula was used to calculate the death rate:

$$q_{x+1/2,\,t} = \frac{D_{x+1,\,t}}{\left[0,5 * \left(N_{x,\,t} + N_{x+1,\,t+1} + D_{x+1,\,t}\right)\right]}$$

$q_{x+1/2,\,t}$ = death rate for average age x+1/2 during year t
$D_{x+1,\,t}$ = number of deaths at age x+t at December 31 during year t
$N_{x,t}$ = population at January 1 for age x during year t.

Migration is included in this formula, for the population is calculated by the differences in population age x, at January 1, year t, and the population at age x+1, year t+1 which is corrected for the mortality during that period (Van der Meulen and Janssen, 2007).
This kind of life table will not be used for Corop regions. As already mentioned in paragraph 3.2 the age specific mortality data is rounded, and therefore not totally accurate. Information on the specific number of deaths is available for Corop regions, based on the cause of death data (total mortality of all causes). Also, since the Corop life tables will be used to make a cause of death decomposition, it is important the life tables match the cause of death data. Therefore the life tables will not be based on the mortality data, but on the cause of death data. The cause of death

data is based on age at death (so age last birthday). Therefore life tables based on age last birthday will be used for the Corop regions. The death rate is calculated by dividing the age specific deaths by the midyear population (e.g population 2004 = pop 2004+pop 2005/2).
The age groups of the Corop life tables will also be different, since the cause specific mortality data is not specified for the youngest age groups. The life tables will have the following age groups: 0-50,50-60, 60-65,65-70, 70-75, 75-80, 80-85, 85-90, and 90+.

Once the death rates were known, the life tables for both municipalities and Corop regions were further constructed using normal life table procedures (Preston et al, 2001). The average person years lived in the interval (nax) is not exactly known so the value of nax cannot be directly observed. Therefore an arbitrary set of values had to be taken. The value for nax for the Netherlands is available from the Human Mortality Database (2008), which is the closest estimation of the nax for the Northern Netherlands. The nax for the Netherlands is not (yet) available for the period used in this study, the most recent data available is for 2000-2004 or 2005-2006. Since this study covers a five year period, the age and sex specific nax for 2000-2004 is used.

3.3.1.2 Age standardized mortality rate 80+

In addition, also the age standardized mortality rate for 80+ was calculated. These are the age-specific death rates, weighted by the age distribution of the population. For municipalities the calculation is based on the population as calculated in the life tables and the age specific mortality (for age at December, 31). For the Corop regions, the age standardized mortality rates were calculated based on the midyear population and age specific mortality (for age at last birthday).

The Crude Death Rate can be calculated by:

$$CDR = \frac{D}{N} = \frac{\sum_{x=0}^{\infty} {}_nD_x}{N} = \frac{\sum_{x=0}^{\infty} \frac{{}_nD_x}{{}_nN_x} {}_nN_x}{N}$$
$$= \sum_{x=0}^{\infty} \frac{{}_nD_x}{{}_nN_x} \cdot \frac{{}_nN_x}{N} = \sum_{x=0}^{\infty} {}_nM_x \cdot {}_nC_x$$

Whereby nNx is the number of persons aged x to x+n and is used as an estimate of person-years lived in the age interval x to x+n during the year.
The total person years lived is estimated by N, which is the size of the total population.
By dividing nNx by N you get nCx, which is the proportion of the total population in the age interval x to x+n. So the CDR can be calculated by the age specific death rates (nMx) and the age distribution of the population (nCx) (Preston et al., 2001).

This equation can also be written as:

$$CDR = \sum_{i=1}^{\infty} M_i \cdot C_i$$

Whereby i is used to denote the age group.

Since this thesis focuses specifically on elderly, the CDR is calculated for age 80+. To do this only the age specific death rates and the proportion of the population for the age groups above 80 are summed up, resulting in the CDR for age 80+.

The age distribution varies between populations, which makes comparisons between municipalities difficult. By standardization, the influence of the age composition is minimized.
Standardization can be done in two ways: a direct and an indirect way. Both require information on the age-specific population, but direct standardization uses age specific events while indirect

standardization uses the total number of events. Since age specific information is available for both the population as the number of deaths, direct standardization can be applied. To calculate the age standardized mortality rate the formula becomes:

$$ASCDR^j = \sum_{i=1}^{\infty} M_i^j \cdot C_i^s$$

Whereby M_i^j is the age specific death rate of the population of interest, and C_i^s is the proportion of the population in the ith age interval in the standard population (Preston et al, 2001). Again only the information for the age groups above 80 are used, to the age standardized rate specifically for elderly aged 80 and over.

With standardization you keep the same age specific death rate, but you replace the age distribution for that of the standard population. Which population is chosen as standard is arbitrary, but caution is needed, since the choice of standard population can affect the amount and the direction of difference between the death rates. When comparing only two populations, the average can be taken, but in this case several municipalities are compared. Then it is advised to use a standard population that is close to the mean or median of the population structures of the study populations (Preston et al., 2001). In this case the midyear population per age group in the Netherlands for 2004-2008 is used as standard population. It is most likely the mean of the population of the Northern Netherlands is close to that of the Netherlands as a whole. The data on the Dutch population is gathered from Statistics Netherlands (2010).

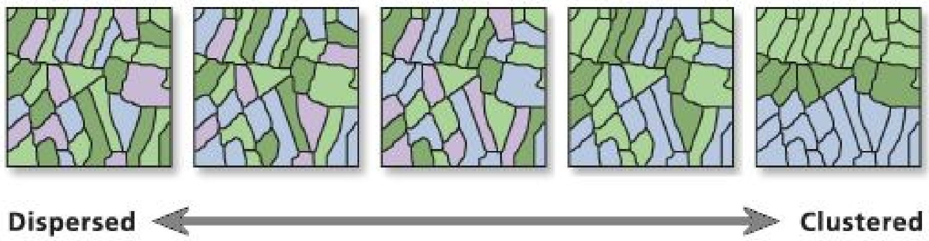
3.3.2 Cluster analysis

Since the analysis is on a regional level, it is useful to visualize the results by using maps.
This is done by making use of Geographic Information Systems (GIS), in this case the program ArcGIS. A shapefile map (a basis map) with the municipalities, districts and neighbourhoods of the Netherlands is obtained from Statistics Netherlands. The map is based on information from the Kadaster (Statistics Netherlands, 2010i). The map is based on the projection Double_Sterographic, and the geographic coordinate system is GCS_Amersfoort.
Since the area of interest are municipalities and Corop regions in the Northern Netherlands, all municipalities form the provinces of Groningen, Friesland and Drenthe have been selected and turned into a separate layer. A map from the Corop regions is created by joining the municipalities of each Corop together into each Corop region.
The resulting life expectancies and age standardized (cause specific) mortality rates are joined to the layers of either municipalities or Corop, so the information of the tables is attached to the attribute table, and can be visualized in the map. Based on this attribute table the results can be visualized by classifying the values in groups. There are various ways of classification and they influence the way the data is visualized. The data does not have very distinct natural breaks, so classification according to natural breaks is not very suitable. Classification according to quantile can be misleading, since all categories have the same number of cases, which could lead to biases (Environmental Systems Research Institute, 2008). Therefore the data is classified according to equal interval, whereby the values are assigned to categories of equal size.

The second research question looks to what extend the regions are clustered, and where this clustering is happening. ArcGIS has two 'toolboxes' to analyze patterns. The first is called global calculations, and identifies overall patterns and clustering in the data. The second holds the local calculations, which give information about the extend and locations of clustering.
A tool which is an example of the first is the Global Moran's I. The tool is based on the First Law of Geography which says: 'everything is related to everything else, but nearby things are more related than things far away'. So the Global Moran's I looks whether similar features are clustered in space. Figure 3.2 shows when features are considered dispersed or clustered.

The output of the Global Moran's I tool will look like this figure, and indicates to what extend the features are clustered. (Environmental Systems Research Institute, 2006).
When there is clustering, a tool from the local calculations toolbox can be used. One of these is the Anselin Local Moran's I. This tool identifies where features with similar values cluster. By using a Z-score, it is shown whether features are surrounded by similar values (high positive z-score) or by dissimilar values (low negative z-score) (Environmental Systems Research Institute, 2009a).

Figure 3.2 Grades of spatial autocorrelation



Source: Environmental Systems Research Institute, 2006.

3.3.3 Cause of death analysis

To see which causes contribute to the differences in life expectancy and the age standardized mortality rate cause of death analysis is used. Since age specific cause of death data was available for Corop regions only, this analysis will only be done for the Corop regions. The causes of death that will be used can be found in table 3.4 in paragraph 3.2.

The cause of death analysis can be done in several ways. Mostly used is a decomposition technique. This technique is used in several researches that look at difference in life expectancy between men and women and over time (e.g. Nusselder and Mackenbach, 2000; Yoshinaga and Une, 2005; Nakaji et al, 2004; Meslé and Vallin, 2006). It can also be used to explain differences between age groups (Nusselder and Mackenbach, 2000) and subgroups in the population, like socioeconomic groups or among regions and countries (e.g. Velkova, Wolleswinkel-van den Bosch, and Mackenbach, 1997). Nusselder and Mackenbach, (2000) used age and cause specific mortality rates to calculate comparative mortality figures. This method was used complementary to decomposition, though they state decomposition is better at explaining changes than age and cause specific mortality rates.

For this thesis both age and cause specific mortality rates and a decomposition technique will be used. First the cause specific mortality rate will give an overview of levels of mortality for Corop regions for the several causes. However, this is not suitable to see which causes contribution to the differences in life expectancy at age 80. Therefore a decomposition of the life expectancy at age 80 is needed to see which causes contribute to the differences in life expectancy at age 80 for each Corop region and the Northern Netherlands.

3.3.3.1 Age standardized cause specific mortality rates 80+

To calculate the age and cause specific mortality rate, mortality data (for age last birthday) and the midyear population for the age groups 80-84, 85-89 and 90+ were needed. Then the cause specific death rate is calculated using the following formula:

$$\frac{\text{Number of deaths for specific cause (in specific age group)}}{\text{Total population (in specific age group)}} \times 1000$$

(National Association for Public Health Statistics and Information Systems, 2007)

The result is then used as input for a calculation similar of that of the age standardized crude death rate. The age and cause specific death rate is multiplied by the proportion of the population for that age group, and then the age groups are summed to give the cause specific mortality rate at age 80. Like with the crude death rate, standardization is needed to make the cause specific mortality rates comparable. This is done using the age composition of the Netherlands for the three age groups (the same standard population as used for the crude death rate).

3.3.3.2 Decomposition method

The decomposition was based on the life tables constructed for the first sub question.
There are several methods of decomposition, all developed during the 1980s. Andreev, Arriaga and Pressat all developed a discrete method of decomposition, while Pollard came with a continuous version. The methods of decomposition by Andreev and Pressat are exactly the same, and comparable to that of Arriaga, though written in a different form (Andreev, et al. 2002). The main difference between these methods and the one from Pollard is the use of a discrete or continuous approach, but the results are approximately the same (Pollard, 1988). The method of Arriaga is preferred since it easier applicable to traditional life tables (Preston et al, 2001), therefore this method will be used. With the decomposition method it is possible to measure the contribution to life expectancy of the increase (or decrease) in the mortality rate in an age group from a given cause. The only assumption is that the distribution of deaths by cause is constant within each age group in each population.

The formula to estimate the specific contribution of differences in mortality rates from a cause between ages x and x+n is:

$$_n\Delta_x^i = {}_n\Delta_x \cdot \frac{{}_nR_x^i(2) \cdot {}_nm_x(2) - {}_nR_x^i(1) \cdot {}_nm_x(1)}{{}_nm_x(2) - {}_nm_x(1)}$$

(Preston et al, 2001).
$_n\Delta_x$ is the contribution of all-cause mortality differences in age group x to x+n to the differences in life expectancies.
$_nm_x$ (1) and $_nm_x$ (2) are the all cause mortality rates between ages x and x+n for the population in a Corop region (1) and the Northern Netherlands (2).
$_nR_x$ (1) and $_nR_x$ (2) are the proportion of deaths from cause I between ages x and x+n for the population in a Corop region (1) and the Northern Netherlands (2).

3.3.4 Statistical analysis

SPSS will be used to test if there is a statistical significant difference in life expectancy between the municipalities. To see how far the life expectancy of the regions lies from the life expectancy of the Netherlands, the standard score (or z-score) can be used.
The formula used to calculate this is:

$$\text{z- score} = \frac{\text{value} - \text{mean}}{\text{Standard deviation}}$$

(Norušis, 2006 p. 90).
The z-score indicates how many standard deviations a cause is above or below the mean. A standard score of 0 means the value for the regions is equal to the mean (of the Netherlands), a standard score of 1 is one standard deviation above the mean, and a standard score of -1 is one standard deviation below the mean. Next to that, the z-score tells what the confidence interval of a value is. When the z-score is higher than 1.96 it falls within the 95% confidence interval, and a z-score higher than 2.58 falls within a 99% confidence interval. Since these high significance levels did not yield much result, a somewhat lower significance of 90% is also used, corresponding to a z-score of 1.645 (Norušis, 2006).

4. Results

4.1 Regional differences in old age mortality

The regional differences in old age mortality will be measured in two ways: the differences in life expectancy at age 80, and the differences in age standardized mortality rates 80+. First the results of the life expectancies for municipalities and Corop regions will be shown, then the results for the age standardized mortality rate 80+ for municipalities and Corop regions.

4.1.1 Life expectancy municipalities

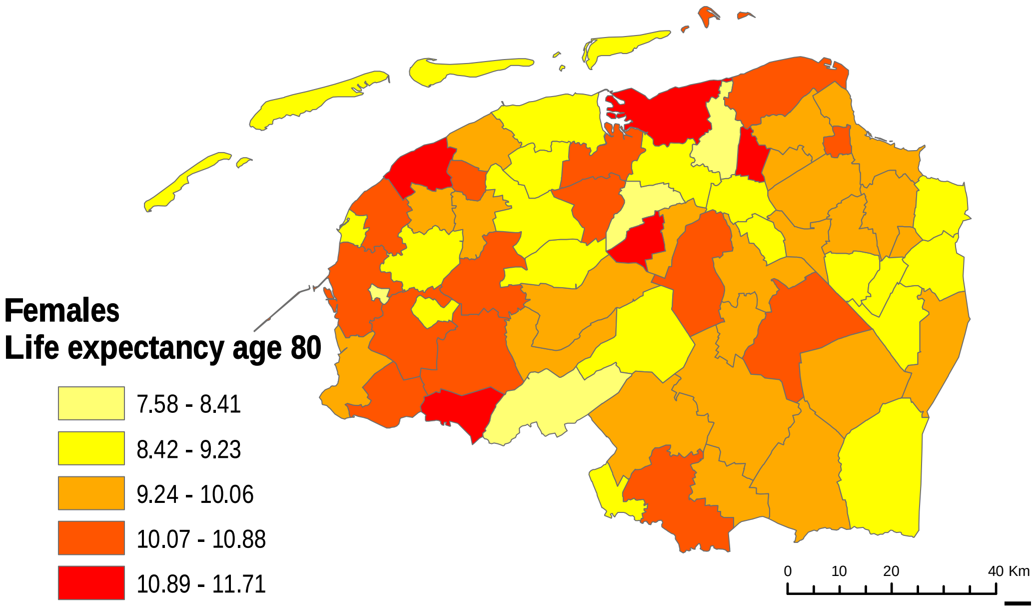
This paragraph will discuss the life expectancy at age 80 for municipalities as resulted from the life tables. As a reference, the life expectancies for the Netherlands and the Northern Netherlands were also calculated, the results are shown in table 4.1. As the table shows females aged 80 in the Netherlands have about 9 years left to life, for males this is on average around 7 years. For the total population (males and females) the life expectancy at age 80 is around 8 years. As the table shows the life expectancy at age 80 for the Northern Netherlands is not very different from that of the Netherlands, though it is somewhat higher. Interesting is that though the Northern Netherlands have a slightly higher life expectancy at age 80, at birth the life expectancy is slightly higher for the Netherlands, except for females.

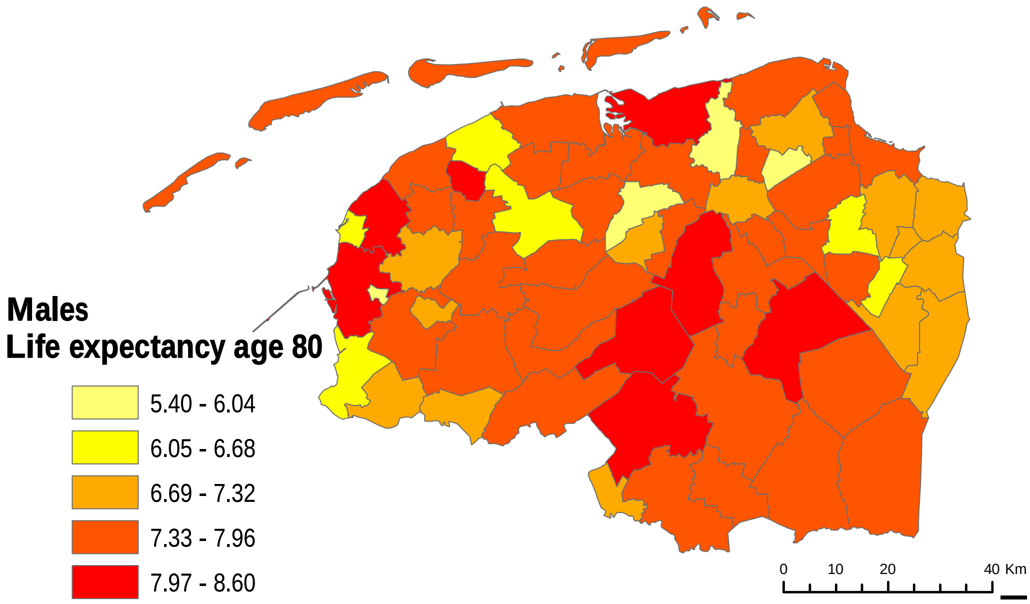
Table 4.1: Comparison between life expectancy at birth and at age 80 for the Netherlands and the Northern Netherlands

	Netherlands	Northern Netherlands	Netherlands	Northern Netherlands
Females	81.85	81.89	9.04	9.06
Males	77.54	77.51	7.18	7.25
Total	79.78	79.76	8.36	8.38

The life expectancy at age 80 for municipalities is shown in figure 4.1. Though a lot of municipalities have a life expectancy at age 80 close to that of the Northern Netherlands, the map clearly shows there is regional variation. When looking at the map of total differences in life expectancy (for males and females together) the life expectancy ranges from 6.67 to 10.23 years.
The lowest life expectancies can be observed in Bolsward, where the life expectancy at age 80 is only 6.6 years, and Grootegast and Winsum (respectively 7.06 and 7.28 years). The highest life expectancies are found in Kollumerland and Nieuwkruisland (10.23 years) and De Marne (10.13 years). When comparing this map with those of both males and females, most municipalities with a high life expectancy for the total population also show high life expectancies for males and females separately. For females Bolsward and Winsum also have one of the lowest life expectancies, 7.58 and 7.74 respectively. Grootegast also has a life expectancy of 7.83 for women age 80, and is therefore also one of the municipalities in the lowest category. Leeuwarderadeel was the municipality with the highest life expectancy for both males and females, but when looking at women alone, this is not the case. Leeuwarderadeel with a life expectancy of 10.15 at age 80 is even a little above the mean female life expectancy of 9.02 in the Northern Netherlands. Females aged 80 living in De Marne and Marum will on average live another 11.5 years, which is the highest life expectancy in the Northern Netherlands. Compared to females, men in the Northern Netherlands live on average two and a half year shorter. Again Bolsward and Grootegast show low life expectancies at age 80, on average men live only 5.70 and 5.40 years after the age of 80. Males living in Franekeradeel and Leeuwarderadeel have the highest life expectancy at age 80, of 8.59 and 8.60 years. Also for males in De Marne the life expectancy of 8.42 years at age 80 is relatively high. When looking at the maps, there seems to be some similarities between the maps. Some municipalities that show high or low life expectancies for females do also for males. However there also are municipalities that have a high or low life expectancy for females, but have the contrary for males.

Figure 4.1 Life expectancy at age 80 by municipality, females, males and males and females.





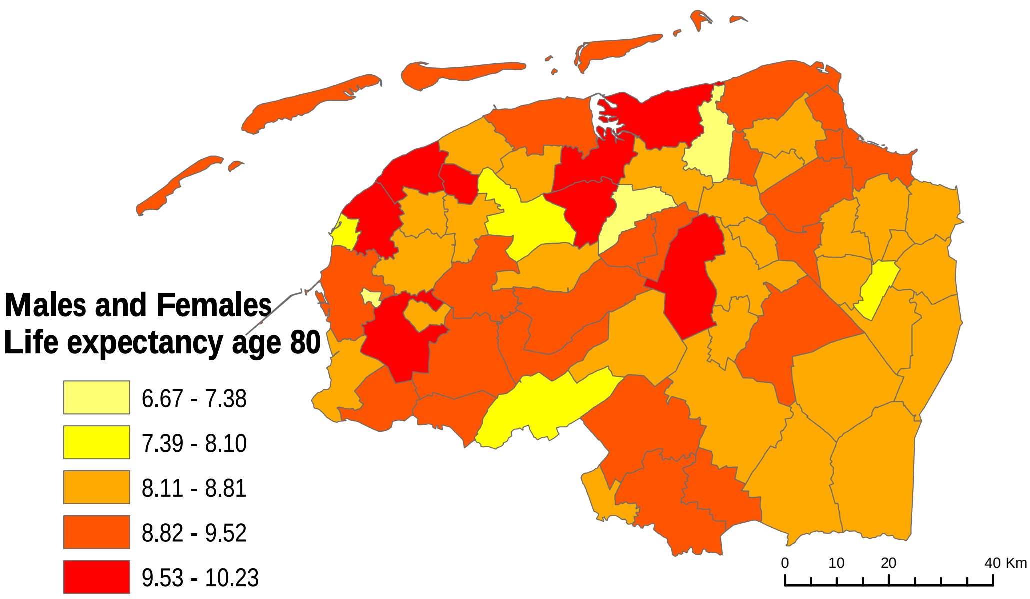


Figure 4.1 showed the calculated life expectancy for each municipality. The map already showed there are some municipalities that show a clear higher or lower life expectancy at age 80 than that of the Northern Netherlands. However, the map does not show to what extend the municipalities really differ. Therefore figure 4.2 shows the significant different based on the z-scores. Also a table of the significant municipalities is made, which can be found in the appendix, table 4.6.

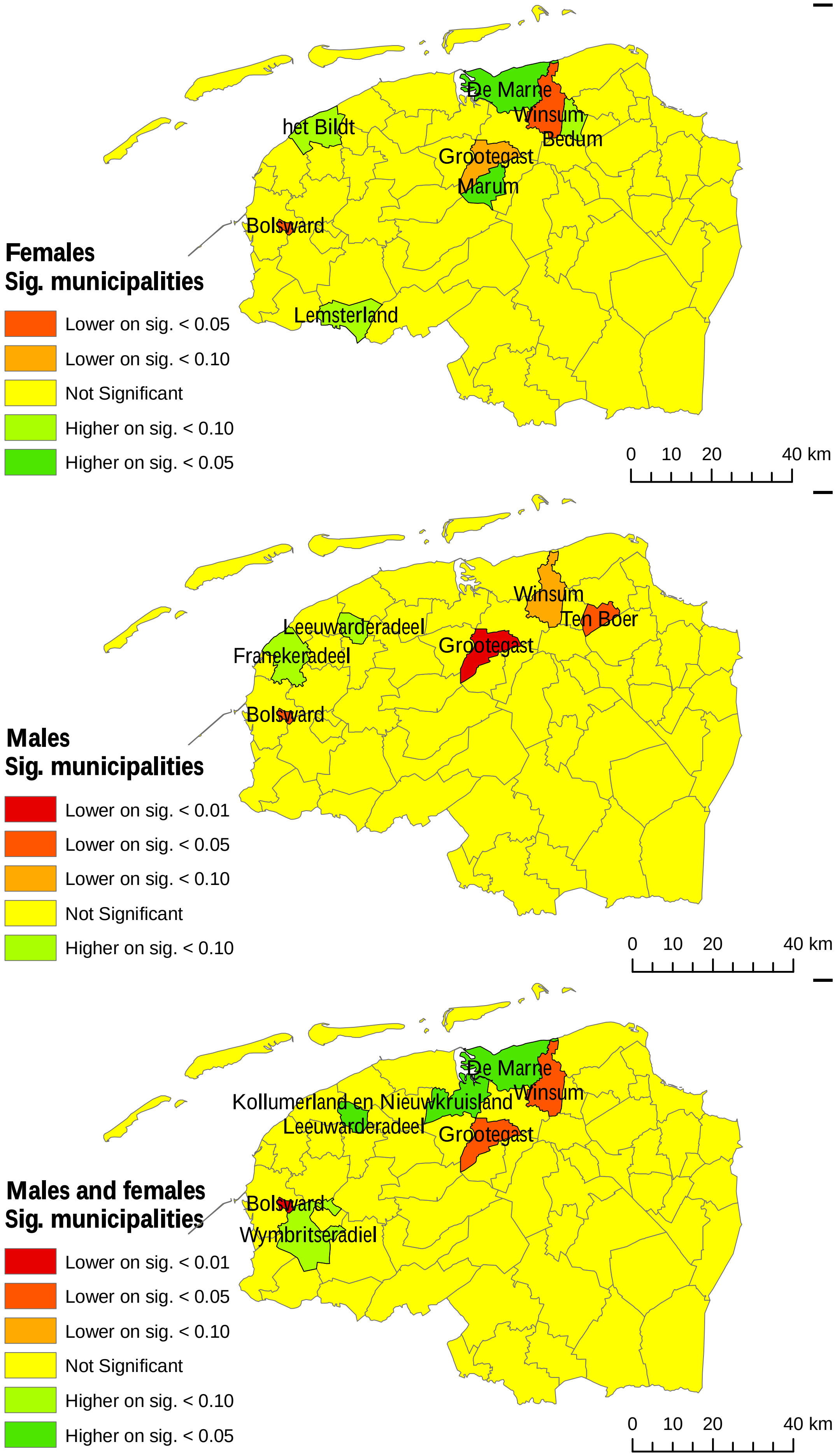
The first map of figure 4.2 shows the significantly different municipalities for females. As the map shows there are two municipalities with a significant higher life expectancy on a 0.05 significance level. These municipalities are De Marne and Marum. There are also three other municipalities showing higher life expectancies, though there significance level is lower (0.10).
The municipalities with a significant lower life expectancy are also shown in the figure. Winsum and Bolsward are significantly lower on a 0.05 significance level, Grootegast on a 0.10 significance level.

The municipalities with a significant different life expectancy at age 80 for males are visible in the second map. As the figure shows, there are only two municipalities with a higher life expectancy at age 80, which are Franekeradeel and Leeuwarderadeel. However both have a significance level of only 0.10. Municipalities with a lower life expectancy are again Winsum, Bolsward and Grootegast, as were also lower for females. For males, Ten Boer also shows a lower life expectancy for at age 80. When looking at the significance level, Grootegast is highly significant on a 0.01 significance level. So this municipality shows a considerably lower life expectancy at age 80 for males than the other municipalities in the Northern Netherlands.

The third map shows the municipalities that are significant for the total population (both males and females). When comparing this map to those of females and males, some similarities, but also some differences arise. The municipalities De Marne and Leeuwarderadeel also have a significant higher life expectancy for respectively females and males. However, Kollumerland and Nieuwkruisland, and Wymbritseradiel appear only in the map for males and females.
The municipalities Winsum, Bolsward and Grootegast show significantly lower life expectancies at age 80, which could be expected since they also do so for females and males. While Grootegast was highly significant for males, it is Bolsward which has a significance level of 0.01 for the total population.

It is also interesting to note that municipalities with significant higher or lower values are directly next to each other (for example Winsum-De Marne and Grootegast-Marum). This is most visible in the maps for females and the total population. It could be expected municipalities with either high or low values are situated close to each other, though in these maps they are not.
To see if municipalities with a significant lower or higher life expectancy at age 80 also do so at birth, the municipalities with significant life expectancies at age 80 and significant life expectancies at birth are compared. A table or the municipalities showing significant life expectancies at birth can be found in the appendix, table 4.7. The result was that not many municipalities showing significant lower or higher life expectancies at birth also did so at age 80. The municipalities Bolsward and De Marne respectively showed a lower and higher life expectancy at birth, and at age 80 for females. Their life expectancy at birth was significant at a 0.10 level, while the life expectancy at age 80 was significant at a 0.05 level. Males showed no municipalities that are both significant at birth and at age 80. Leeuwarderadeel showed a higher life expectancy significant at a 0.01 level for the total population. The life expectancy in this municipality is also significantly higher (on a 0.05 level) at age 80.

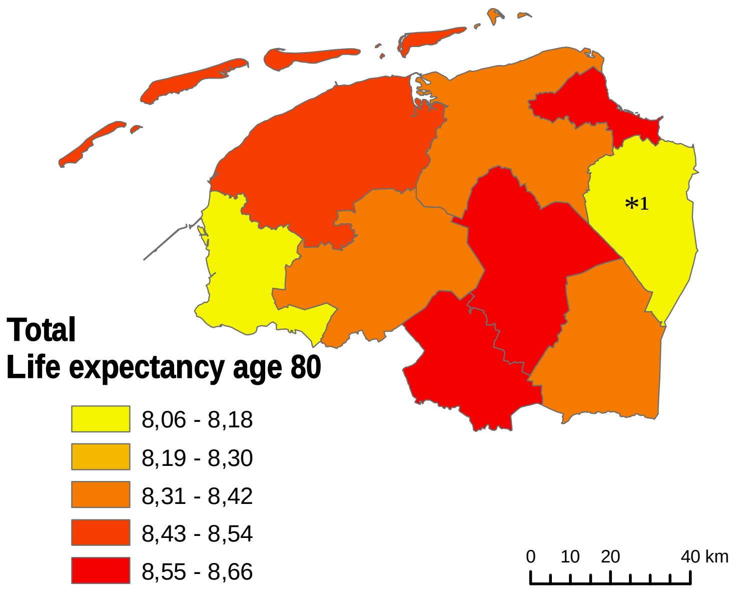
Figure 4.2 Differences in life expectancy for females, males, and males and females.



4.1.2 Life expectancy Corop

The analysis of the regional life expectancies at age 80 just done for municipalities, is also done at Corop level to show the life expectancy patterns one level above municipalities. This will also be useful since the cause of death analysis will be based on Corop level.

Figure 4.3 Life expectancy at age 80 for total population in Corop regions in the Northern Netherlands.

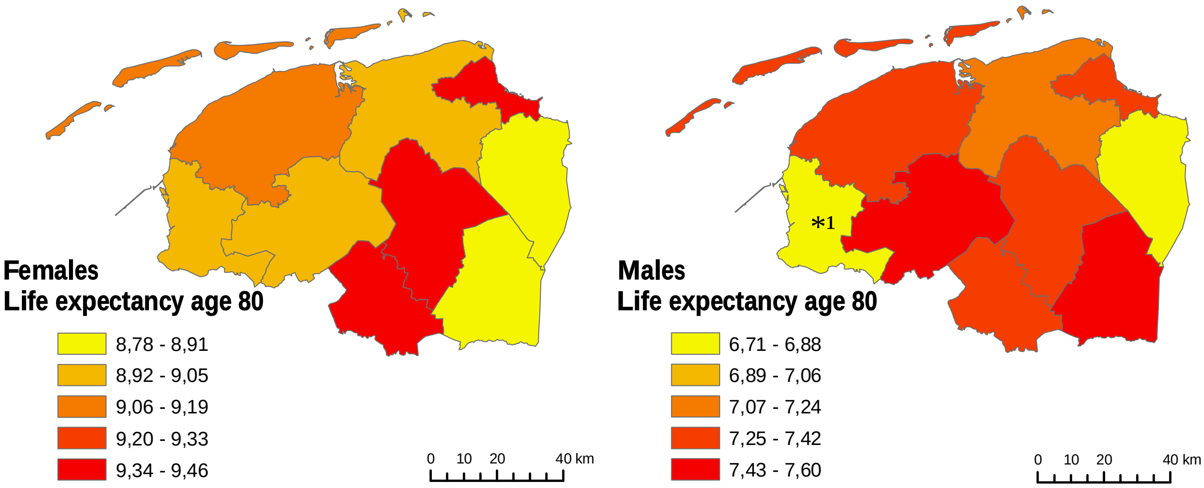


*1 Significant different from average of NN on 90% CI.

Figure 4.3 shows the life expectancy at age 80 for males and females in the different Corop regions. The corresponding life expectancies at birth and at age 80 for each Corop level can been found in table 4.8 in the appendix. As the figure shows, there are also regional differences in life expectancy at age 80 on Corop level. The Corop regions Delfzijl, and Northern and South-west Drenthe show higher life expectancies, while East Groningen and South-west Friesland show relatively lower life expectancies. On average, males and females in the Northern Netherlands have about 8.38 years to live at age 80. The Corop region East Groningen has a life expectancy at age 80 of 8.06 years, which is significantly lower than the Northern Netherlands. The highest life expectancy at age 80 (8.66 years) can be found in Region Delfzijl, but is not high enough to be significantly different. The figure also shows that the variation in differences is smaller than those at municipality level. At Corop level the life expectancy ranges from 8.06 to 8.66 years, while at municipality this is much larger (from 6.67-10.23 years).

The life expectancy at age 80 specified for females and males are shown in figure 4.4. When comparing both maps, a different pattern in life expectancy is visible for males and females. Again the life expectancy for females is higher, but the variation in life expectancy is larger for males. The first map shows the life expectancy at age 80 for females. The Corop region with the lowest life expectancy at age 80 is South-east Drenthe, where females on average live another 8.77 years. Region Delfzijl has the highest life expectancy age 80 (9.46 years). In the Northern Netherlands females live on average another 9.06 years, but none of the Corop regions differs enough to be significant. Remarkable is that though South-east Drenthe has the lowest life expectancy age 80 for females, it has the highest for males (7.60 years). The lowest life expectancy at age 80 for males can be found in South-west Friesland, where men aged 80 live only 6.71 years. This Corop region is significantly lower, related to the male life expectancy of 7.25 in the Northern Netherlands.

Figure 4.4 Life expectancy at age 80 for females and males in Corop regions in the Northern Netherlands.



*1 Significant different from average of NN on 90% CI.

Like is done for municipalities, the life expectancy at age 80 is compared to the life expectancy at birth. A table of the life expectancies at birth and at age 80 for each Corop region can be found in the appendix. When comparing the life expectancy at birth to that at age 80, East-Groningen shows both a significantly lower life expectancy at birth, and at age 80 for the total population. At birth, the inhabitants of the Northern Netherlands are expected to life till the age of 79.7. In East-Groningen the life expectancy is only 78.8 years. This difference is significant on a 0.05 significance level. At age 80, the difference between the life expectancies becomes less, here East-Groningen is only significantly different on a 0.10 level. As was already mentioned none of the Corop regions had a significant different life expectancy at age 80 for females. However, when looking at the life expectancy at birth, East-Groningen shows a somewhat lower life expectancy. Females in the Northern Netherlands get on average 81.9 years. In East-Groningen this is almost one year less. Also for males East-Groningen shows a lower life expectancy at birth of almost one year. Males in East-Groningen life about one year less than the life expectancy of 77.5 for males in the Northern Netherlands.

4.1.3 Age standardized mortality rate 80+ municipalities

Next to the life expectancy, also the age standardized mortality rate at ages 80 and higher is calculated for municipalities and Corop regions in the Northern Netherlands. This can give a complementary view on the regional differences in old age mortality next to the life expectancy.

Again first the age standardized mortality rate 80+ of the Netherlands and the Northern Netherlands are compared. The results are shown in table 4.2. As the table shows, on average 103 females per 1000 inhabitants aged 80 and older in the Netherlands die. For males this number is much higher, 129 deaths per 1000 elderly. In total (males and females combined) around 111 elderly per 1000 inhabitants aged 80 and older died. The numbers for the Northern Netherlands are slightly lower, especially for males, which could be expected, since the life expectancy for the Northern Netherlands is also slightly higher compared to the Netherlands.

Table 4.2 Comparison between age standardized mortality rate 80+ for the Netherlands and the Northern Netherlands.

	Netherlands	Northern Netherlands
Females	102.9	102.7
Males	129.2	127.5
Total	111.4	111.0

Figure 4.5 shows the age standardized mortality rate 80+ for the municipalities in the Northern Netherlands for females, males and females and males. Again regional differences in mortality are visible. The first map shows the age standardized mortality rate 80+ specified to females. There is a wide variation visible in mortality level, since the categories range from 46.3 till 143.7 deaths per 1000 elderly. The lowest ages standardized mortality rate 80+ is observed in Wymbritseradiel, the highest in Bolsward. The second map is specified to males, also here regional variation is present. The municipality of Leeuwarderadeel has the lowest age standardized mortality rate 80+ of 81.5 deaths per 1000 inhabitants 80+. The highest morality level is observed in Grootegast with a mortality rate at 80+ of 194.3 deaths per 1000. As table 4.2 already showed 111 males and females aged 80 die per 1000 inhabitants in the Northern Netherlands. At municipality level, there are municipalities which have a mortality rate 80+ which is much lower or higher than that of the Northern Netherlands. The municipality with the highest age standardized mortality rate 80+ is Bolsward with 159.8 deaths per 1000, the lowest is Leeuwarderadeel with 81.8 deaths per 1000 people 80+.

Figure 4.5 Age standardized mortality rate 80+ by municipality, for females, males and males and females.

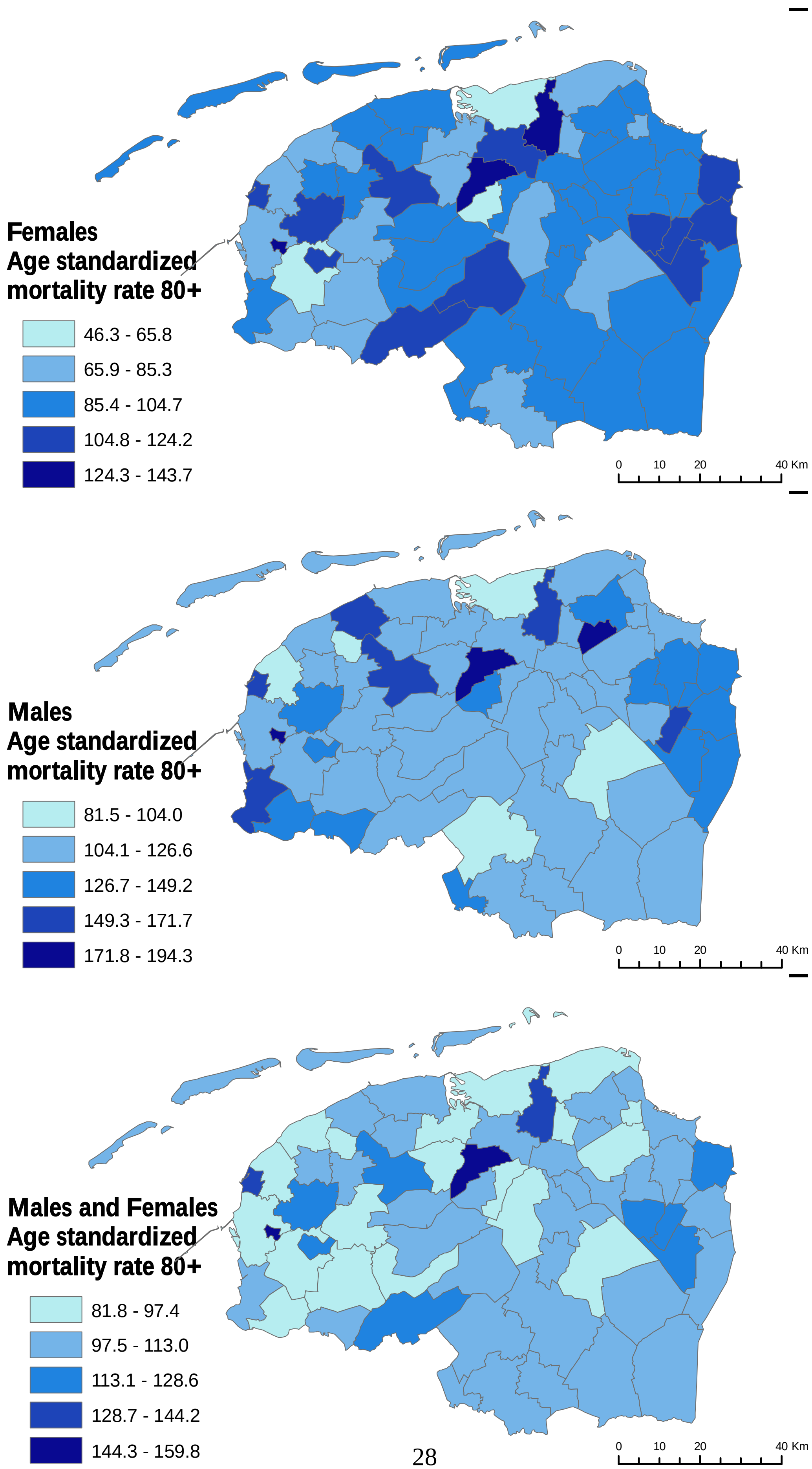


Figure 4.6 Differences in age standardized mortality rate 80+ for females, males and males and females.

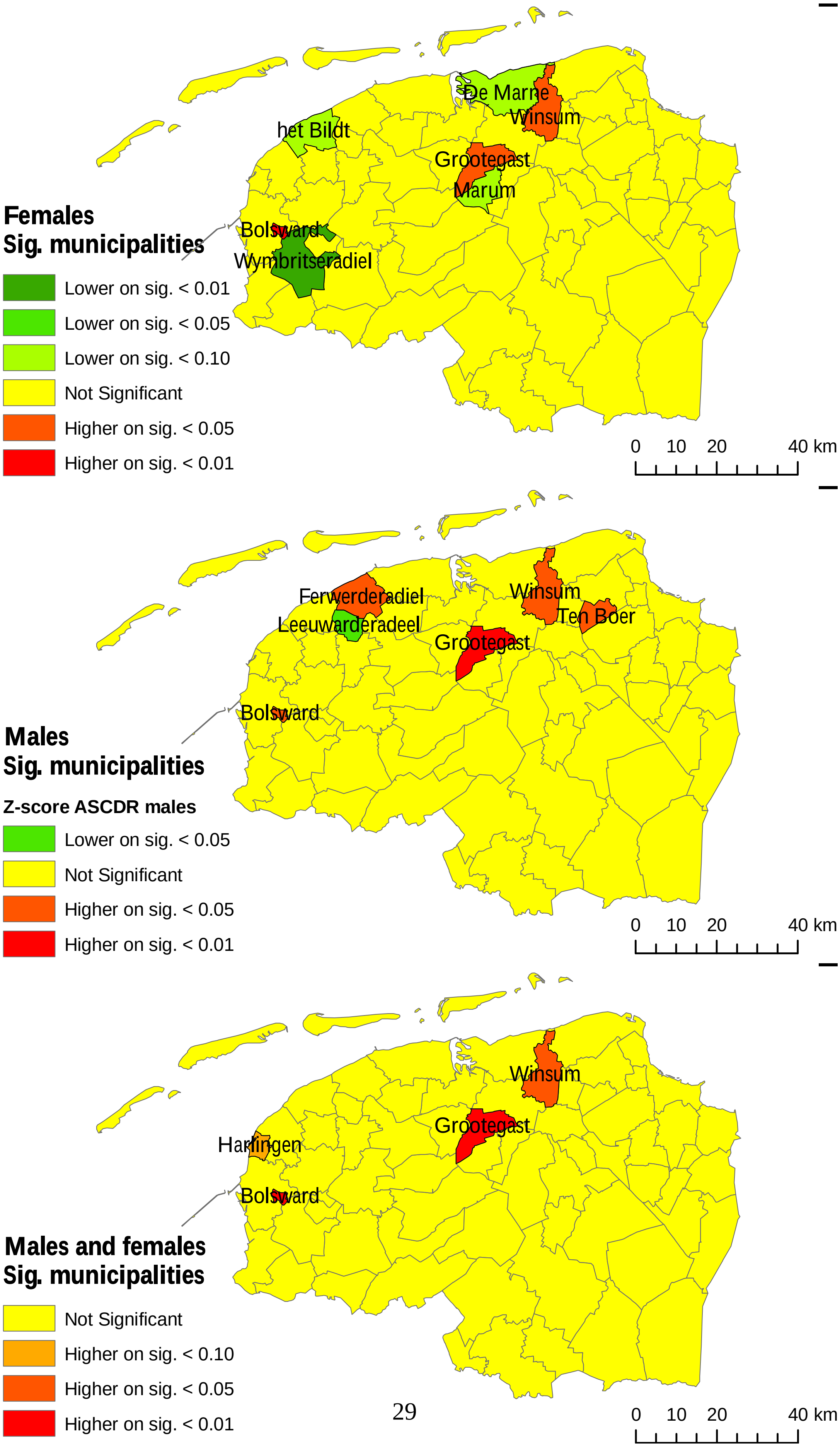


Figure 4.6 shows which municipalities have a significantly different mortality rate for ages 80 and older. A corresponding table giving an overview of the significant municipalities can be found in the appendix, table 4.9. The first map shows the significantly different municipalities for females. Marum, De Marne and het Bildt all have only a lower age standardized mortality rate 80+, significant on a 0.10 level. As already mentioned Wymbritseradiel has the lowest age standardized mortality rate 80+ for females, and is also significantly lower at a 0.01 significance level. Municipalities with a higher age standardized mortality rate 80+ are Grootegast and Winsum and Bolsward, of which Bolsward is highly significant. The differences in age standardized mortality rate 80+ for males is shown in the second map of figure 4.7. As the map shows there is only one municipalitity which is significantly lower for males, which is Leeuwarderadeel. A higher age standardized mortality rate 80+ is visible in Winsum, Ferwerderadiel, Bolsward and Ten Boer, which all are significant on a 0.05 level. Grootegast already showed the highest mortality rate, and is significantly different on a 0.01 significance level. Finally the third map shows the age standardized mortality rate 80+ for both males and females. The map shows no municipalities which significantly differ from the mortality rate 80+ of the Northern Netherlands. There are however municipalities showing relatively higher mortality levels. Harlingen and Winsum are significant on respectively a 0.10 and 0.05 significant level. Bolsward and Grootegast are highly significant, as could be expected since they are also for females and males separate.

When comparing the municipalities that have a significant life expectancy or age standardized mortality rate 80+ (e.g. by looking at the maps, or the tables in the appendix) some similarities can be found. This could be expected, since it is logical to assume municipalities with a significant higher life expectancy, have a relatively lower age standardized mortality rate 80+.
As paragraph 4.1.1 showed, Bolsward, Winsum and Grootegast have a significantly lower life expectancy for females, males and males and females. These are also the municipalities that have a higher age standardized mortality rate 80+ for all three categories. For males, Grootegast even shows a lower life expectancy at age 80 and a higher mortality level, both significant on a 0.01 significance level. Also the municipality Ten Boer has a lower life expectancy and higher mortality rate for elderly males.

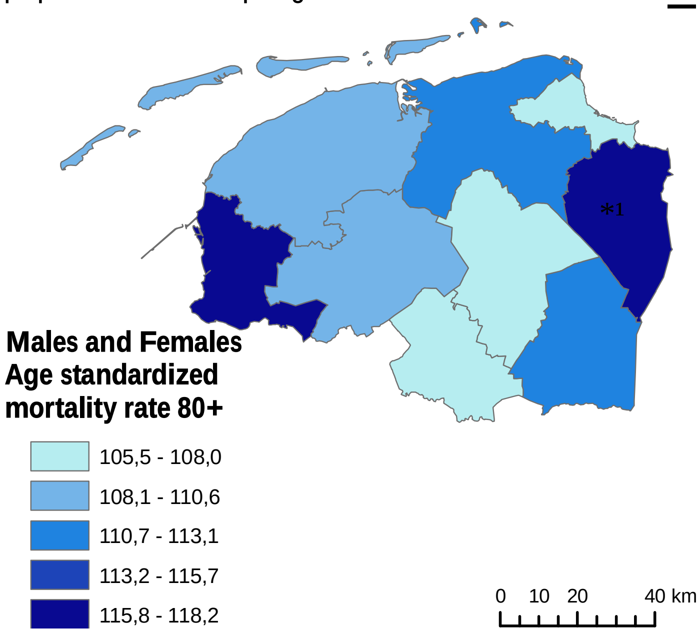
When looking at municipalities showing higher life expectancies and lower mortality rates, again most are similar. For females, Het Bildt, De Marne and Marum all show higher life expectancies and lower age standardized mortality rates 80+, as does Leeuwarderadeel for males. However, there are also municipalities showing a significantly higher life expectancy at age 80, but these do not appear to have a lower age standardized mortality rate 80+. This is especially the case for males and females, where none of the municipalities with a higher life expectancy have significantly lower mortality rates. Another exceptional case is Wymbritseradiel, which has a highly significant mortality rate for females, but does not show a higher life expectancy.

4.1.4 Age standardized mortality rate 80+ Corop

Also for Corop regions, the age standardized mortality rate 80+ is calculated, complementary to the life expectancy at age 80, discussed in paragraph 4.1.2. The regional differences in the mortality rate for elderly in Corop regions in the Northern Netherlands will be discussed in this paragraph.

The results of the age standardized mortality rate for males and females age 80 and over is shown in figure 4.7. This figure shows the age standardized mortality rate per 1000 people aged 80+ for the total population. It are the regions Delfzijl, Northern and South-west Drenthe which show the lowest mortality levels. The highest age standardized mortality rates 80+ are visible in South-west Friesland and East-Groningen. The latter has a mortality rate 80+ of 118.2 deaths per 1000 people aged 80+. Compared to the 111 deaths per 1000 elderly in the Northern Netherlands, this is significantly different (on a 0.10 level). The region with the lowest mortality rate, Region Delfzijl, has 105.5 deaths per 1000 people aged 80+, but is not significantly different.

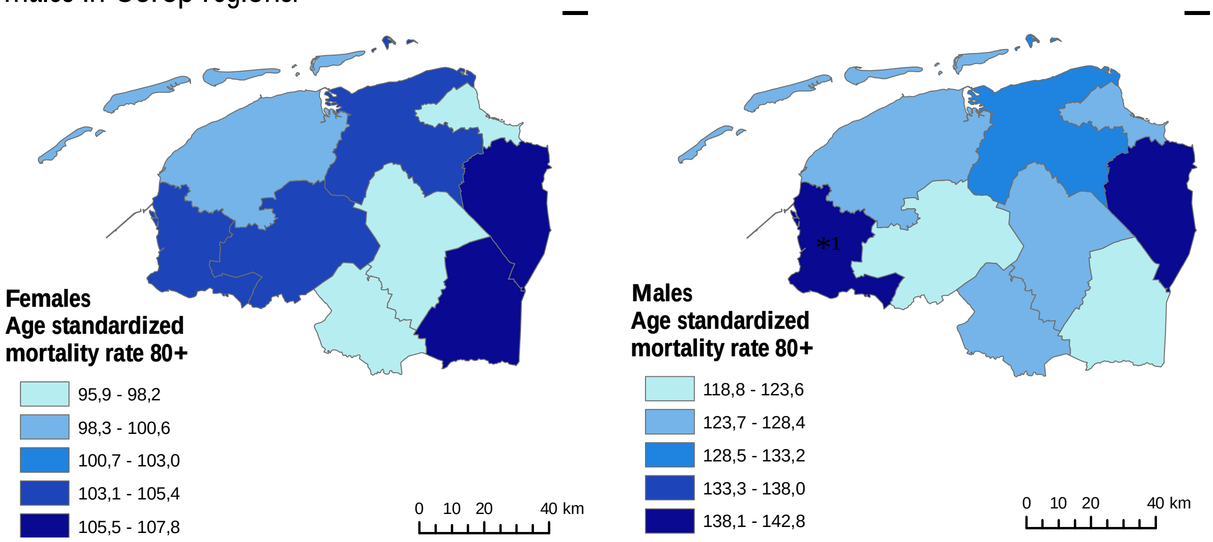
Figure 4.7 Age standardized mortality rate 80+ per 1000 inhabitants aged 80+ for the total population in Corop regions.



*1 Significant different from average of NN on 90% CI.

Figure 4.8 shows the age standardized crude death rates 80+ separated for males and females.
The first map for females is almost similar to the map of the total population (figure 4.8), only South-east Drenthe shows a relatively high mortality level for females. The region has an age standardized mortality rate 80+ of 107.8 deaths per 1000 people aged 80+. The lowest age standardized mortality rate 80+ for females 80+ is observed in Region Delfzijl where only 95.9 elderly per 1000 die. However, none of these regions differ enough from the 102.7 deaths per 1000 elderly in the Northern Netherlands to be significant.
The second map of figure 4.8 is specified for males. Table 4.2 already showed the Northern Netherlands has a male mortality rate 80+ of 127.5 deaths per 1000 elderly. As the map shows there are Corop regions with a much lower or higher mortality rate than this. While south-east Drenthe showed one of the highest mortality levels for females, the region has one of the lowest age standardized mortality rates 80+ for males. Only 118.8 males per 1000 elderly die in this Corop region. This is considerably lower than the 142.8 men age 80+ dying per 1000 inhabitants in South-west Friesland, which is the Corop region with the highest mortality. The relative high mortality rate makes South-west Friesland significant on a 0.10 significance level.

Figure 4.8 Age standardized mortality rate 80+ per 1000 inhabitants aged 80+ for females and males in Corop regions.



*1 Significant different from average of NN on 90% CI.

When comparing the maps of the life expectancies in paragraph 4.1.2 to the ones of the age standardized mortality rate, they show the same pattern. For both the life expectancy and the age standardized mortality rate 80+ it are the same regions that are significant.

The Corop regions Region Delfzijl, Northern and South-west Drenthe show a higher life expectancy at age 80 and lower mortality levels for both females and males and females.

For males, these three regions also have a relatively high life expectancy at age 80 and a low mortality rate 80+, but the spatial pattern is somewhat different. South-east Drenthe and South-east Friesland are the Corop regions showing the lowest levels of old age mortality for males.

It is interesting that South-east Drenthe has the highest life expectancy at age 80 and the lowest mortality rate, it has one of the lowest life expectancy and highest mortality rates for females.

Other regions with a low life expectancy and high age standardized mortality rate 80+ are East Groningen, and South-west Friesland. East Groningen has a significantly different life expectancy and age standardized mortality rate 80+ for males and females, South-west Friesland is significantly different for males.

4.2 Clustering in life expectancy at age 80 and age standardized mortality rates 80+

When looking at the maps of the life expectancy at age 80 and the age standardized mortality rate 80+ (figure 4.1 and figure 4.6) it is visible some areas with similar values are next to each other. When there is an area of municipalities or Corop regions with the same values, it could indicate a cluster of similar values. Although an area may look like a cluster, it may not always be one when analyzing it statistically. Therefore the life expectancy at age 80 and the age standardized mortality rate 80+ for municipalities and Corop regions is analyzed using the Global Moran's I tool from ArcGIS. This tool looks whether municipalities or Corop regions with the same values are spatially clustered or dispersed. When the Global Moran's I indicates clustering, the location and extend of clustering can be indicated using the Anselin Local Moran's I tool.

Table 4.3 shows the results of the Global Moran's I at municipality level. As an output the Global Moran's I gives several values. The Moran's I index indicates the clustering. It ranges from -1 till 1, whereby -1 indicates dispersion and +1 indicates clustering. Also the z-score and its corresponding p-value are given, these say something about the significance of the Moran's I value. The related null hypothesis states there is no spatial clustering of values (the features are randomly distributed). So when the Moran's I value is significant it means there is clustering, when not significant there is no clustering. It should be stated that the Global Moran's I test is more reliable when 30 or more features are used. This means that for municipalities the results are reliable (since there are 65 municipalities). However, at Corop level, the Northern Netherlands only has nine Corop regions. This means the results at Corop level are less reliable than the ones at municipality level.

As table 4.3 shows there is no clustering at municipality level. The values of the Moran's I index for the life expectancy at age 80 is negative for females, males and males and females (total). This indicates the pattern tends to be dispersed. This is also the comment given for females and total: somewhat dispersed but the dispersion may be due to random choice. The pattern for males is completely random, meaning there is neither dispersion nor clustering.
Also the age standardized mortality rate at municipality level tends to be dispersed. Also this dispersion may be due to random chance, so also here no clear pattern is visible.
Since neither the life expectancy at age 80 nor the age standardized mortality rate 80+ showed a clustered pattern, there is no point in performing the Anselin Local Moran's I tool.

Table 4.3 Results of Global Moran's I at municipality level.

Municipality level	Moran's I index	z-score	significance	Clustering
Life expectancy at age 80 females	-0.12	-1.33	0.183	Somewhat dispersed, may be due to random chance.
Life expectancy at age 80 males	-0.05	-0.49	0.621	Random
Life expectancy at age 80 total	-0.12	-1.37	0.169	Somewhat dispersed, may be due to random chance.
Age standardized mortality rate 80+ females	-0.12	-1.32	0.187	Somewhat dispersed, may be due to random chance.
Age standardized mortality rate 80+ males	-0.11	-1.24	0.216	Somewhat dispersed, may be due to random chance.
Age standardized mortality rate 80+ total	-0.12	-1.41	0.158	Somewhat dispersed, may be due to random chance.

The same analysis is done for the life expectancy at age 80 and the age standardized mortality rate 80+ at Corop level. The results are shown in table 4.4. Also here there is no tendency of clustering. All moran's I index values are negative, indicating dispersion instead of clustering. The values are more negative than the ones at municipality level, so at Corop level the pattern is more dispersed than at municipality level. Both the life expectancy at age 80 and the age standardized mortality rate 80+ for females show a higher negative Moran's I index, so these are more dispersed. As a comment the analysis also states there is dispersion, but there is a likely chance this is due to random choice. The pattern for males for both the life expectancy at age 80 and the age standardized mortality rate 80+ is randomly distributed.

Table 4.4 results of Global Moran's I at Corop level

Corop level	Moran's I index	z-score	significance	Clustering
Life expectancy at age 80 females	-0.65	-1.79	0.074	Dispersion, 5-10% chance that patterns is result of random choice
Life expectancy at age 80 males	-0.25	-0.46	0,647	Random
Life expectancy at age 80 total	-0.50	-1.32	0,187	Somewhat dispersed, may be due to random chance.
Age standardized mortality rate 80+ females	-0.67	-1.86	0,063	Dispersion, 5-10% chance that patterns is result of random choice
Age standardized mortality rate 80+ males	-0.23	-0.38	0,703	Random
Age standardized mortality rate 80+ total	-0.49	-1.31	0,191	Somewhat dispersed, may be due to random chance.

So no clustering was found on either municipality or Corop level. This means that though there are regional differences in life expectancy and the level of mortality, these regions are not close to each other as could be expected from previous studies. Figure 4.2 and figure 4.7 even show the contrary. Municipalities with a significantly higher or lower life expectancy or mortality level are often situated next to each other, especially for females.
The cluster analysis is also done for the cause specific mortality rates, mentioned in the following paragraph.

4.3 Regional differences in cause specific mortality

The past paragraphs looked at the regional differences in old age mortality in the Northern Netherlands, by looking at which municipalities and Corop regions have deviating life expectancies at age 80 and a different age standardized mortality rate 80+. To see which causes of death are responsible for these regional differences, the following two paragraphs will show the results of the cause of death analysis. This analysis was only possible for Corop region, so the results will only be discussed on Corop level. First the results of the age standardized cause specific mortality rates 80+ are given in this paragraph. This will show the regional deviation in occurrence of several causes of death. Then the results of the decomposition of the life expectancy will be discussed in the next paragraph, to give more insight into which causes influence the life expectancy of each Corop region.

Again first the cause specific mortality rates 80+ of the Netherlands and the Northern Netherlands are given as a reference. The results are shown in table 4.3. A similar table with the cause specific mortality for each Corop region can be found in the appendix, figures 4.10, 4.11 and 4.12.
As table 4.5 shows, most deaths are caused by cardiovascular diseases and other diseases. The causes with the least number of deaths are lung cancer and external causes of death. When comparing the mortality from each cause by sex, females show a lower mortality from all causes, except from mental disorders. This is the only cause whereby males show lower mortality rates than females. The difference between cause specific mortality rates 80+ for men and women is largest for lung and other cancers. Here the mortality is relatively high for males.
Like with the life expectancy and age standardized mortality rate, the number for the Netherlands and Northern Netherlands are close together, though the Northern Netherlands also tends to have lower cause specific mortality rates.

Table 4.5 Comparison between age standardized cause specific mortality rates 80+ for the Netherlands and the Northern Netherlands.

	Total		**Females**		**Males**	
	Neth.	North. Neth.	Neth.	North. Neth..	Neth.	North. Neth.
Total	111,4	111,0	102,9	102,7	129,2	127,5
Infectious and respiratory diseases	15,8	15,3	12,7	12,1	22,2	21,7
Lung cancer	3,1	2,8	1,3	1,0	7,0	6,7
Other cancers	17,2	17,7	14,4	14,7	23,1	23,7
Mental disorders	9,0	9,3	10,1	10,6	6,8	6,7
Cardiovascular diseases	40,5	40,7	38,5	38,6	44,8	44,8
External causes of death	3,2	2,9	3,0	2,6	3,5	3,5
Other causes of death	22,6	22,2	23,0	23,0	21,7	20,4

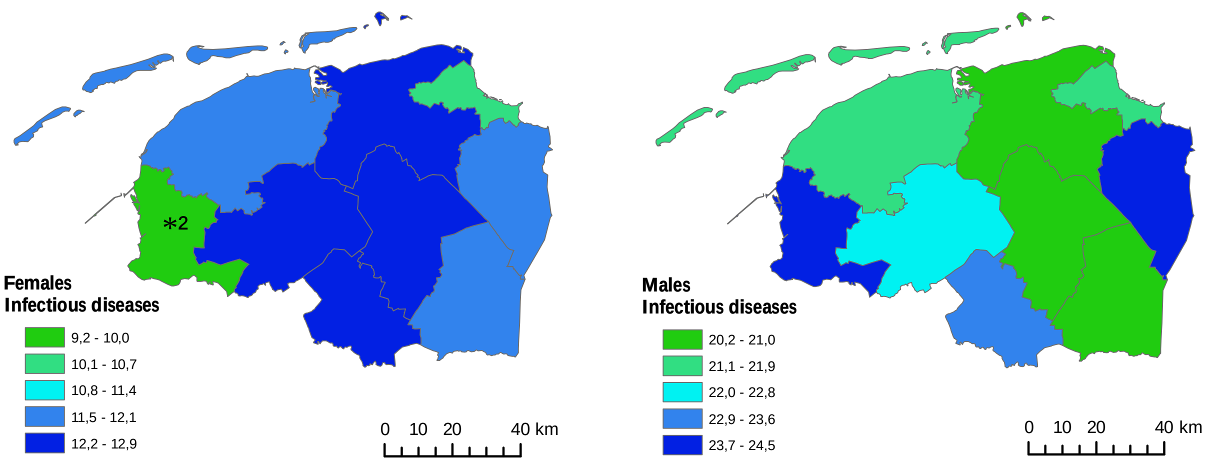
This paragraph will further discuss the age standardized cause specific mortality rate 80+ by showing the mortality rates for each Corop region per cause. The results will be shown in maps to better visualize the regional differences in occurrence. The same cluster analysis as done in paragraph 4.2 is used to analyze the amount of clustering in each cause specific map. As in paragraph 4.2 not all maps showed interesting results. Therefore the results of the cluster analysis are only mentioned when clustering or other remarkable results were found.

4.3.1 Infectious and respiratory diseases

Figure 4.9 shows the age standardized mortality rate at age 80+ for infectious and respiratory diseases per 1000 inhabitants aged 80 years and older.
The first map shows the mortality rate for infectious diseases for females. In the Northern Netherlands on average 12 of the 1000 females aged 80 or older die of infectious diseases. Most females aged 80+ dying of infectious and respiratory diseases can been found in Corop regions in the middle of the Northern Netherlands. The highest mortality rate is observed in South-west Drenthe, which is 12.9 deaths per 1000 inhabitants aged 80+. The Corop region with the least deaths of infectious and respiratory diseases is South-west Friesland. Here only 9.2 elderly per 1000 die of infectious diseases. This is significantly different on a 0.05 confidence level.

The figure on the right shows the mortality rates for infectious and respiratory diseases for males. This figure is totally different from the one for females. Regions with a high number of females dying of this cause show relatively small numbers for males. The average mortality rate for infectious diseases is 22 deaths per 1000 inhabitants aged 80 and over. The lowest mortality rate is found in South-east Drenthe, where 20 of the 1000 inhabitants age 80+ die of infectious diseases. The Corop region with the highest mortality rate is South-west Friesland (24.5).
For the total population the average mortality rate is 15.8 deaths per 1000, whereby Region Delfzijl has the lowest mortality rate (14 deaths per 1000 elderly) and South-west Drenthe has the highest mortality rate (16 deaths per 1000 elderly). So for the total population the difference between the regions is not that big.

Figure 4.9 Age standardized mortality rate 80+ for infectious and respiratory diseases per 1000 inhabitants aged 80+. For females and males 2004-2008.



*2 Significant different from average of NN on 95% CI.

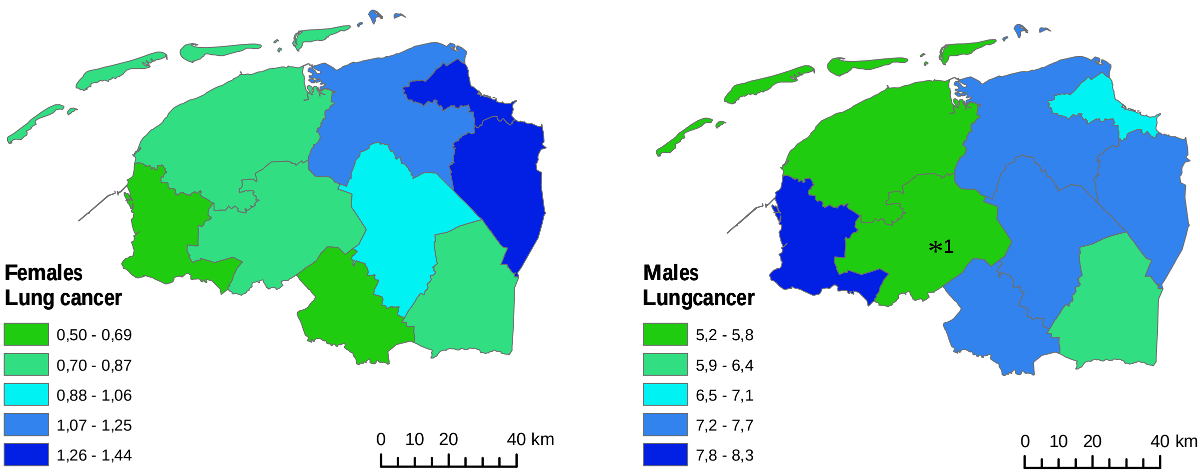
4.3.2 Lung cancer

When comparing the death rates of the various causes to each other, lung cancer is the cause with the lowest number of deaths. When comparing the maps of the lung cancer mortality for 80+ in figure 4.10 there is clearly a difference between men and women.

Not many females die of lung cancer and the regions with the highest mortality rate are situated in Groningen, especially in the eastern parts of Groningen. Both Corop regions have a mortality rate of 1.4. On average one person per 1000 elderly dies of lung cancer for females in the Northern Netherlands. In south-west Drenthe the mortality rate is the lowest, 0.5 deaths per 1000 inhabitants aged 80+.

For males, shown in the map on the right, the average mortality rate is higher than for females, about 7 males per 1000 elderly die of lung cancer. South-west Friesland shows a low mortality rate for females, but for males the region has the highest mortality rate for lung cancer (8.3). A significant lower mortality rate (on a 0.10 confidence level) is visible in South-east Friesland, which is 5 deaths per 1000 inhabitants 80+. On average the mortality rate is 3 deaths per 1000 80+ for the males and females combined. South-east Friesland has the lowest mortality rate (of 2.3), East Groningen the highest (3.4).

Figure 4.10 Age standardized mortality rate 80+ for lung cancer per 1000 inhabitants aged 80+. For females and males 2004-2008.



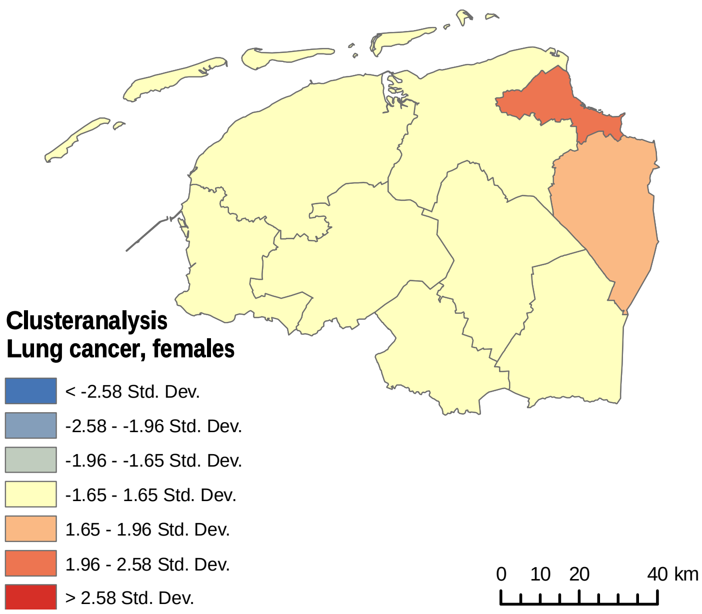
*1 Significant different from average of NN on 90% CI.

As the map for females clearly shows, the regions with high mortality rates for females aged 80+ are situated in the eastern part of the Northern Netherlands. Since the regions with similar values are grouped together, there might be clustering. From the cluster analysis (global Moran's I) this was also the result. The Moran's I Index was 0.54, which means the values tend to be clustered (as mentioned in paragraph 4.2 the Moran's I Index ranges from -1 till +1, whereby -1 indicates dispersion and +1 clustering). The corresponding z-score is 2.31 with a significance of 0.02.

The comment, related to the analysis states: 'there is less than 5% likelihood that this clustered pattern is the result of random choice'.

Since clustering is found, the Anselin Local Moran's I tool can be used to locate the clustering. Figure 4.11 shows the resulting map. As could be expected the Corop regions Delfzijl and East-Groningen are indicated as significant. This means both regions are surrounded by regions of similar (high) values. Region Delfzijl is more significant than East-Groningen as it is surrounded with areas of similar high values, while East-Groningen also borders regions with lower values.

Figure 4.11 Result of the Anselin Local Moran's I for lung cancer, females.

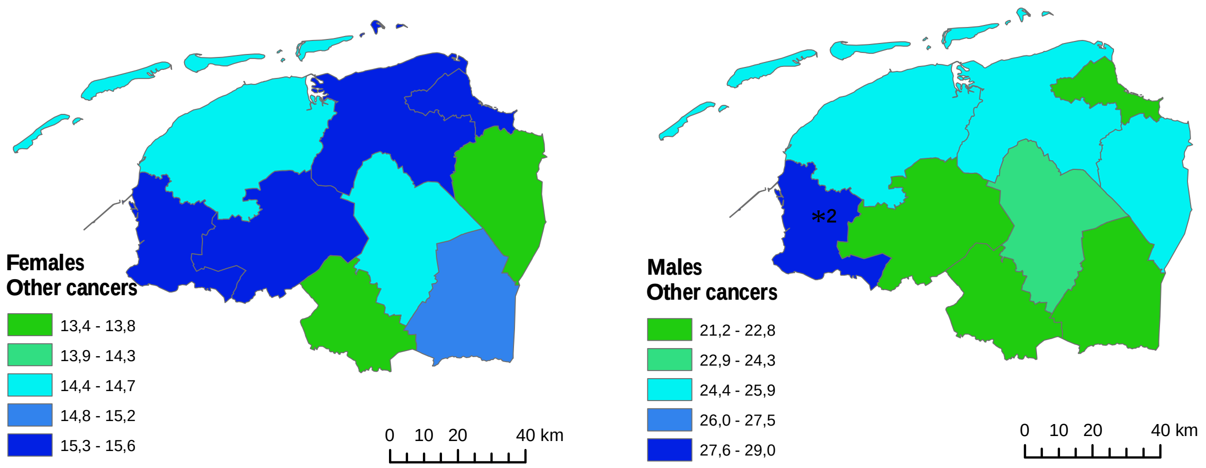


4.3.3 Other cancers

Figure 4.12 shows the mortality rate at 80+ for other cancers for females and males. Both maps show the highest mortality levels in the Northern regions. The first map shows the mortality rate for females. While East Groningen has one of the highest rates for lung cancer, the mortality rate for other cancers is one of the lowest. Both East Groningen and South-west Drenthe have a mortality rate of 13.4. Elderly women in the Corop region Groningen Other have the highest mortality rate (15.6). Both regions are not significantly different from the mean of 14.7.

The second map shows the cancer mortality rate for elderly males. Here it are also the northern Corop regions that show high cancer rates. Especially South-west Friesland has a high cancer mortality rate, 29 of 1000 elderly die of cancer. This is significantly different from the mortality rate for the Northern Netherlands (23.8). The regions with the highest and lowest cancer mortality rates are adjacent to each other, since South-east Friesland has the lowest mortality rate for other cancers (21.2). For the total population the Northern Netherlands has a mortality rate of around 18 deaths per 1000 inhabitants aged 80 and over. South west Drenthe has the lowest cancer mortality rate, and again Southwest Friesland has the lowest.

Figure 4.12 Age standardized mortality rate 80+ for other cancers per 1000 inhabitants aged 80+. For females and males 2004-2008.



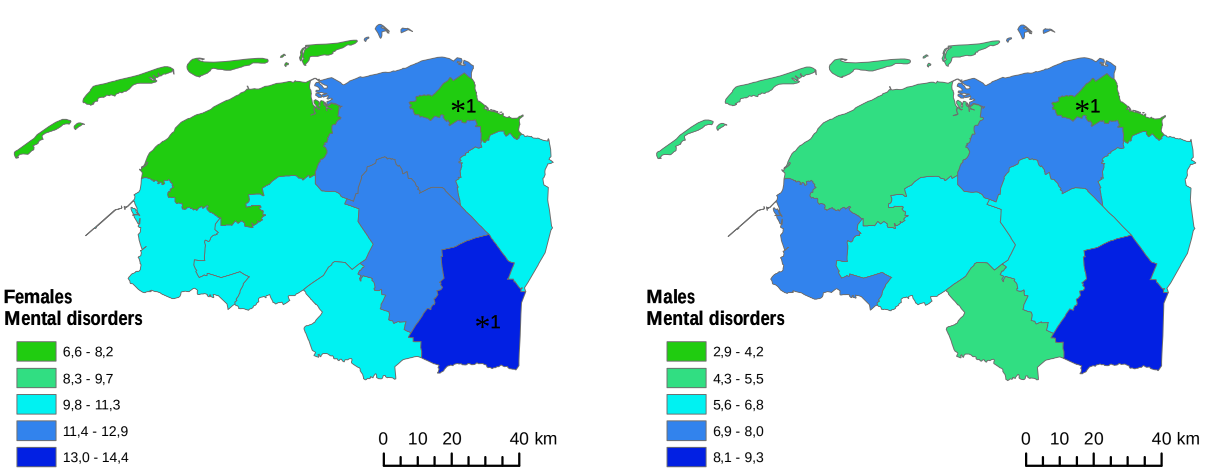
*2 Significant different from average of NN on 95% CI.

4.3.4 Mental disorders

Figure 4.13 shows the mortality rate at 80+ for mental disorders for females and males. As the maps show, mental disorders are one of the few causes whereby males have a lower mortality rate than females. On average 10 females per 1000 elderly die of mental disorders, while this is only 6.4 for males. For both females and males Region Delfzijl has the lowest mortality rate for mental disorders (6.6 and 2.9 respectively). For both sexes this is a significant difference of 0.10 from the mean of the Northern Netherlands. South-east Drenthe has a mortality rate of 14.4 for females, and 9.3 for males, and is the highest mortality rate for both sexes. For females South-east Drenthe has a significantly higher mortality rate, for males this is not the case.

Delfzijl and South-east Drenthe also have the lowest and highest mortality rate for the total population. They both differ from the average of 9.3 on a significance level op 0.10.

Figure 4.13 Age standardized mortality rate 80+ for mental disorders per 1000 inhabitants aged 80+. For females and males 2004-2008.

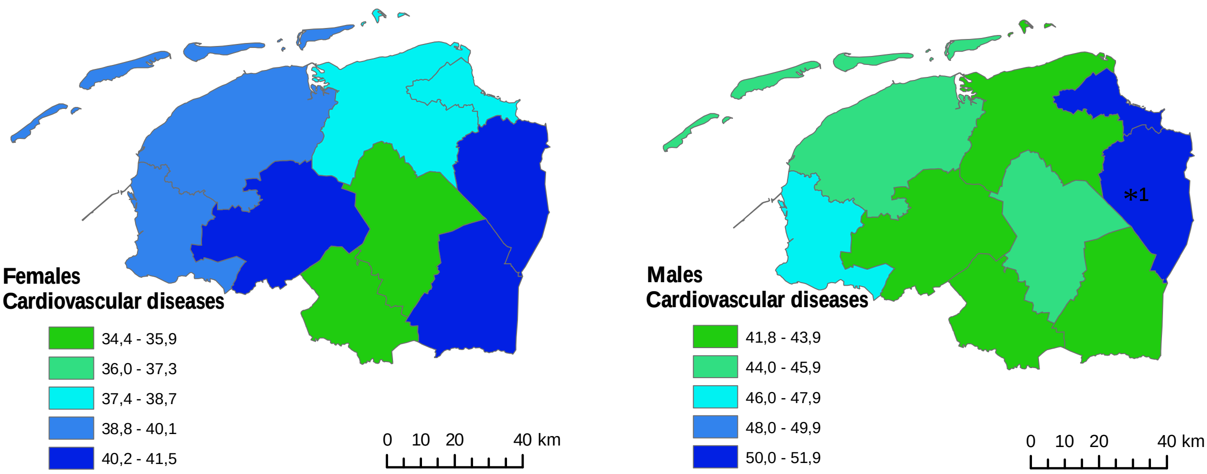


*1 Significant different from average of NN on 90% CI.

4.3.5 Cardiovascular diseases

When comparing the death rate of cardiovascular diseases to the death rates of the other cause, it is the cause with the highest mortality rate per 1000 elderly.
On average 39 females per 1000 and 45 males per 1000 elderly die of cardiovascular diseases.
When looking at figure 4.14 of the mortality rate 80+ for cardiovascular diseases, the Corop region North-Drenthe shows the lowest mortality rate for females per 1000 inhabitants aged 80 and over. For females there are not many regions that are lower than the mean mortality rate for the Northern Netherlands. For males however, a lot more Corop regions are beneath the mean. Also regions with a high mortality rate for females show a low mortality rate for males.
For males South-east Drenthe hast the lowest mortality rate.
The Corop region with the highest mortality rate 80+ for cardiovascular diseases for both females and males is East Groningen (41.5 and 51.9 respectively). This is significantly higher on a 0.10 significance level for males. East Groningen also has the highest mortality rate 80+ for the total population (44.9). This is significantly different from the mean of the Northern Netherlands for males and females, which is 40.7. The region with the lowest mortality rate 80+ is Southwest-Drenthe.

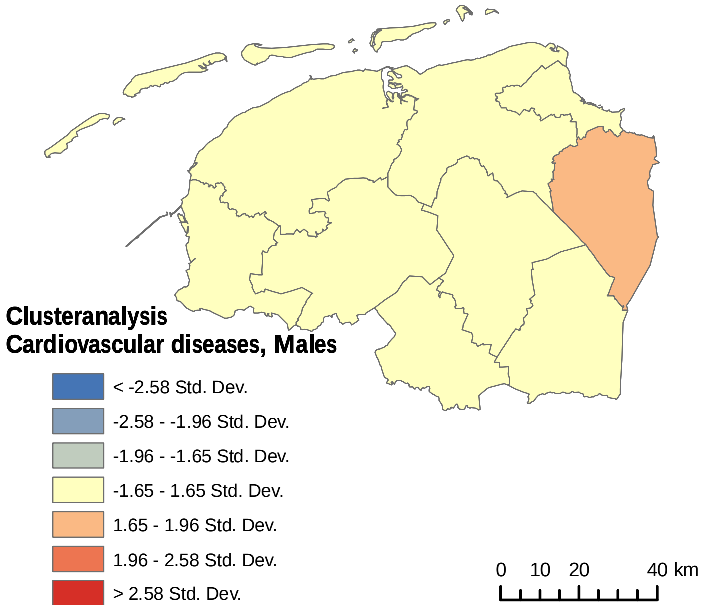
Figure 4.14 Age standardized mortality rate 80+ for cardiovascular diseases per 1000 inhabitants aged 80+. For females and males 2004-2008.



*1 Significant different from average of NN on 90% CI.

The cluster analysis done on the map for males showed a somewhat clustered pattern. The Moran's I index is 0.27, with a z-score of 1.39 and p-value of 0.166. As a comment the analysis gives: 'while somewhat clustered, the pattern may be due to random chance'. So although the cluster analysis showed a pattern which was slightly clustered, it is not very significant.
Still, since there is some clustering the Anselin Local Moran's I can be performed. The resulting map is shown in figure 4.15. The map shows East-Groningen as the only region surrounded by similar values. However, also on the map it is visible the significance of the region is not very high.

Figure 4.15 Result of the Anselin Local Moran's I for cardiovascular diseases, males.



4.3.6 External causes

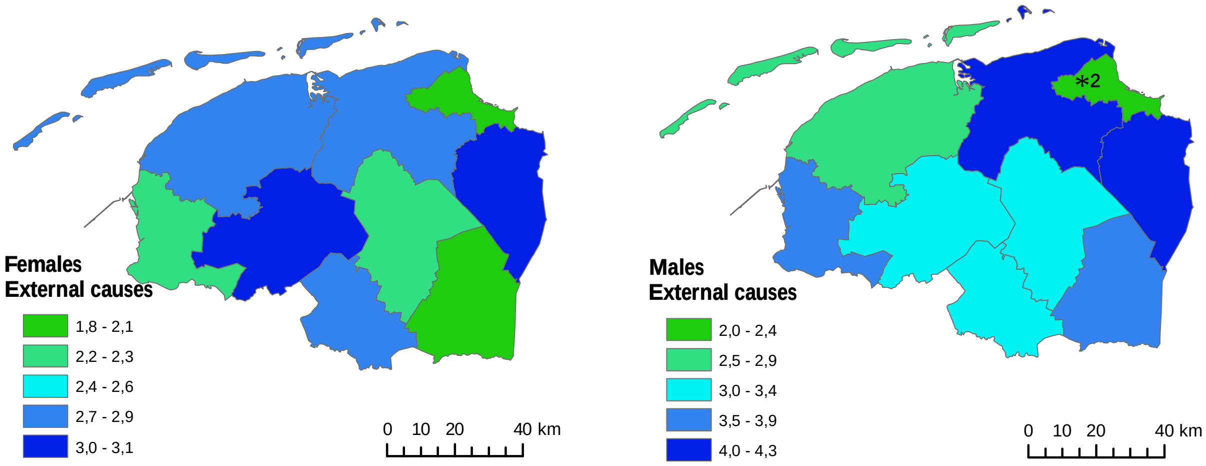
Figure 4.16 shows the mortality rate 80+ for external causes of death.
Relatively few people die of external causes. The first map shows the mortality rate for females. South-east Drenthe and Region Delfzijl have the lowest mortality rate, with the mortality rate of Region Delfzijl on 1.8. The highest mortality rate for 80+ is observed in South-east Friesland (3.1). Both do not different enough from the mortality rate of the Northern Netherlands (2.5) to be significantly lower or higher.

The second map shows the mortality rate age 80+ for males. Most Corop regions in the south are around the mean for the Northern Netherlands of 3.4. In region Delfzijl only 2 of 1000 elderly die of external causes. This is a significant difference on a 0.05 level.
This region with a relative low mortality rate is surrounded by the two regions with very high mortality rates. The highest is found in the region Groningen Other.

The mortality rate at age 80+ of the Northern Netherlands for the total population is 2.8, so just above that for females. Again Region Delfzijl has the lowest mortality rate. With a rate of 1.86 the region differs significantly from the Northern Netherlands. East Groningen is the only region showing higher mortality rates for females and for males, and is therefore also the region with the highest mortality rate for the total population (3.4).

The cluster analysis on the maps of external causes of death did not show clustering, but it did show another remarkable pattern. The Moran's I Index for males is -0.78, which is close to -1, which indicates dispersion. Related to the Moran's I Index is a z-score of -2.53 with a significance of 0.011. This indicates: 'there is less than 5% likelihood that this dispersed pattern is the result of random choice.

Figure 4.16 Age standardized mortality rate 80+ for external causes per 1000 inhabitants aged 80+. For females and males 2004-2008.

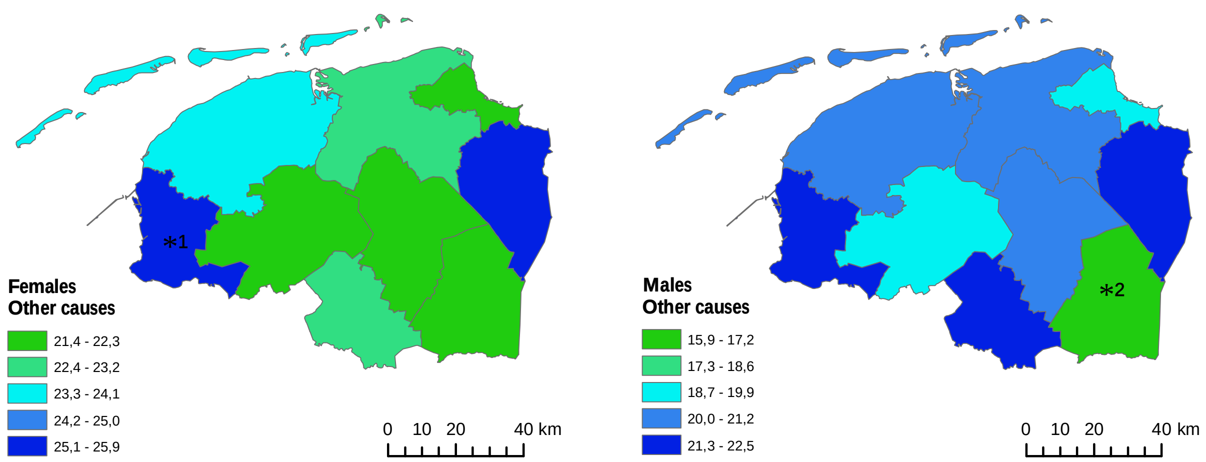


*² Significant different from average of NN on 95% CI.

4.3.7 Other causes

Finally the regional differences in causes other than here fore mentioned are explored. The results are displayed in figure 4.17. For females, the mortality rate for the Northern Netherlands is 23.1. As the map shows, there are only three regions that are above this mean. Especially the province of Drenthe shows low mortality rates for 80+ for other causes. With a mortality rate 80+ of 21.4 the Corop region North-Drenthe has the lowest mortality rate. The highest can been found in South-west Friesland, where 26 of the 1000 elderly die of other causes. The map for males shows only one region with a low mortality rate: the Corop region South-east Drenthe. Here only 16 of 1000 elderly die of other causes. Compared to the mortality rate of the Northern Netherlands this is a significant difference. Again the regions with the lowest and highest mortality rates are adjacent each other, since South-west Drenthe hast the highest mortality rate 80+ for males (25.9). When comparing the two maps, only the region South-east Drenthe has a low mortality rate for both females and males. It is therefore also the region with the lowest mortality rate for the total population. On average 22 of 1000 elderly males and females die of other causes. With a mortality rate of 24.8, South-west Friesland differs significantly on a significance level of 0.05.

Figure 4.17 Age standardized mortality rate 80+ for other causes per 1000 inhabitants aged 80+. For females and males 2004-2008.



When comparing the maps of the causes to each other, some regions appear that show high or low mortality rates for a number of cases.
For example for females, Region Delfzijl often belongs to the regions with lowest mortality rates. Only for lung cancer and other cancers the region has one of the highest mortality rates. Also the Corop regions North and South-west Drenthe often show low mortality rates, except for infectious diseases. This is also visible for males, especially for East Groningen and South-west Friesland, which have high mortality for almost all causes. It is therefore not surprising that similarities arise when comparing the cause specific maps to those of the overall mortality (figure 4.8 in paragraph 4.1.4). Also, when comparing the maps of females and males, often the same pattern is visible and it are the same regions with very low or high mortality rates. However, for some causes, like infectious diseases and cardiovascular diseases, there are regions that [*2] can have one of the lowest values for females, while they have the highest for males, and vice versa.

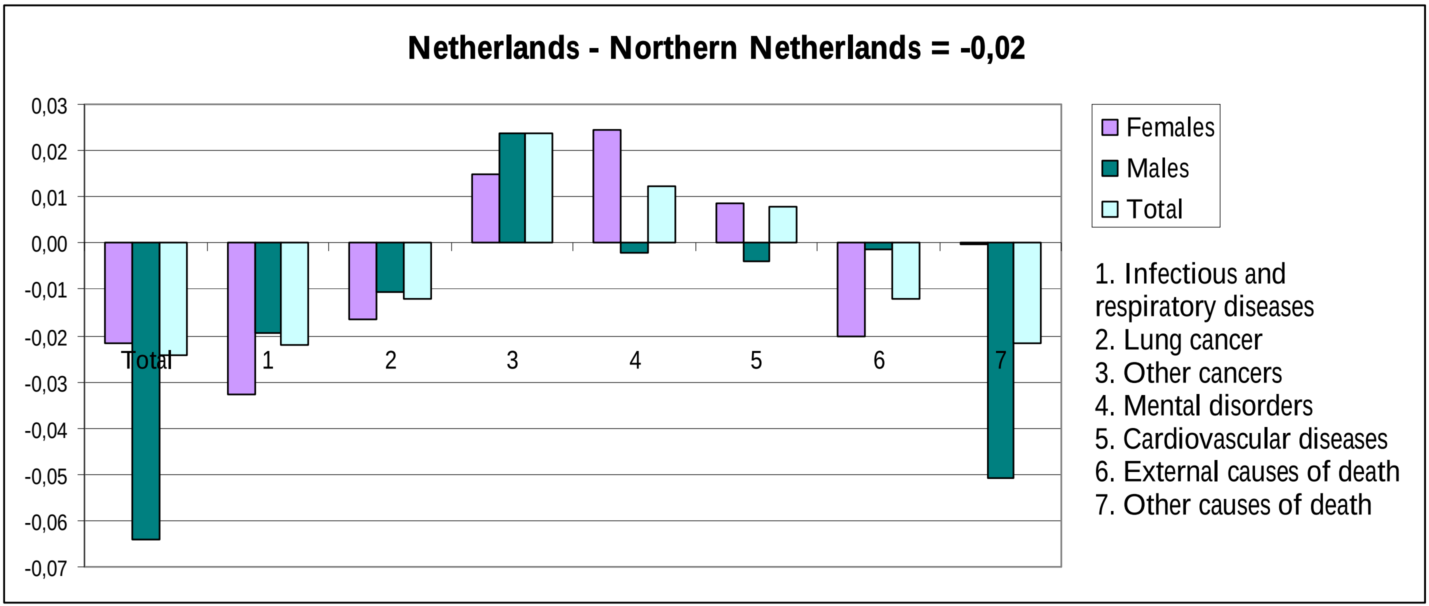
4.4 Contribution of causes of death to the regional differences in life expectancy

As the previous paragraph already indicates, there are certain causes that contribute more to the difference in mortality rate than others. This is also the case for the difference in life expectancy between the Corop regions and the average life expectancy for the Northern Netherlands.
To see which causes contribute most to the differences in life expectancy, a decomposition is done. The decomposition gives insight into which causes contribute positively or negatively to the difference in life expectancy. Next to the mortality rates this will give further insight into which causes are responsible for the regional differences in life expectancy.

For each cause it will be examined what it contributes to the difference in life expectancy for each Corop region, compared to the Northern Netherlands. This way it becomes visible how much each cause contributes to the differences in life expectancy over the different Corop regions.
Figures of the decomposition per Corop region can be found in the appendix, figure 4.26 till 4.34. These figures indicate for each Corop region how much each cause contributes to the difference in life expectancy of that Corop region and the Northern Netherlands. When a cause contributes positively it indicates mortality from that cause is lower in the Northern Netherlands than in the Corop region. When a cause contributes negatively, mortality from that cause is higher in the Northern Netherlands compared to the Corop region.

Figure 4.18 shows the decomposition in life expectancy at age 80 for the Northern Netherlands. The bars for the Total difference indicate the difference in life expectancy between the Netherlands and the Northern Netherlands. Since it is a negative difference, this indicates the life expectancy is higher in the Northern Netherlands in all three categories. The other bars indicate the contribution of the causes of death to this difference in life expectancy. As the figure shows the Northern Netherlands has lower mortality from most causes. Mortality from infectious and respiratory diseases, lung cancer and other diseases is especially low compared to the Netherlands.

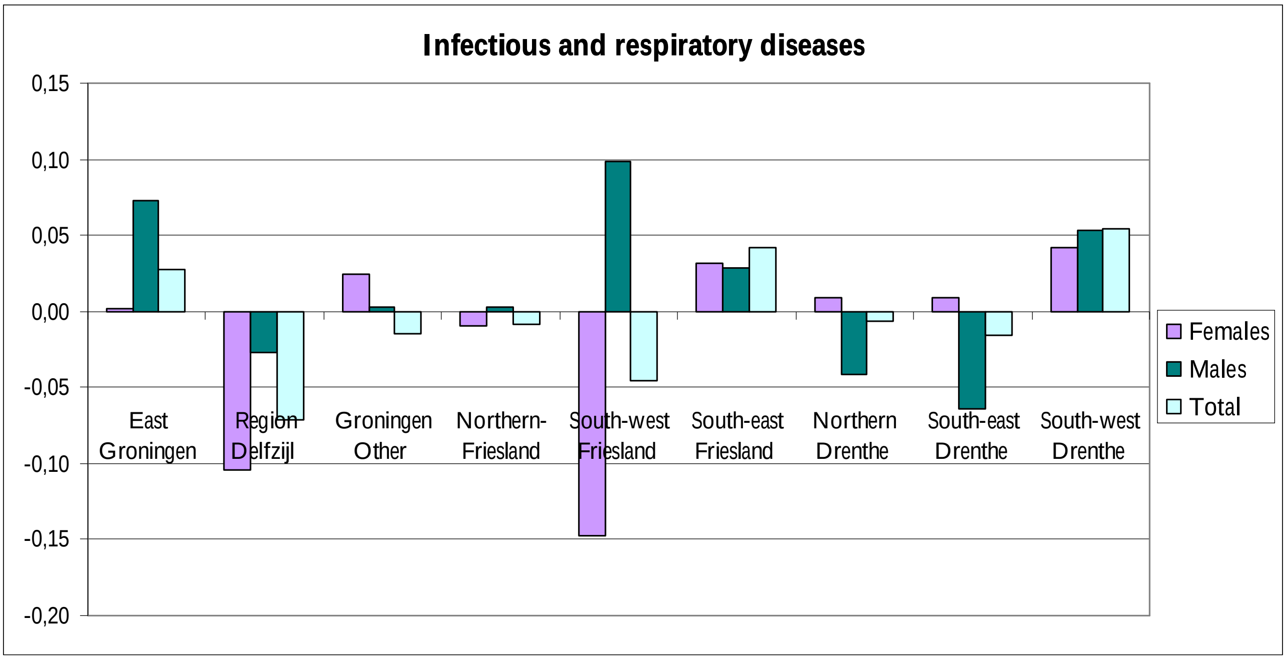
Figure 4.18 Decomposition in life expectancy 80 in the Northern Netherlands



4.4.1 Infectious and respiratory diseases

Figure 4.19 shows the contribution of infectious and respiratory diseases in the difference in life expectancy between the Corop region and the Northern Netherlands.
As the figure shows, most regions have a small positive contribution of infectious and respiratory diseases, meaning the mortality from this cause is higher in these Corop regions than in the Northern Netherlands. This positive contribution is mostly visible for females. When looking at the contribution to the life expectancy for males, there are more regions showing a negative contribution, like Northern and Sout-east Drenthe. Region Delfzijl is the only region where infectious and respiratory diseases contribute negatively for females, males and males and females. South-west Friesland is also interesting. Here the contribution for females is very negative, while the contribution for males is very positive. So the mortality from infectious and respiratory diseases is much lower for females, but much higher for males.

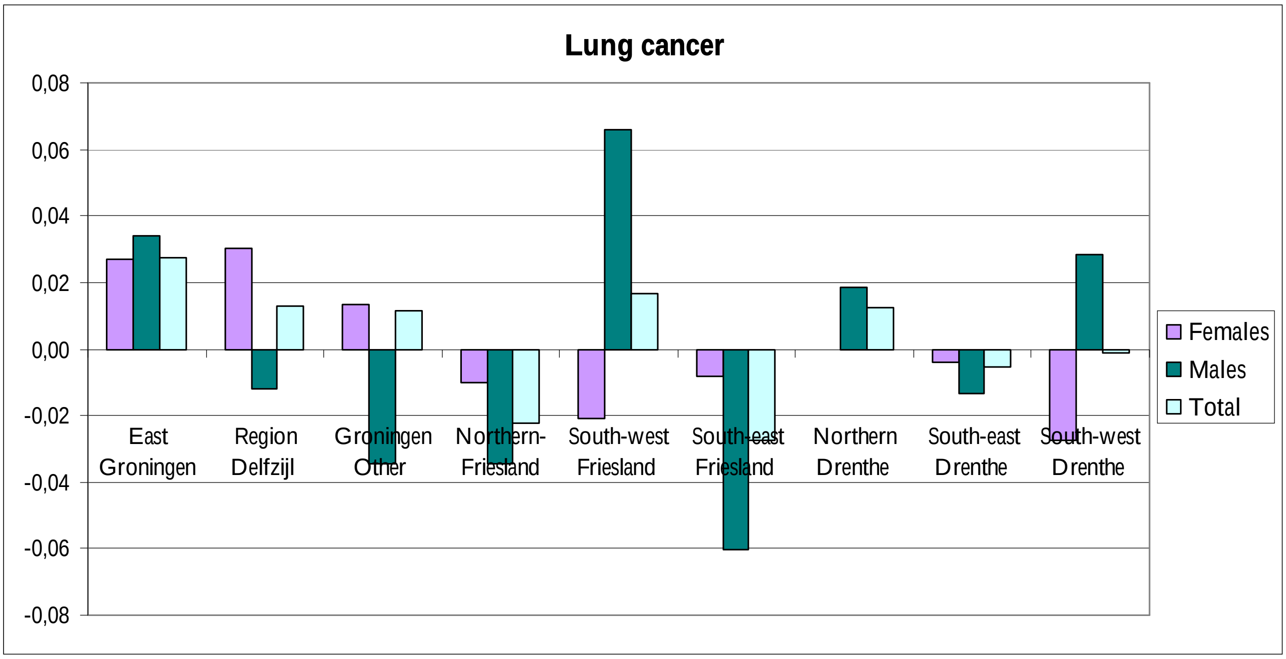
Figure 4.19 Contribution of infectious and respiratory diseases to the differences in life expectancy at age 80 between the Northern Netherlands and the Corop regions.



4.4.2 Lung Cancer

The contribution of lung cancer to the difference in life expectancy for each Corop region is showed in figure 4.20. This figure also shows wide variation in the contribution over regions and over sex. East Groningen is the only region where lung cancer contributes positively for all three categories. A negative contribution for all three categories is visible in Northern and South-east Friesland and South-east Drenthe. The other regions show a varying pattern for both sexes.
Especially South-west Friesland shows higher mortality from lung cancer for males.
When looking at the different patterns, it is interesting that females in the three Corop regions in Groningen all show a positive contribution, while the contribution is negative for females in other Corop regions. So the lung cancer mortality for females is higher in Groningen compared to the other regions in the Northern Netherlands.

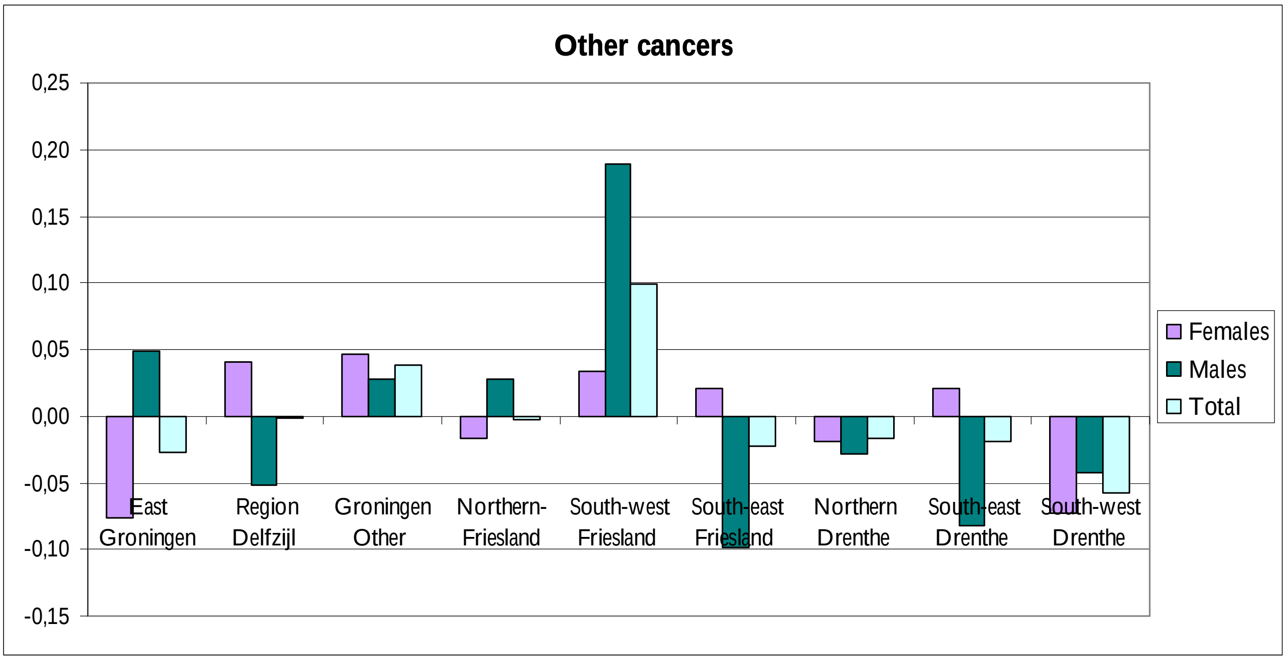
Figure 4.20 Contribution of lung cancer to the differences in life expectancy at age 80 between the Northern Netherlands and the Corop regions.



4.4.3 Other Cancers

As figure 4.21 shows, mortality from cancers is lower than that of the Northern Netherlands in most Corop regions. The only exceptions are South-west Friesland and Groningen Other, here the mortality is relatively high.
When looking at both sexes separate the pattern stays almost the same for males. Females, however, show a positive contribution in several regions, indicating more women die of cancer compared to men.

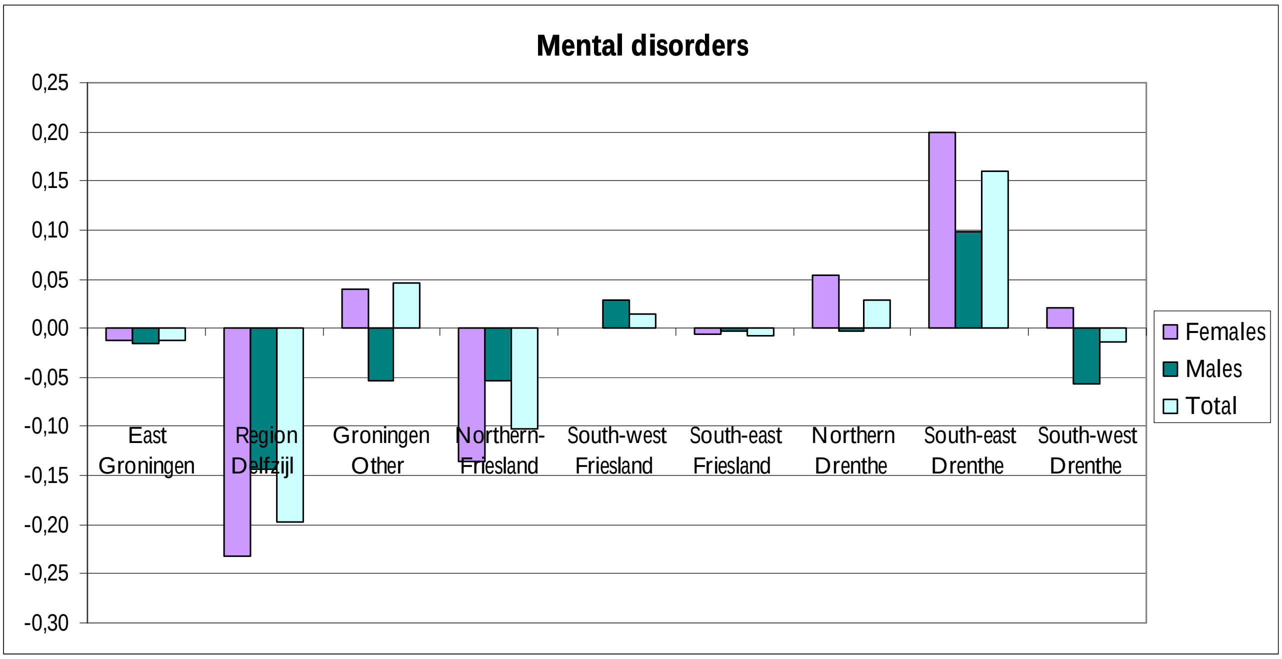
Figure 4.21 Contribution of other cancers to the differences in life expectancy at age 80 between the Northern Netherlands and the Corop regions.



4.4.4 Mental disorders

Also for mental disorders there are large regional variations in the contribution of the cause to the difference in life expectancy. As figure 4.22 shows, large negative contribution for all categories can be found in Region Delfzijl and Northern Friesland. On the other hand, South-east Drenthe shows a large positive contribution for all categories. Mortality from mental disorders has little influence on the life expectancy in the other regions, since the contribution are very small.

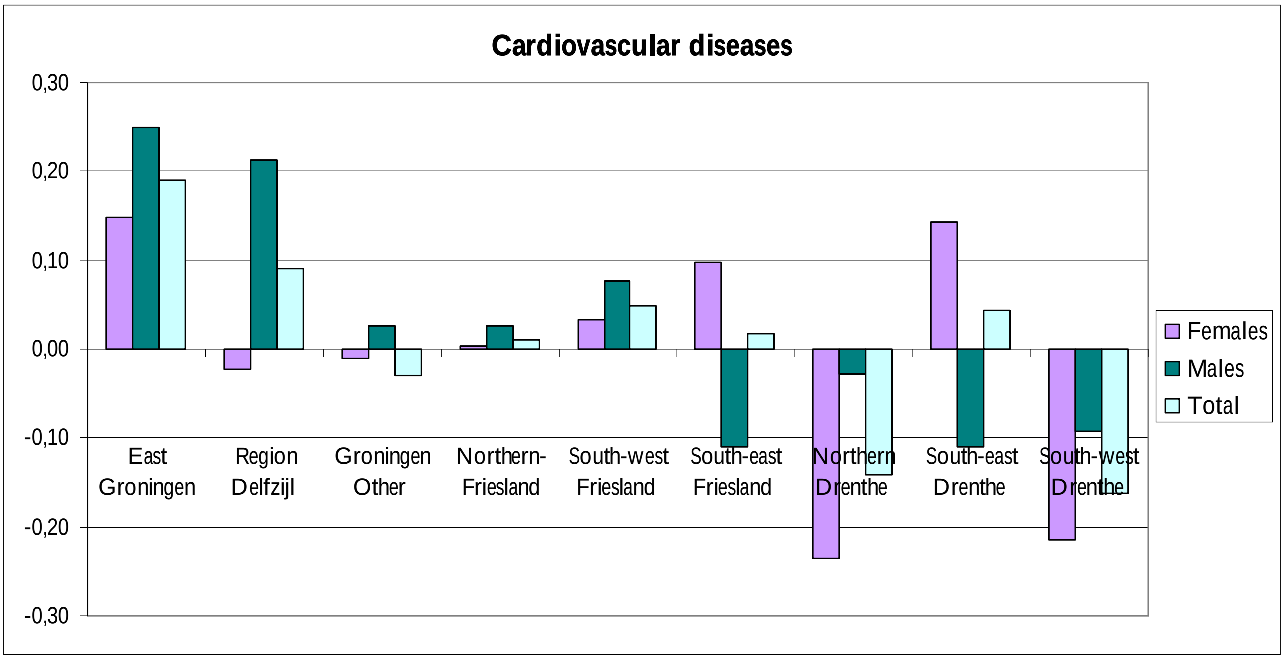
Figure 4.22 Contribution of mental disorders to the differences in life expectancy at age 80 between the Northern Netherlands and the Corop regions.



4.4.5 Cardiovascular diseases

Figure 4.23 already showed mortality from cardiovascular diseases is relatively high in the regions East Groningen and Region Delfzijl. When looking at the decomposition, it are also these two regions that show a high positive contribution to the life expectancy.
When looking at the regional difference in cardiovascular diseases it
The same figure shows only two regions with low mortality levels from cardiovascular diseases. Figure 4.23 shows the same two regions with a large negative contribution: Northern and South-west Drenthe. The other regions show a positive contribution for females, or hardly any contribution at all.

Figure 4.23 Contribution of cardiovascular diseases to the differences in life expectancy at age 80 between the Northern Netherlands and the Corop regions.

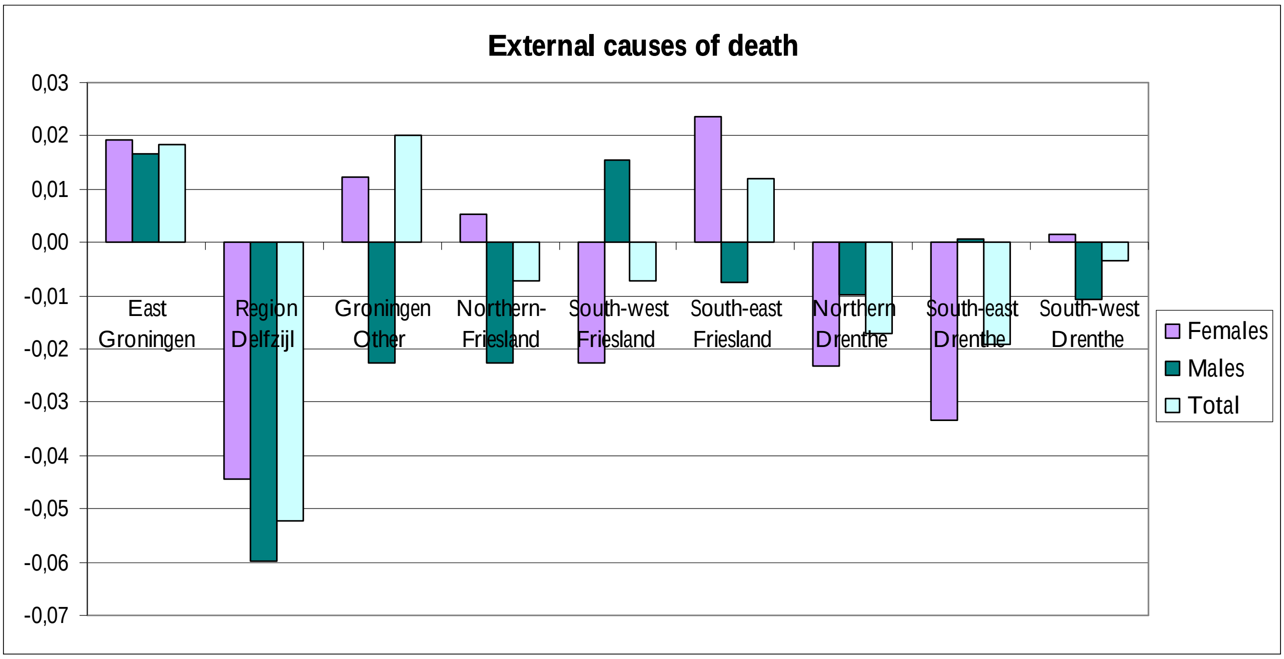


4.4.6 External causes of death

Figure 4.24 shows the contribution of external causes of death to the difference in life expectancy at age 80 in the different Corop regions.

As the figure shows, the overall trend for the total population is one of negative contributions, except for the regions East Groningen, Groningen other and South-east Friesland. So these three regions have a higher mortality level from external causes than the Northern Netherlands, while all other regions experience lower mortality levels. Also for males, most regions show a negative contribution of external causes to the life expectancy. For females, there are more regions showing a positive contribution.

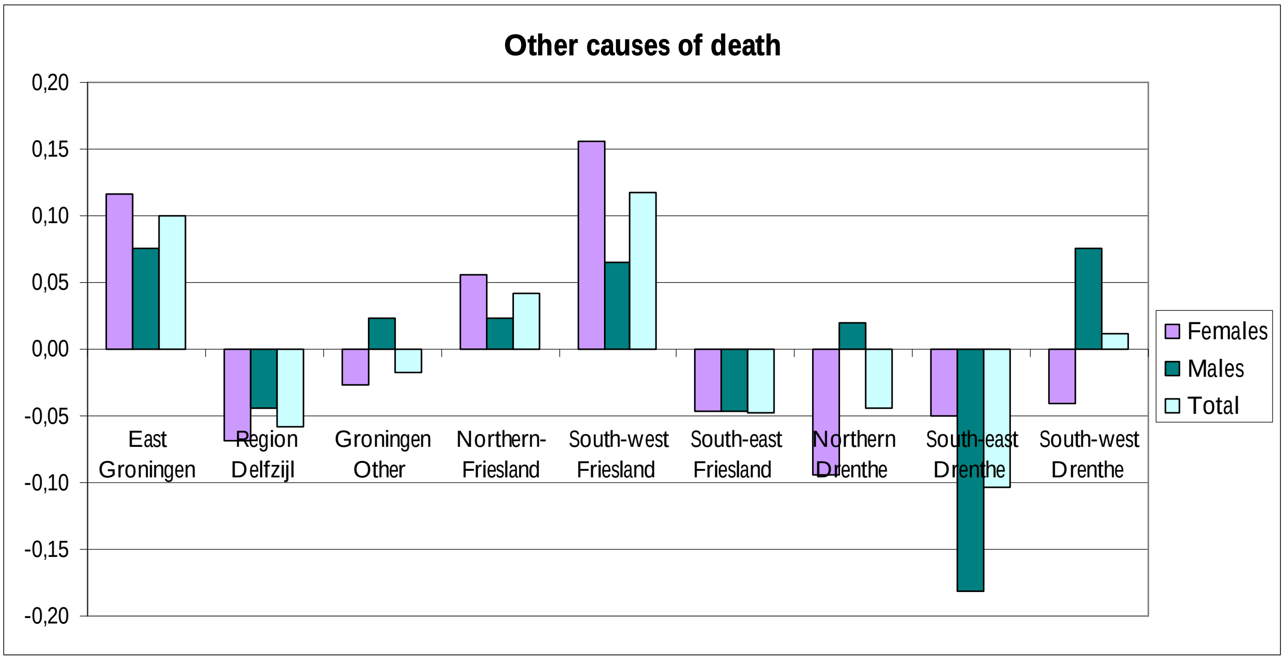
Figure 4.24 Contribution of external causes of death to the differences in life expectancy at age 80 between the Northern Netherlands and the Corop regions.



4.4.7 Other causes of death

Finally, figure 4.26 shows the contribution to the difference in life expectancy at age 80, of all causes other than the ones hereforementioned. As the figure shows, the mortality from other causes is high for all categories in three regions. These are East Groningen and northern and South-west Friesland. These are also the only regions showing a positive contribution for females. So for the total population and for females, the overall trend in the different Corop regions in the Northern Netherlands is one of lower mortality from other causes of death compared to the Northern Netherlands in total. For males it is the contrary, since there are more Corop regions showing a positive contribution to the difference in life expectancy. Only South-east Drenthe has a very high negative contribution. This could be expected since the region already showed a much lower age standardized mortality rate 80+ from other causes of death for males.

Figure 4.25 Contribution of other causes of death to the differences in life expectancy at age 80 between the Northern Netherlands and the Corop regions.



The Northern Netherlands showed a lower mortality from most causes compared to the Netherlands. The only exceptions are cancers, mental disorders and cardiovascular diseases.
At Corop level, Corop regions which showed a higher or lower life expectancy at age 80 can be compared to the figures of the contribution each cause makes to different Corop regions.
There are large variations in occurrence of a cause visible between Corop levels. Also for sex, variations are visible, and a Corop can have low levels of mortality from a cause for females, while high for males, and vice versa. Overall a trend is visible whereby regions showing higher life expectancies at age 80 show high level of mortality from lung and other cancers, cardiovascular diseases and external and other causes. Corop regions showing low life expectancies often have a large positive contribution from lung and other cancers, cardiovascular diseases and other diseases.

5. Conclusion

5.1 Conclusion

What are the regional differences in old age mortality in the Northern Netherlands, and which causes of death contribute to the difference?

So to answer my research question it can be concluded regional differences are visible. The life expectancy at age 80 for males and females ranges from 6.7 till 10.2 years. Also specified for males and females the regional differences in life expectancies are as large as three years. Next to the life expectancy, the age standardized mortality rate 80+ is used to measure old age mortality.
Also here differences among municipalities are visible, as the mortality rate ranges from 82 till 160 deaths per 1000 males and females aged 80 and over.
There are three municipalities, Bolsward, Winsum and Grootegast, which show a lower life expectancy at age 80 and a higher age standardized mortality rate 80+. This is visible for females, males and males and females, so we can say these municipalities definitely show higher levels of old age mortality. The pattern is less clear for municipalities showing a higher life expectancy and lower mortality rates 80+. For females there are three municipalities with a significant higher life expectancy at age 80 and a significant lower mortality rate 80+. These are Het Bildt, De Marne and Marum. For males this is shown in the municipality Leeuwarderadeel. When looking at males and females, some municipalities show significantly higher life expectancies, but no municipalities show significantly lower mortality rates 80+.

From the literature study it could be expected the differences in old age mortality are smaller at Corop level compared to municipalities, since smaller levels show more variation. This was also shown in this thesis. At Corop level, the differences between regions became much smaller, and the variation in life expectance at age 80 was reduced to a maximum difference of one year. Also the variation in the age standardized mortality rate 80+ became smaller and ranges from 106 till 118 deaths per 1000 males and females aged 80 and over. The maps for the life expectancy at age 80 and the mortality rate 80+ showed exactly the same pattern. The Corop regions Region Delfzijl, Northern and South-west Drenthe show low levels of old age mortality, while East-Groningen and South-west Friesland showed relatively high levels of mortality.

Though it could be assumed regions with similar life expectancies and mortality levels are situated close to each other or be clustered, the cluster analysis found no significant clustering.
On the contrary, when looking at the significant municipalities, some municipalities with low levels of old age mortality are situated next to municipalities with high levels of old age mortality.

The regional differences in old age mortality are related to regional differences in cause specific mortality. Overall Corop regions with a high level of all-cause mortality for ages 80 and older show high levels of cause specific mortality. For example East Groningen, which has one of the highest mortality levels for both females, males as males and females, is often also the region with the highest mortality level for a specific cause. There are also certain diseases that tend to cluster in the eastern part of Groningen, like lung cancer for females, and cardiovascular diseases for males. Region Delfzijl, with one of the lowest levels of old age mortality, often shows low levels of cause specific mortality. However an interesting discovery was that this region shows very low mortality rates for mental disorders and external causes of death, which was observed for both females and males. So these causes could be the reason why Region Delfzijl has a higher life expectancy and a lower age standardized mortality rate 80+. The low mortality levels for this cause are only observed in Region Delfzijl, so they cannot explain the lower levels of old age mortality observed in the other Corop regions.

The decomposition gives more insight into which causes contribute to higher or lower life expectancies at age 80. Overall, Corop regions with a higher life expectancy at age 80 showed lower mortality levels from lung and other cancers, cardiovascular diseases and external and other causes. A lower life expectancy is mainly caused by higher level of mortality from lung and other cancers, cardiovascular diseases and other diseases. Also for females cardiovascular diseases plays an important role in old age mortality. Regions where elderly have more years to live tend to have lower mortality levels from cardiovascular and diseases and other causes. Cardiovascular diseases also lead to lower life expectancies at age 80 in some regions, but also lung cancer plays a role. It is also interesting that fewer deaths from mental disorders have a large positive influence on the life expectancy in Region Delfzijl, while the same cause leads to a lower life expectancy in the regions in Drenthe. Males mainly have a higher life expectancy from lung and other cancers, cardiovascular diseases and other causes. Lung cancer and other causes on the other hand, also play a role in the lower life expectancy at age 80 that some regions show.

As this shows, there are some causes leading to both a higher and lower life expectancy in the Northern Netherlands. Cardiovascular diseases are visible for both sexes as for the total population. They have both a positive as a negative influence on the life expectancy. Also lung and other cancers and other diseases are recurrent as important causes in differences in the life expectancy. These causes of death are typical for a country in the fourth stage of the epidemiologic transition mentioned in chapter 2.During this stage cardiovascular diseases and cancers are the main causes of death.
Also former studies already showed cardiovascular diseases as one of the causes responsible for the stagnating decline in old age mortality observed in some countries. This may be happening at smaller scale at municipalities and Corop level. The clustering of lung cancer and cardiovascular diseases for respectively females and males visible in East Groningen could be related to the lower socio-economic status in this region. Lifestyle and risk behaviour could be related to this.

5.2 Discussion

Regional variation in old age mortality in the Northern Netherlands has been found. Since most regions are highly significant for females, males as well as males and females, it can be assumed these are really deviating regions. However there are also differences in significant municipalities for the life expectancy at age 80 and the mortality rate 80+. This could be caused by the use of two different measurements, but it could also be related to the data.
As was mentioned in the Data and Methods chapter, the mortality data for municipalities is rounded. Though this does not have a large effect on most municipalities, it can lead to a difference in the life expectancy at age 80 of around 6 months. These extra months can make a municipality look significant, while it is not. Therefore only municipalities significant for both the life expectancy at age 80 and the mortality rate 80+ are considered to be really different.
The data can also be misleading related to the cause specific mortality rates and the decomposition. Statistics Netherlands only publishes information about the primary cause of death (Statistics Netherlands, 2010c). When a death is caused by multiple causes, it can be difficult to make a difference between primary and secondary causes of death. In case of doubt, the procedure of the WHO is used to choose which cause is the primary cause and which one is the secondary. However, with increasing age it becomes more difficult to specify a single cause of death, which could lead to overestimation of the number of elderly dying from a specific cause (Alpérovitch et al. 2009).

Another problem is related to the level of analysis. Since mortality data was only available on Corop level, it is difficult to say something about the cause of death for municipalities.
The significantly different municipalities often fall within the same Corop region, making it hard to say something about the relation of old age mortality between municipality and Corop level. For example, De Marne, Winsum, Grootegast and Marum all fall into the Corop region Groningen Other, while some of them have a high life expectancy for females, and other have a low life expectancy. Therefore it is impossible to say something about the causes of death of municipalities based on Corop level.

However, since the differences in life expectancy at age 80 and age standardized mortality rate 80+ show much more variation at municipality level, it would be interesting to look at the role of cause of death. For further research it might therefore be interesting to perform the cause of death analysis at municipality level to gain more insight into which causes contribute to the large variation in old age mortality. The decomposition done for this study also showed other causes often contribute to the differences in life expectancy. Since only a limited number of causes are taken into account and all other causes are labelled 'other', a more detailed list of causes might yield more detailed results.

5.3 Recommendations

As showed in this thesis, the Northern Netherlands does show regional differences in old age mortality. The difference in life expectancy at age 80 between Corop regions can be as large as one year, but at municipality level, the differences can be much larger, even up to three years. This already indicates some regions show room for improvement.
Taken into account the cause of death can give more insight into how the regional differences came into being. One of the conclusions from this study is that cardiovascular diseases and lung and other cancers have a large impact on the life expectancy at age 80. This could be related to underlying determinants like the socio-economic status, behaviour or environment.
Though this study does not look into these underlying determinants, it might be a topic of study for further research. One of the regions with a high level of old age mortality found in this study is East-Groningen. This is a region known for its lower socio-economic status. One of the findings was also that lung cancer mortality for females and mortality from cardiovascular diseases for males are clustered in this region. So this could be related to the lower socio-economic status leading to a higher prevalence of risk behaviour.
One of its neighbouring regions, Region Delfzijl, actually shows one of the lowest levels of old age mortality. Though this region also shows high mortality levels from lung and other cancer, mortality from other causes is very low. The region shows very low mortality levels from mental disorders and external causes. When further research is done on factors influencing mortality from these causes, it can help to reduce mortality from mental disorders and external causes in other regions.

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Appendix

Figure 3.3 Boxplot of life expectancy 80 for males and for the total life expectancy.

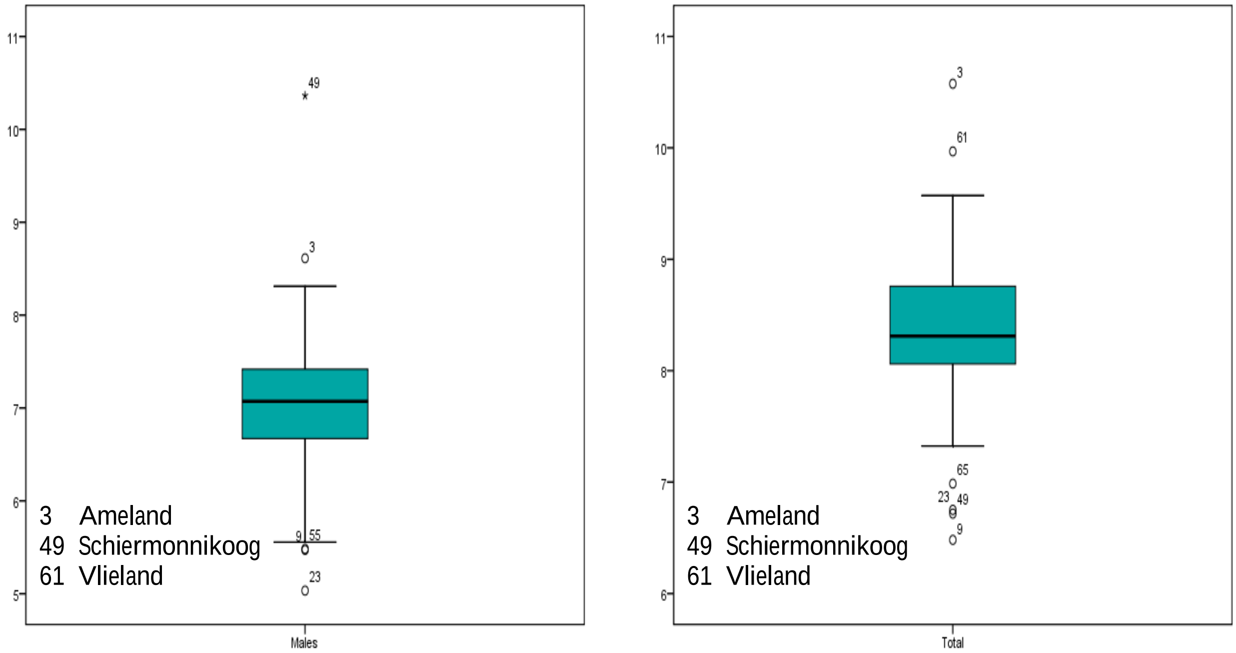


Table 4.6 Municipalities with significant lower or higher life expectancy at birth.

	Females	Males	Total
Lower on sig.<0.10	Bolsward	Pekela	
Lower on sig.<0.05		Reiderland Winschoten Vlagtwedde	
Lower on sig.<0.01	Menterwolde		Reiderland
Higher on sig.<0.10	De Marne Leeuwarderadeel Boarnsterhim Bedum Menaldumadeel	Littenseradiel	Marum Boarnsterhim
Higher on sig.<0.05	Menaldumadeel		
Higher on sig.<0.01			Waddeneilanden Leeuwarderadeel

Table 4.7 Municipalities with significant lower or higher life expectancy at age 80.

	Females	Males	Total
Lower on sig.<0.10	Grootegast	Winsum	
Lower on sig.<0.05	Bolsward Winsum	Bolsward Ten Boer	Grootegast Winsum
Lower on sig.<0.01		Grootegast	Bolsward
Higher on sig.<0.10	Lemsterland Bedum Het Bildt	Leeuwarderadeel Franekeradeel	Wymbritseradiel
Higher on sig.<0.05	De Marne Marum		De Marne Kollumerland en Nieuwkruisland Leeuwarderadeel
Higher on sig.<0.01			

Table 4.8 Life expectancy at birth and at age 80 for Corop regions

Corop region	Le 0	Le 80
Females		
Oost-Groningen	81,02*[1]	8,84
Delfzijl en omgeving	81,88	9,46
Overig Groningen	81,83	8,96
Noord-Friesland	82,14	9,17
Zuidwest-Friesland	81,66	9,03
Zuidoost-Friesland	81,79	8,95
Noord-Drenthe	82,62	9,37
Zuidoost-Drenthe	81,43	8,78
Zuidwest-Drenthe	82,40	9,35
Males		
Oost-Groningen	76,48*[2]	6,76*[1]
Delfzijl en omgeving	77,40	7,37
Overig Groningen	77,57	7,21
Noord-Friesland	77,45	7,28
Zuidwest-Friesland	77,45	6,71
Zuidoost-Friesland	77,86	7,54
Noord-Drenthe	77,97	7,32
Zuidoost-Drenthe	77,41	7,60
Zuidwest-Drenthe	77,83	7,29
Total		
Oost-Groningen	78,81*[2]	8,06*[1]
Delfzijl en omgeving	79,68	8,66
Overig Groningen	79,79	8,33
Noord-Friesland	79,85	8,47
Zuidwest-Friesland	79,60	8,14
Zuidoost-Friesland	79,88	8,42
Noord-Drenthe	80,34	8,56
Zuidoost-Drenthe	79,46	8,34
Zuidwest-Drenthe	80,18	8,55

*[1] Significant lower than average for NN on 90% CI.
*[2] Significant lower than average for NN on 95% CI.

Table 4.9 Municipalities with significant lower or higher age standardized mortality rate 80+

	Females	Males	Total
Lower on sig.<0.10	Marum De Marne	-	-
Lower on sig.<0.05	-	Leeuwarderadeel	-
Lower on sig.<0.01	Wymbritseradiel	-	-
Higher on sig.<0.10	-		Harlingen
Higher on sig.<0.05	Grootegast Winsum	Ferwerderadiel Bolsward Winsum Ten Boer	Winsum
Higher on sig.<0.01	Bolsward	Grootegast	Bolsward Grootegast

Table 4.10 Age standardized cause specific mortality rates 80+ for Corop regions in the Netherlands, males and females.

Corop Region	Total	Infectious and respiratory diseases	Lung cancer	Other cancers	Mental disorders	Cardio-vascular diseases	External causes of death	Other causes of death
East Groningen	118,2	15,8	3,4	17,2	9,1	44,9	3,3	24,5
Region Delfzijl	105,5	13,8	3,1	17,8	5,4	42,5	1,9	21,1
Groningen Other	112,1	15,0	3,1	18,5	10,3	40,1	3,3	21,9
Northern-Friesland	109,1	15,1	2,4	17,6	7,2	40,9	2,8	23,1
South-west Friesland	116,0	14,2	3,1	19,9	9,7	41,6	2,7	24,8
South-east Friesland	110,5	16,2	2,3	17,4	9,2	41,1	3,2	21,0
Northern Drenthe	107,5	15,2	3,1	17,4	10,0	37,9	2,6	21,3
South-east Drenthe	111,8	14,9	2,7	17,3	12,7	41,6	2,5	20,0
South-west Drenthe	107,6	16,4	2,8	16,6	9,1	37,3	2,9	22,5

Table 4.11 Age standardized cause specific mortality rates 80+ for Corop regions in the Netherlands, females.

Corop Region	Total	Infectious and respiratory diseases	Lung cancer	Other cancers	Mental disorders	Cardio-vascular diseases	External causes of death	Other causes of death
East Groningen	107,3	12,0	1,4	13,4	10,4	41,5	3,0	25,5
Region Delfzijl	95,9	10,2	1,4	15,4	6,6	38,4	1,8	22,0
Groningen Other	104,6	12,5	1,2	15,6	11,3	38,5	2,8	22,6
Northern-Friesland	100,6	11,9	0,8	14,4	8,0	38,7	2,7	24,0
South-west Friesland	103,1	9,2	0,6	15,5	10,7	39,0	2,2	25,9
South-east Friesland	104,8	12,8	0,9	15,2	10,5	40,4	3,1	21,9
Northern Drenthe	97,4	12,3	1,0	14,4	11,7	34,4	2,2	21,4
South-east Drenthe	107,8	12,1	0,9	15,0	14,4	41,4	2,0	22,1
South-west Drenthe	97,7	12,9	0,5	13,4	11,1	34,8	2,7	22,4

Table 4.12 Age standardized cause specific mortality rates 80+ for Corop regions in the Netherlands, males.

Corop Region	Total	Infectious and respiratory diseases	Lung cancer	Other cancers	Mental disorders	Cardio-vascular diseases	External causes of death	Other causes of death
East Groningen	141,1	23,7	7,6	25,1	6,3	51,9	4,0	22,5
Region Delfzijl	124,8	21,1	6,5	22,5	2,9	50,4	2,0	19,4
Groningen Other	128,5	20,2	7,1	24,7	8,0	43,7	4,3	20,4
Northern-Friesland	126,7	21,8	5,8	24,5	5,3	45,4	2,9	21,1
South-west Friesland	142,8	24,5	8,3	29,0	7,6	47,1	3,8	22,5
South-east Friesland	119,9	22,4	5,2	21,2	6,6	42,0	3,3	19,2
Northern Drenthe	125,9	20,7	7,1	23,0	6,7	44,1	3,2	20,9
South-east Drenthe	118,8	20,2	6,4	21,6	9,3	41,8	3,5	15,9
South-west Drenthe	126,2	23,2	7,4	22,6	5,2	42,1	3,2	22,5

Figure 4.26 Contribution of causes of death to the differences in life expectancy at age 80 between the Northern Netherlands and East Groningen, females and males, 2004-2008.

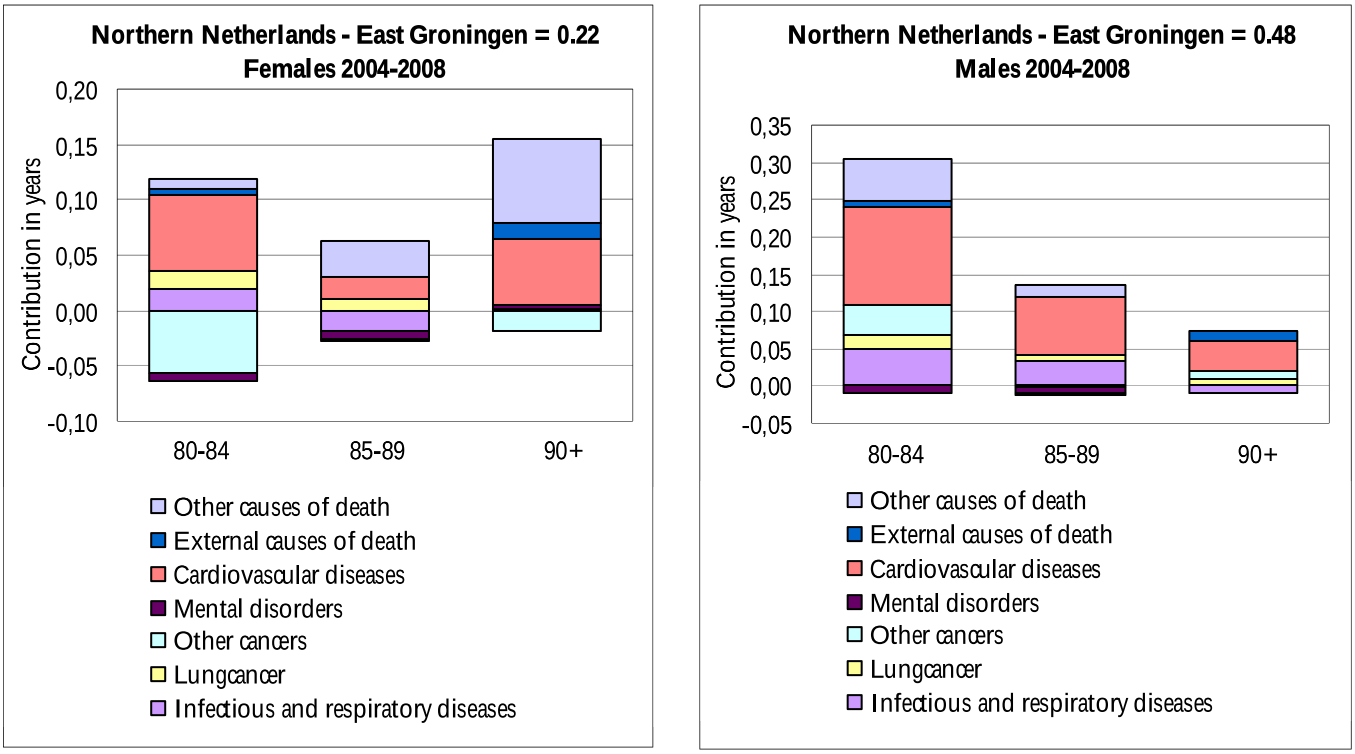


Figure 4.27 Contribution of causes of death to the differences in life expectancy at age 80 between the Northern Netherlands and Region Delfzijl, females and males, 2004-2008.

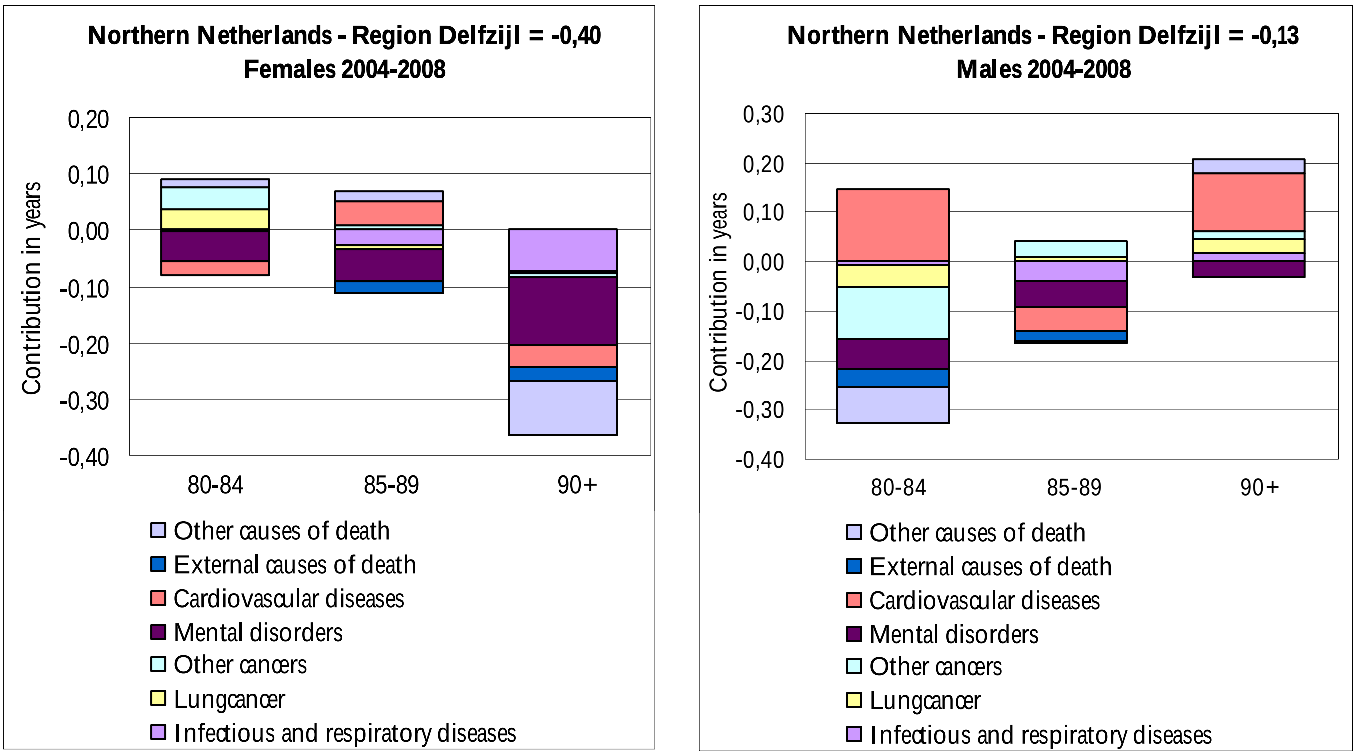
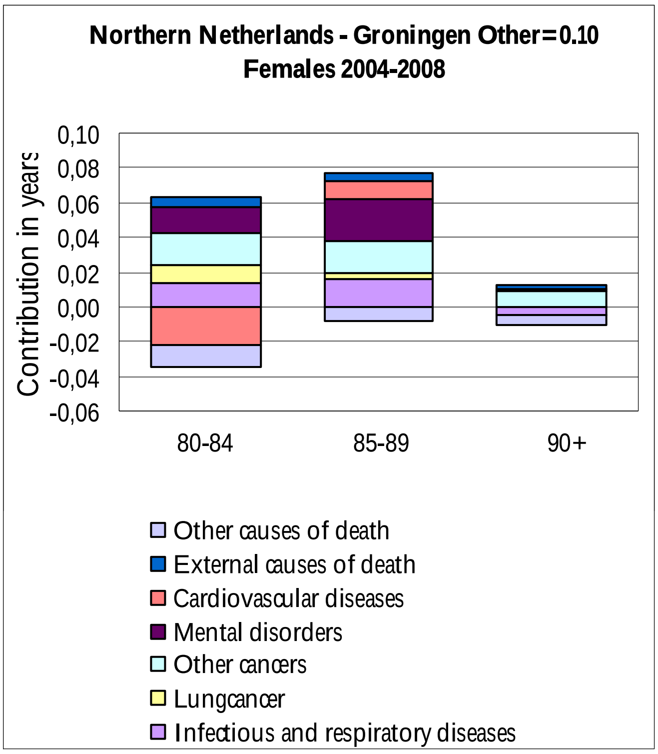


Figure 4.28 Contribution of causes of death to the differences in life expectancy at age 80 between the Northern Netherlands and Groningen Other, females and males, 2004-2008.



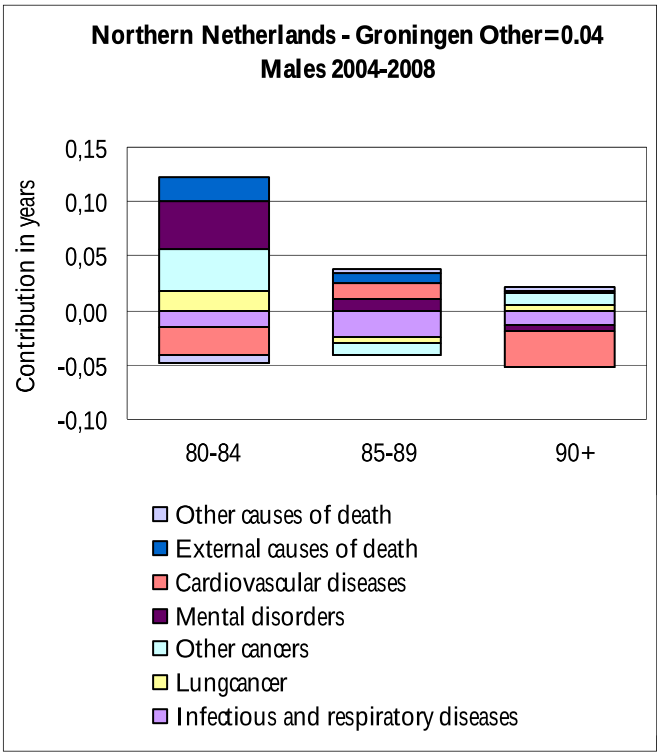
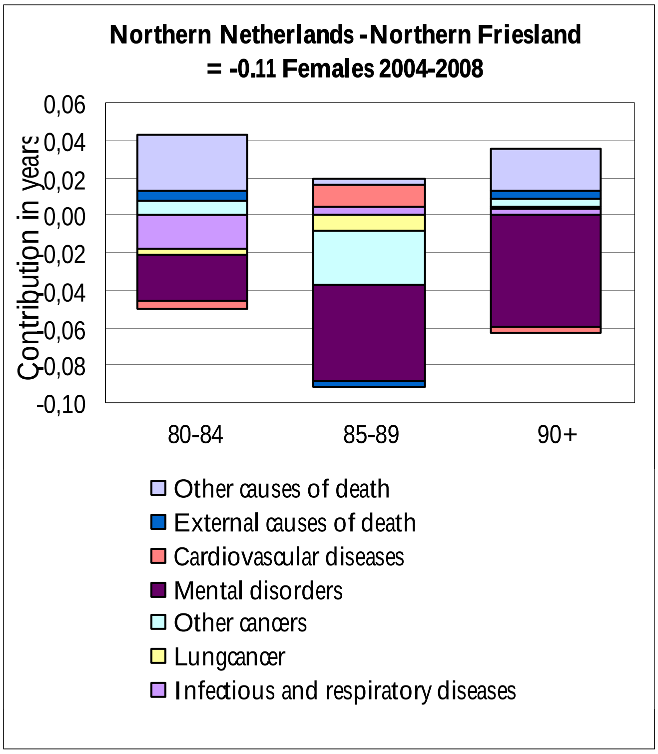


Figure 4.29 Contribution of causes of death to the differences in life expectancy at age 80 between the Northern Netherlands and Northern Friesland, females and males, 2004-2008.



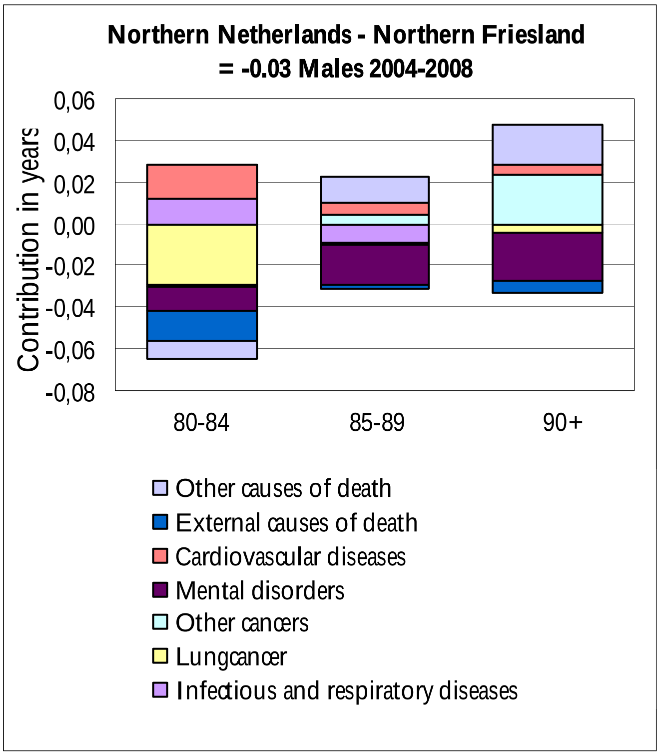


Figure 4.30 Contribution of causes of death to the differences in life expectancy at age 80 between the Northern Netherlands and South-west Friesland, females and males, 2004-2008.

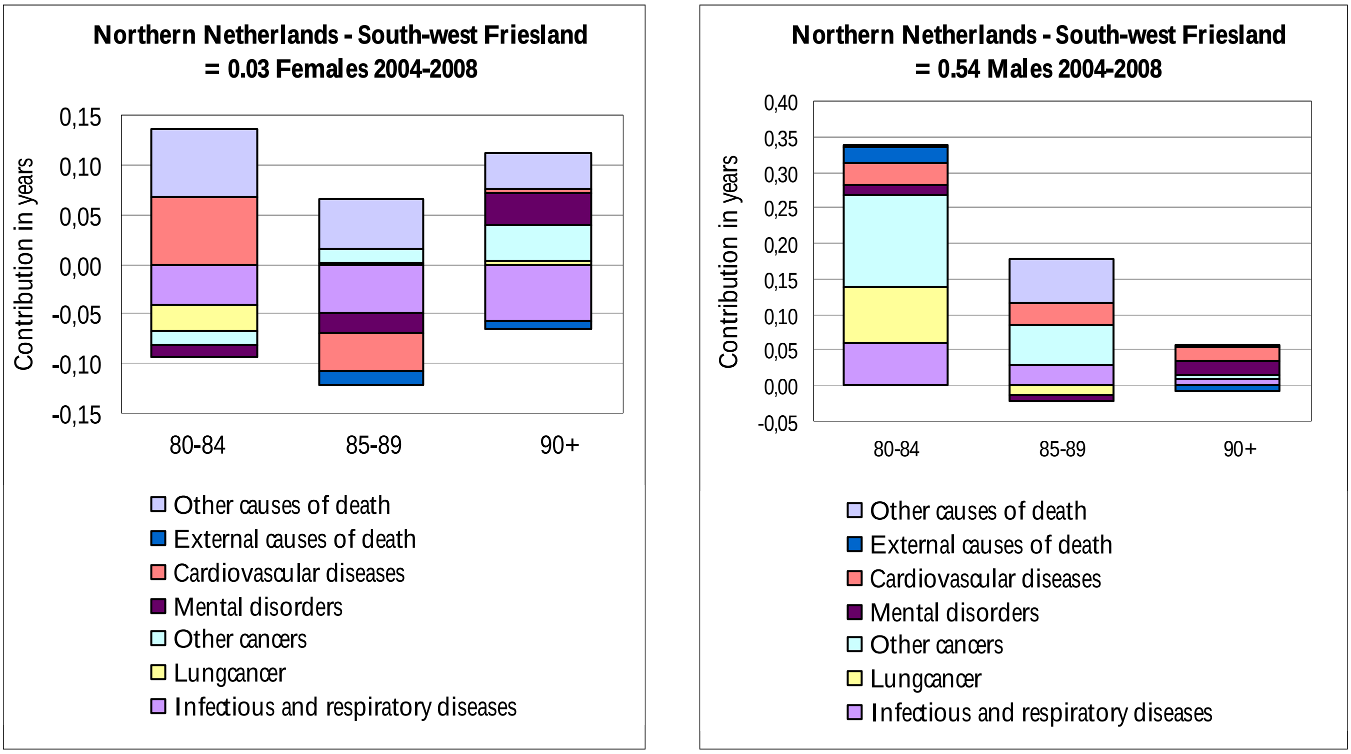


Figure 4.31 Contribution of causes of death to the differences in life expectancy at age 80 between the Northern Netherlands and South-east Friesland, females and males, 2004-2008.

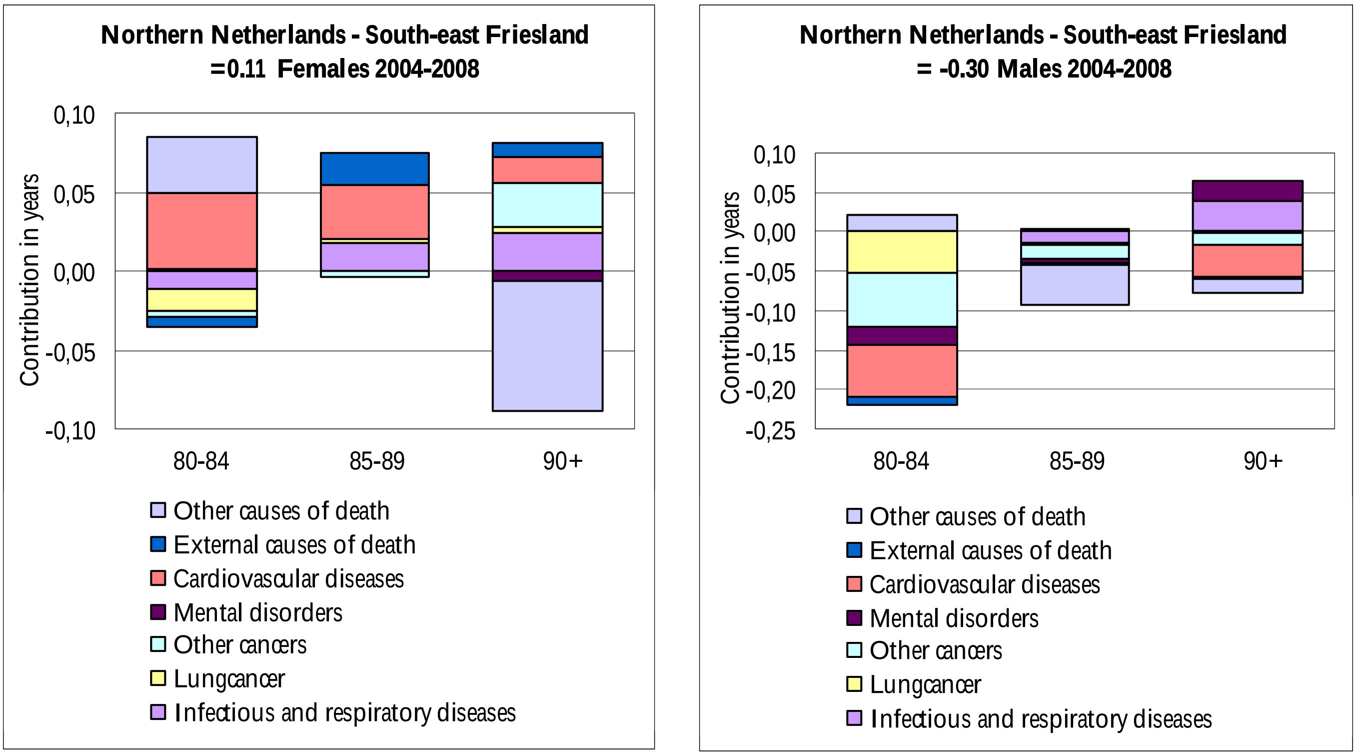


Figure 4.32 Contribution of causes of death to the differences in life expectancy at age 80 between the Northern Netherlands and North-Drenthe, females and males, 2004-2008.

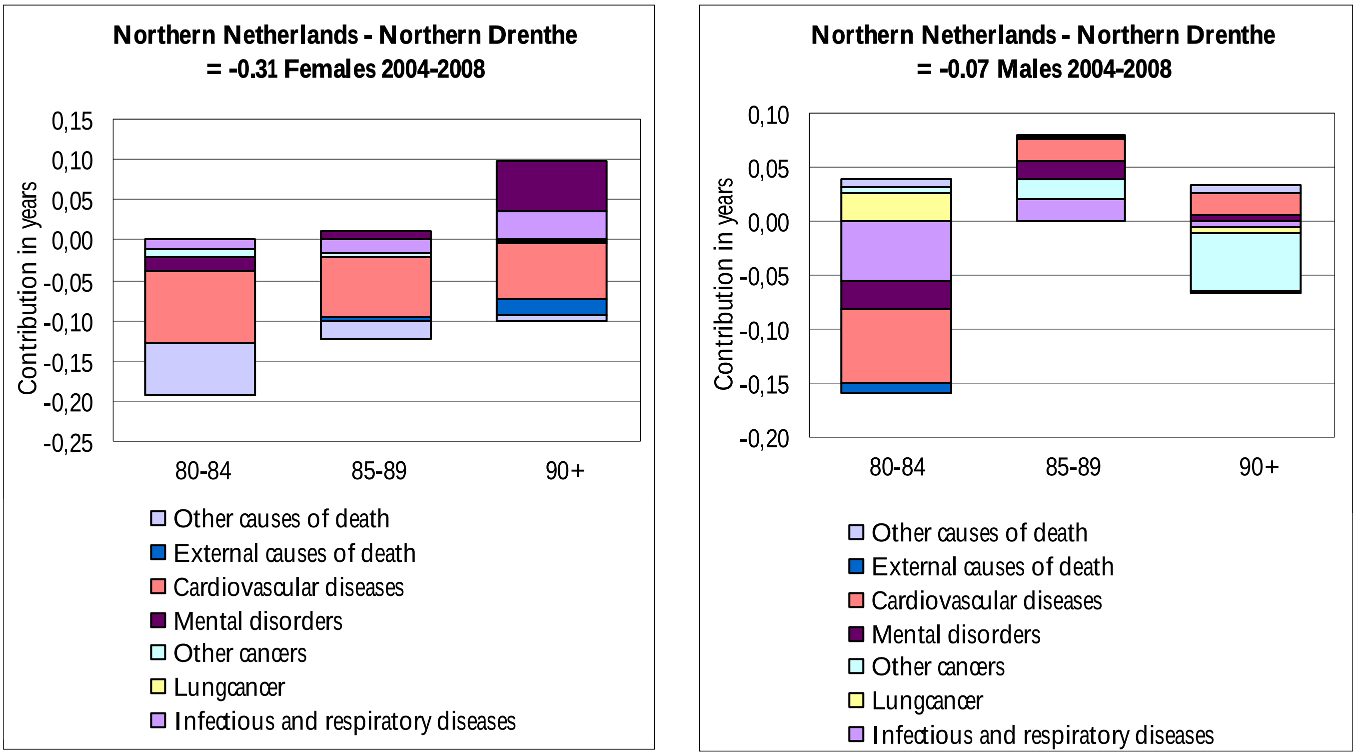


Figure 4.33 Contribution of causes of death to the differences in life expectancy at age 80 between the Northern Netherlands and South-east Drenthe, females and males, 2004-2008.

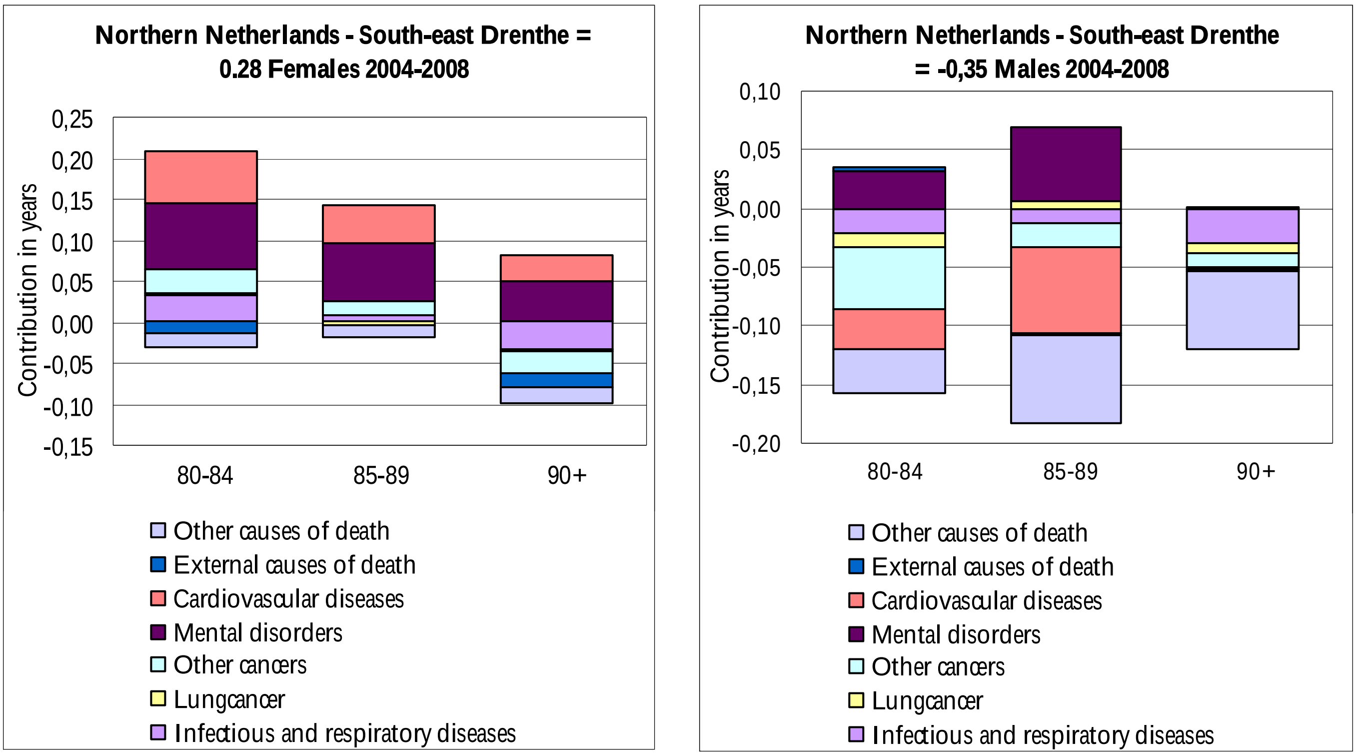


Figure 4.34 Contribution of causes of death to the differences in life expectancy at age 80 between the Northern Netherlands and South-west Drenthe, females and males, 2004-2008.