

## ORIGINAL ARTICLE

# Health Care Consequences of Demographic Changes in Mecklenburg–West Pomerania

Projected Case Numbers for Age-Related Diseases up to the Year 2020, Based on the Study of Health in Pomerania (SHIP)

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## SUMMARY

**Background:** The population in the German federal state of Mecklenburg–West Pomerania is growing older. A resulting rise in age-related diseases will likely lead to a greater need for medical care, even though the population as a whole is declining. The predicted number of patients affected by these diseases varies from one district to another because of local differences in demographic trends.

**Methods:** Case numbers were forecasted on the basis of representative data on the morbidity from chronic diseases, which were derived from the Study of Health in Pomerania (SHIP), the conjoint cancer registry of the East German federal states (GKR), and a study on dementia morbidity. These data were combined with demographic prognoses for Mecklenburg–West Pomerania and its rural and urban districts up to the year 2020.

**Results:** The largest increases in case numbers are predicted for dementia (+91.1%), myocardial infarction (+28.3%), diabetes mellitus (+21.4%), and incident colon carcinoma (+31.0%; all figures are expressed in relation to the year 2005 as a baseline). The predicted changes in case numbers vary widely from one district to another.

**Conclusion:** All of the German federal states located in the former East Germany are likely to experience similar developments to those predicted for Mecklenburg–West Pomerania, as will many rural areas of the former West Germany, in which a demographic transition is already evident. Because of the predicted rise in the number of patients, new health care concepts will have to be rapidly developed, implemented, and evaluated in order to ensure that comprehensive medical care will be delivered where it is needed.

Demographic development in Mecklenburg–West Pomerania is marked by low birth rates, emigration, and increased life expectancy. As a result, the population is both aging and decreasing (1–3). Within a period of 20 years, the age structure in this federal state has changed from being the youngest to one of the oldest in Germany. The aging of the population is associated with increases in morbidity (4, 5) and the need for medical and nursing care (6–8). Although these changes are essential determinants for planning medical care capacities, they have not yet been adequately considered. Thus, the planning of the number of practicing physicians is based on population figures and not on the numbers of cases or patients (9). Moreover, there are geographical differences in demographic development, so that the changes in patient numbers should be examined separately for each region. However, this has never been pursued systematically, for example, in planning for regional hospitals, which determines the total number of beds required in the federal state and then distributes them over the regional hospitals.

To permit need related planning of the number of physicians at a regional level by considering the expected number of patients with widespread diseases, these have been projected for Mecklenburg–West Pomerania based on forecasts of population changes up to 2020. Forecasts for rural and urban districts were based on population forecasts from the Rostock Center for the Study of Demographic Change. Forecasts for the whole state were based on these forecasts, as well as the forecasts of the Statistical Office of Mecklenburg–West Pomerania (3, 10, 11). In the population forecast from the Rostock Center, the increase in life expectancy and related changes in the elderly population were modeled separately for each administrative district. The overall changes in the population of Mecklenburg–West Pomerania can be derived from changes in the individual rural and urban districts and separately administered

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towns. On the other hand, the Statistical Office's state forecast provides information about the development in the state as a whole and does not consider regional trends. As a consequence, the Statistical Office's state forecast predicts a smaller increase in the absolute number of older people than the forecast from the Rostock Center.

The aim of the present study was to use these forecasts to determine the number of persons in Mecklenburg–West Pomerania aged between 25 and 84 years in 2020 who will have ever suffered from or who will be suffering from the following diseases (prevalence):

- Myocardial infarction
- Stroke
- Hypertension
- Diabetes mellitus
- Osteoporosis
- Dementia (in the age group 65 years or older).

Furthermore, it was calculated how many people will be first diagnosed to have any sort of cancer or colon cancer (incidence).

We have developed a model for forecasting the expected number of cases, allowing for the future changes in the age structure of the population, as well as changes in the proportions of the sexes. This model will now be presented. All changes in case and population numbers are relative to the year 2005.

## Methods

### Prevalence and incidence data from epidemiological studies and registers

The Study of Health in Pomerania (SHIP), the conjoint cancer registry of the East German federal states (*Gemeinsames Krebsregister*, GKR), and Bickel's study (12) were used to provide the database for the epidemiological parameters (prevalence and incidence).

The SHIP study is a comprehensive, prospective epidemiological cohort study, which is representative for the adult population in the region of West Pomerania (13). The baseline data collection (SHIP-0) was performed between 1997 and 2001. 4310 persons took part in the study (response rate 68.8%). The first 5-year follow-up (SHIP-1) took place from 2002 to 2006. 3300 persons aged 25 to 88 years took part in the follow-up; this equates to a response rate of 83.5% (after subtracting participants who had died in the interim). A standardized computerized personal interview was conducted with the participants about various diseases and risk factors as well as their use of medical services. In addition, numerous medical and laboratory tests were performed.

The SHIP was used to calculate the population-based prevalences of myocardial infarction, stroke and diabetes mellitus (lifetime prevalence), on the basis of medical diagnoses reported by the study participants. The interview only records myocardial infarction or stroke which the person survived. As the SHIP interview did not differentiate between type 1 and type 2 diabetes, the data are presented together. It can be

**TABLE 1**

Sample characteristics and prevalence of diseases in SHIP-1, as well as the level of significance of the sex differences (chi-square test)

|                            | Total      | Men               | Women             |    |
|----------------------------|------------|-------------------|-------------------|----|
| <b>SHIP-1</b>              |            |                   |                   |    |
| Number of participants     | 3300       | 1589 (48.2%)      | 1711 (51.8%)      |    |
| Mean Age                   | 52.2 years | 52.3 years        | 52.1 years        |    |
| <b>Prevalence</b>          |            |                   |                   |    |
| Hypertension               | 50.0%      | 56.2%             | 44.5%             | *2 |
| Diabetes                   | 9.5%       | 10.7%             | 8.5%              | *1 |
| Myocardial Infarction      | 3.3%       | 5.0%              | 1.7%              | *2 |
| Stroke                     | 2.5%       | 3.0%              | 2.1%              |    |
| Osteoporosis               | 5.1%       | 1.7%              | 8.0%              | *2 |
| <b>Prevalence (Bickel)</b> |            |                   |                   |    |
| Dementia                   | 7.2%       | –                 | –                 |    |
| <b>Incidence (GKR)</b>     |            |                   |                   |    |
| Cancer (colon)             | –          | 37.6 per 100 000  | 25.9 per 100 000  |    |
| Total cancer               | –          | 476.3 per 100 000 | 307.7 per 100 000 |    |

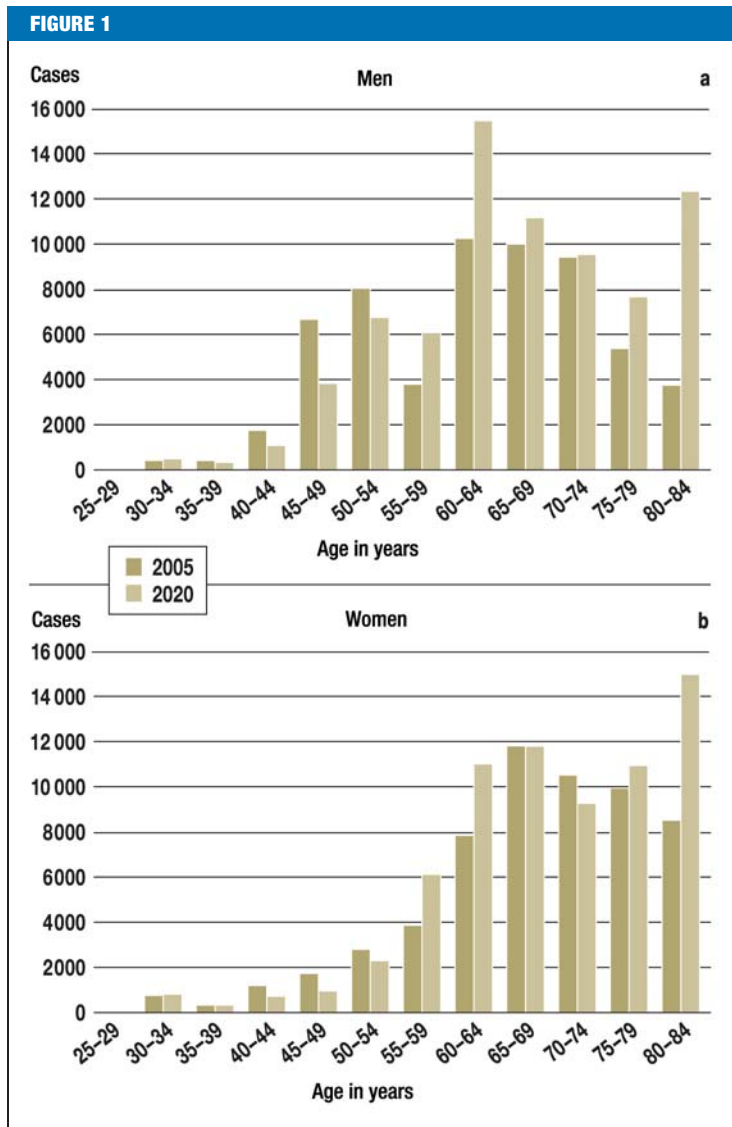
\*1 p<0.05; \*2 p<0.01; prevalence of dementia taken from Bickel (12); on the basis of the standard European population age-standardized incidence of cancer in Mecklenburg–West Pomerania for 2004 (GKR, 18)

assumed, however, that type 2 diabetes makes up about 90% to 95% of cases (14). The 1-year prevalence of osteoporosis was derived from SHIP-1. The point prevalence of hypertension was determined from SHIP-1; the mean was taken of the last two of the three standardized measurements of systolic and diastolic blood pressure (15). Hypertension was defined as a mean systolic blood pressure of  $\geq 140$  mm Hg and/or mean diastolic blood pressure of  $\geq 90$  mm Hg, and/or intake of anti-hypertensive drugs (16).

The SHIP data were evaluated with the statistics software StataSE 10.1. Corresponding to the SHIP study design, the prevalences were weighted according to the ratios within the population (17). Sex- and age-specific differences in the prevalences were tested with the chi-square test. Separate forecasts were made for the sexes and age groups on the basis of these results.

Data for the 1-year incidence of all types of cancer and of colon carcinoma—the most frequent form of cancer for the overall population—in Mecklenburg–West Pomerania were taken from the GKR for the year 2004 (18, 19), as the number of cases was very low in SHIP.

The estimates of the prevalence of dementia, including Alzheimer's disease, were taken from Bickel's study (12), as individuals with intermediate or severe dementia were incapable of fully participating in SHIP, due to the comprehensive interviews and medical tests. As a result, the number of patients could not be absolutely reliably recorded. Bickel's data only cover persons aged 65 or over, but dementia in persons aged under 65 is very rare (about 3% of cases) (12).



Forecast of the number of cases of diabetes mellitus in Mecklenburg–West Pomerania in 2005 and 2020, based on the Rostock Center population forecast. a) men, b) women

**Population forecasts**

Population forecasts are scenarios for demographic development resulting from variations in the parameters of fertility, migration, and mortality. This study used two population forecasts based on different assumptions and using different methods.

The forecast of the Statistical Office of Mecklenburg–West Pomerania was calculated at the level of the federal state. It was assumed that the total fertility rate (TFR) in Mecklenburg–West Pomerania up to 2010 will be 1390 live children per 1000 women, which will then increase to 1450 for the period from 2011 to 2020. For the migration beyond the state borders within Germany, the calculation assumed that emigration and immigration will initially remain at the level of 2005, but markedly decrease from 2008. For

migration beyond the borders of Germany, it was assumed that the slight decrease in immigration will continue till 2009, but that there will be an increase in immigration by 10% from 2010. It was assumed that the life expectancy for men would increase by 3.08 years by 2020 and for women by 3 years (3).

The population forecast of the Rostock Center was generated with the cohort component method and provides results at the level of the rural and urban districts, as well as aggregated results for the whole of Mecklenburg–West Pomerania. The forecast paid special attention to the older population. The future size of the population in the older age groups is highly dependent on regional changes in mortality. The assumptions about the development of mortality were derived by using the Lee–Carter procedure for each administrative district, with the assumption of a further increase in life expectancy within the period of the forecast. The assumptions on changes in fertility and migration are the same as those made by the Statistical Office of Mecklenburg–West Pomerania. Differences between the administrative districts were taken into account by applying the assumed trends to the initial values in each district (10, 11).

**Forecasting the number of cases**

For the forecast of the number of cases of each disease, it was assumed that the prevalences and incidences for each sex and 5-year age group derived from the different data sources will remain constant till 2020. On the basis of the population figures for 2005 and the demographic forecasts for 2020, the prevalences and incidences were used to calculate the number of persons of each sex and age group with an existing or newly diagnosed disease. The sum of the case numbers for both sexes and all age groups for both years gave the total number of cases for Mecklenburg–West Pomerania and each administrative district.

**Results**

**Population-related prevalences and incidences**

Table 1 lists the sample characteristics and disease-specific prevalences from SHIP, separately for men and women.

The overall very high prevalence of hypertension is due to the high prevalence in the older age groups. The prevalence in 25- to 29-year old men is 15.9%, whereas the prevalence in 80- to 84-year old men is 82.4%. The prevalence values for women rise analogously from 3.3% to 80.3%. The age dependence is significant for both men and women (chi-square tests, both  $p < 0.01$ ). The prevalences for diabetes mellitus, myocardial infarction, stroke, and osteoporosis for both sexes all significantly increase with age (each  $p < 0.01$ ).

According to Bickel, the prevalence of dementia in persons aged 65 years or over is 7.2% for both sexes (12). In the total population of Mecklenburg–West Pomerania, the age-standardized incidence of all types of cancer per 100 000 inhabitants is 476.3 cases for men and 307.7 cases for women (basis: 2004). The

**TABLE 2**

Forecast of the number of cases of prevalent or incident age-associated diseases in Mecklenburg–West Pomerania in 2005 and 2020, as well as the percentage and absolute changes in the number of cases in 2020 in comparison to 2005: based on the population forecast of the Rostock Center and the Statistical Office of Mecklenburg–West Pomerania

|                            | 2005            | 2020   |                  |  |                  |
|----------------------------|-----------------|--|------------------|--|------------------|
|                            |                 | Based on the Population Forecast of the Rostock Center |                  | Based on the Population Forecast of the Statistical Office of Mecklenburg–West Pomerania |                  |
| Mecklenburg–West Pomerania | Number of Cases | Number of Cases  | Change           | Number of Cases  | Change           |
| <b>Prevalence</b>          |                 |  |                  |  |                  |
| Hypertension               | 618 855         | 657 423  | +6.2% (+38 568)  | 650 858  | +5.2% (+32 003)  |
| Diabetes                   | 117 919         | 143 138  | +21.4% (+25 219) | 141 125  | +19.7% (+23 206) |
| Myocardial infarction      | 40 976          | 52 560   | +28.3% (+11 584) | 51 549   | +25.8% (+10 573) |
| Stroke                     | 31 322          | 36 969   | +18.0% (+5646)   | 36 422   | +16.3% (+5100)   |
| Osteoporosis               | 66 629          | 79 636   | +19.5% (+13 006) | 79 053   | +18.7% (+12 423) |
| Dementia                   | 19 271          | 36 826   | +91.1% (+17 555) | 34 724   | +80.2% (+15 453) |
| <b>Incidence</b>           |                 |  |                  |  |                  |
| Cancer (colon)             | 728             | 953  | +31.0% (+225)    | 936  | +28.6% (+208)    |
| Total cancer               | 8612            | 10 560   | +22.6% (+1948)   | 10 388   | +20.6% (+1776)   |

incidence of colon carcinoma is 37.6 cases per 100 000 for men and 25.9 cases for women (18).

**Forecasting the number of cases for Mecklenburg–West Pomerania**

Figures 1a and 1b show the numbers of cases of diabetes for Mecklenburg–West Pomerania for 2005 and 2020, based on the population forecast of the Rostock Center. The numbers of cases are split by sex and by 5-year age group.

The number of cases for diabetes will be lower in 2020 than in 2005—up to the age group of 50 to 54 years old. The 30- to 34-year-olds are the only exception, as the number of cases slightly increases in this group. However, for persons aged 55 to 84, the number of cases in 2020 will be much higher than in 2005. The case numbers only decrease for women aged 70 to 74. According to the forecasts, there is an absolute increase in the number of cases with existing diabetes by 25 219 cases or 21.4% (Table 2).

Table 2 shows the number of cases of the diseases over all age groups and both sexes for 2005 and 2020. The changes in the number of cases are also shown, both absolutely and as percentages. The highest increase in the number of cases is expected for dementia, with 91.1%. The expected increases are 28.3% for myocardial infarction, 22.6% for all cancers, and 31.0% for colon carcinoma (based on the population forecast from the Rostock Center). The forecasts of the number of cases based on the population forecast of the Statistical Office of Mecklenburg–West Pomerania all predict slightly lower increases.

With the exception of osteoporosis, the number of cases in the oldest age group (80 to 84 years old) will

have more than doubled by 2020 in comparison to 2005 (Table 3). This increase explains much of the overall increase in the disease burden. There is a corresponding increase in the proportion of older patients within the number of cases. For example, in 2005, 59.9% of dementia patients were 80 years old or older. The corresponding figure in 2020 will presumably be 76.9%.

**Forecasting the numbers of cases for the administrative districts**

Figure 2a shows the changes in the number of cases of cardiovascular diseases for the rural and urban districts in Mecklenburg–West Pomerania.

In all regions of Mecklenburg–West Pomerania, there will be an increase in the number of cases in 2020 in comparison with 2005. Only for hypertension, the expected case numbers will decrease in two administrative districts in 2020—by 3.2% in Demmin and by 4.2% in Uecker-Randow. On the other hand, the number of cases of hypertension in the administrative district of Bad Doberan will increase by 28.8% within the same period. The highest increase in the number of cases is expected for all cardiovascular diseases in the administrative districts of Bad Doberan, Ludwigslust, and Nordwestmecklenburg, whereas the smallest increase is expected to be found in the rural districts of Demmin and Uecker-Randow, as well as the urban districts of Stralsund and Wismar. This pattern of regional differences also shows in the forecasts of the number of cases for cancer.

Figure 2b shows the changes in the number of cases of dementia. In contrast to the forecasts for the other diseases, the number of cases increases most markedly for the rural district of Bad Doberan and for the urban



**TABLE 3**

Changes in the absolute number of cases in Mecklenburg–West Pomerania from 2005 to 2020 in 80- to 84-year-olds, as well as the number of cases in 2005 and 2020 and the proportion of the total number of cases. Forecasts based on the Rostock Center population forecast

|                       | Increase for 80- to 84-year-olds | Number of cases in 2005 (proportion of total patients) | Number of cases in 2020 (proportion of total patients) |
|-----------------------|----------------------------------|--|--|
| <b>Prevalence</b>     |                                  |  |  |
| Hypertension          | +35 293                          | 29 451 (4.8%)  | 64 744 (9.9%)  |
| Diabetes              | +15 107                          | 12 107 (10.3%)   | 27 214 (19.0%)   |
| Myocardial Infarction | +7225                            | 4558 (11.1%)   | 11 783 (22.4%)   |
| Stroke                | +2860                            | 2 271 (7.3%)   | 5131 (13.9%)   |
| Osteoporosis          | +8131                            | 10 154 (15.2%)   | 18 285 (23.0%)   |
| Dementia*             | +16 760                          | 11 543 (59.9%)   | 28 303 (76.9%)   |
| <b>Incidence</b>      |                                  |  |  |
| Cancer (colon)        | +134                             | 93 (12.8%)   | 228 (23.9%)  |
| Total cancer          | +1023                            | 718 (8.3%)   | 1741 (16.5%)   |

\* 80 years old and older, no age limit

districts of Neubrandenburg, Rostock, and Stralsund. The smallest increases are expected in the administrative districts of Demmin and Ludwigslust. In contrast to the other forecasts, these calculations included the very old (above 85 years).

**Discussion**

As a consequence of the demographic development in Mecklenburg–West Pomerania, there is an increase in the number of persons in the higher age groups. This leads to an increasing number of cases with age-associated chronic diseases and this cannot be compensated by the decrease in the population and in the number of cases in the younger age groups. The increase in the number of cases by 2020 is still being underestimated, as persons aged over 85 were not considered in the calculation—except for dementia patients.

One reason for the future increase in the number of older people is the assumed increase in life expectancy. Both the Rostock Center and the Statistical Office of Mecklenburg–West Pomerania assume in their population forecasts that life expectancy will continue to rise and there are good empirical reasons to support this (20, 21). The assumptions on changes in birth rates do not influence the forecasts of the number of cases, as these are based on cohorts already born in 2005. Moreover, the assumptions on migration have only a slight influence, as older persons generally migrate less than the young. Besides, the population forecasts have turned out to be robust towards changes in the assumptions (11).

The forecasts of the number of cases at the level of the rural and urban districts in Mecklenburg–West Pomerania make it clear that any estimate of the

number of cases and the necessary medical care for a whole federal state can overestimate or underestimate the need in an individual region. With the method used in the present study, the regional differences are due to differences in demographic development.

As the demographic process is particularly marked, the number of cases in Mecklenburg–West Pomerania increase markedly. Similar changes will take place in all of the new federal states, as well as in rural areas of the old federal states, in which a demographic transition is already evident. It is possible that the forecasts for Mecklenburg–West Pomerania overestimate the development of the case numbers in other federal states, due to the relatively unfavorable profile for risk factors and morbidity (22). In any case, the method of forecasting can be transferred to calculate the expected case numbers in other federal states, in which regional differences also have to be considered, using population forecasts for small regions. However, there are no available population-based morbidity data for most of the regions.

The prevalence of specific risk factors for chronic age-associated diseases, such as obesity and hypertension, has increased in Germany since 1984 (23, 24). Further research should therefore have the objective of adjusting the forecasts for the expected future constellation of risk factors in a population. In addition to the consequences of aging in the population, changes in the prevalence of risk factors can affect the number of cases and thus the structures required to provide medical care.

The demographically based increase in the morbidity burden and the aging of the population are a peculiar challenge for the future health care system. We must determine how exactly the increase in the number of old and very old patients effects health care utilization and the requirements for physicians. In the context of the aging of physicians and problems in replacing retired physicians, not only in rural Mecklenburg–West Pomerania, but also in other states in West and East Germany (25), it will be necessary to develop innovative models to provide medical care. These must then be implemented in model regions and their efficiency and cost-effectiveness evaluated. Possible approaches might include better interlocking of outpatient and inpatient care, improvements in early detection and prevention, outreach care—perhaps with community medicine nurses (“AGnES experts”)—and specific use of telemedicine.

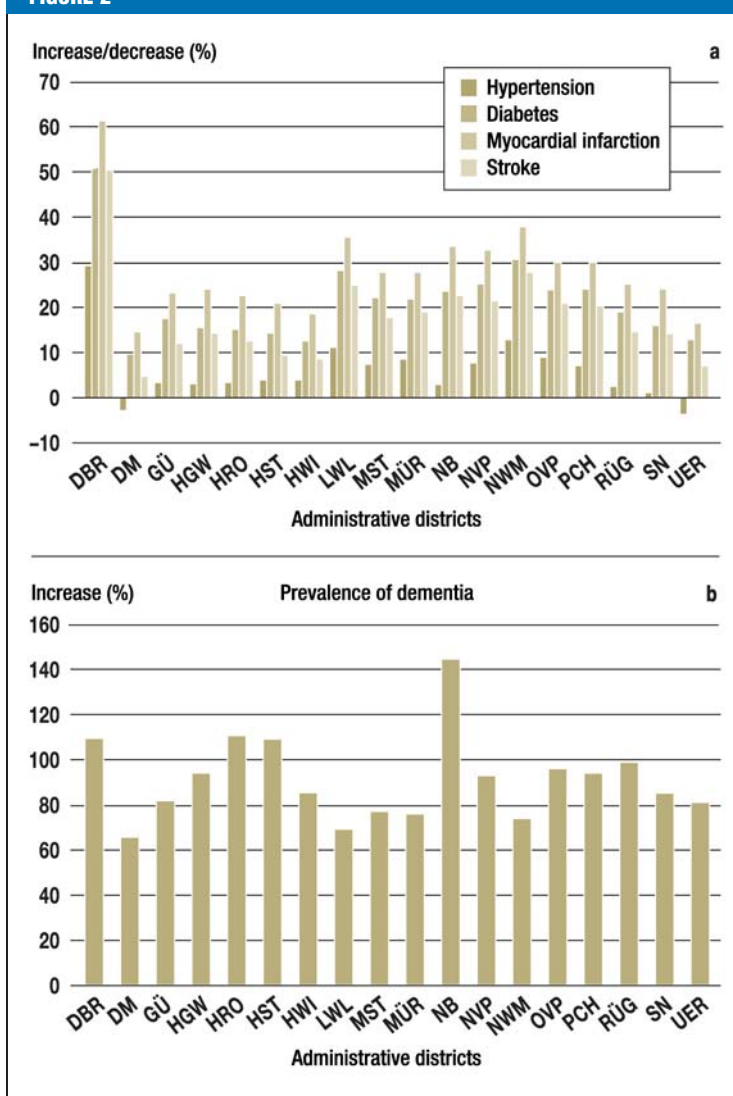
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**Conflict of interest statement**

The authors declare that no conflict of interest exists according to the guidelines of the International Committee of Medical Journal Editors.

FIGURE 2



Percentage changes in the number of cases of diseases (prevalence) from 2005 to 2020 for the different administrative districts of Mecklenburg–West Pomerania\*. Forecasts based on the Rostock Center population forecast. a) hypertension, diabetes, myocardial infarction, stroke, age range 25–84 years, b) dementia, 65 years old or older (\* administrative districts: DBR, Bad Doberan; DM, Demmin; LWL, Ludwigslust; MST, Mecklenburg-Strelitz; MÜR, Müritzt; NVP, Nordvorpommern; NWM, Nordwestmecklenburg; OVP, Ostvorpommern; PCH, Parchim; RÜG, Rügen; UER, Uecker-Randow; GÜ, Güstrow; HGW, Hansestadt Greifswald; HRO, Hansestadt Rostock; HST, Hansestadt Stralsund; HWI, Hansestadt Wismar; NB, Neubrandenburg; SN, Schwerin)

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KEY MESSAGES

- In comparison with 2005, the number of cases of age-associated disease will slightly decrease in 2020 in the younger age groups, but will greatly increase in older people.
- There will therefore be an overall increase in the number of cases of age-associated diseases, accompanied by an increase in the proportion of older people by 2020.
- The greatest increase of case numbers is expected for dementia, myocardial infarction, and cancer.
- With respect to the increase in the number of cases, there will be regional differences between the individual rural and urban administrative districts within Mecklenburg–West Pomerania. These correspond to the regional differences in the forecasted changes in the population development.
- Forecasts of the development of case numbers should be considered in future regional need-related medical planning. At the same time, innovative concepts to guarantee medical care must be developed, implemented, and evaluated on a population-based level.

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