# *Associations between Primary Health Care and UnplannedMedical Admissions in Norway. A multilevel analysis of the entire elderly population.*

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## *Highlights*

- Unplanned medical admissions are of growing concern in western societies
- In a multi-level analysis we studied all Norwegians 65 years and older
- In general; higher primary health care volume did not seem to prevent admissions
- Higher long term care volume might lower the risk for an admission among the oldest


## *Abstract*

Unplanned admissions comprise a major part of all hospital admissions in many advanced societies. A well-functioning primary health care (PHC) in the local community may prevent some of these admissions. Using a multilevel analytical framework, consisting of individuals (N=722,464) nested within municipalities (N=428), nested within local hospital areas (N=52) we studied associations between both General practitioner (GP) and long-term care (LTC) volume, and individual risk of unplanned medical admissions (UMA) among the entire Norwegian elderly population. There was no association between municipality GP and/ or LTC volume and UMA, but we found that higher LTC-levels of provision may prevent hospitalizations amongst the older age groups. A modest geographical variability was observed in adjusted analysis. In conclusion, a higher primary health care volume did not seem to prevent unplanned medical admissions in a universally accessible health care system.



## *Key words*

Primary health care, Long term care, Unplanned admissions, Multilevel analyses, Small area analysis, Norway.


10

## *Introduction*

Unplanned hospital emergency admissions (UHA) constitute a significant proportion of overall hospital admissions, and their share has increased in recent years in many advanced societies (Blunt et al. 2010;Pitts et al. 2012). Although changes from hospital elective activity to out-patient or day-time activity might have contributed to the increase, the observed rise has been of concern for several reasons. Firstly, UHAs are expensive; they encumber hospital planning, disrupt elective care capacity and increase waiting lists. Secondly, for vulnerable chronically ill elderly patients hospital stays can harm more than they benefit, with risks of medication errors, confusion, hospital infections, and over/ mistreatment (Covinsky et al. 2011).Thirdly; it has been argued that some of these emergency admissions, especially from non-surgical reasons, may be avoidable or preventable (Blunt, Bardsley, & Dixon 2010). Nevertheless, UHA may also be a start of a detailed investigation of the actual clinical problem, which in turn might prevent subsequent hospitalizations.

Primary health care (PHC) has a theoretical and ideological basis in continuous, person focused, preventive and family/ community oriented care, which in many cases cannot be shared by secondary care (Starfield 1998). A robust and pro-active PHC including integrated chronic care and case management could theoretically treat more chronically ill elderly in local settings and prevent some acute crises. This may benefit patients, but the effect on overall costs has not been clarified (Kringos et al. 2013;Reid et al. 2010).

Nevertheless, studies on the relationship between PHC-utilization and unplanned admissions are sparse and conflicting in the evidence they provide. From a methodological perspective they also they differ according to age-groups, designs and outcomes. Lower UHA rates were associated with higher general practice supply in two studies (Ionescu-Ittu et al. 2007;Rosenblatt et al. 2000) and with higher primary care physician (PCP) density as an indirect measure of PHC in another (Kravet et al. 2008). However, it is demonstrated that better access to PHC can increase hospital use among some patient populations (Saha et al.

2007). A recent British report found no clear association between access to community services and UHA (Imison et al. 2012). Additional services in the primary health care might also lead to higher admission rates possibly explained by identification of previously undetected cases (Gravelle et al. 2007).

Analogous to other western countries, a key objective of a recently issued health care reform in Norway (Norwegian Ministry of Health and Care services 2009) was to curb the growth of UHA and more specifically unplanned medical (non-surgical) admissions (UMA) by shifting resources from specialized health care to local primary health care (PHC). An OECD report from 2006 claimed that insufficient long term care (LTC) provision in Norwegian municipalities was leading to increased hospitalizations among elderly (Bibbee and Padrini 2006). While general practitioners (GPs) are gatekeepers to Norwegian specialist health care, both as doctors responsible for patient lists covering the 99.6% of the population (Gaardsrud 2012) and as GPs at out of hours casualty clinics, they have up to now had few alternatives to hospital admission in acute cases. This is because municipalities seldom offer emergency care in the LTC-setting.

In Norway approximately 70 % of all admissions to hospital are non-elective (not planned), and out of the non-surgical admissions, nearly 87 % of the admissions are non-elective (Norwegian Directorate of health 2012). A recent report indicated that, especially amongst the elderly, much of the geographical variation in hospital use between Norwegian municipalities was linked to unplanned admissions for non-surgical reasons for people aged 80 years and older (Heiberg 2010). However, we do not know to what extent geographical variation in UMAs arises from differences in the municipality level provision of PHC.

Geographic variations in health care utilization and spending have been well studied but there is still controversy regarding whether observed variations arise from differences in supply or need. Ecological studies conflate variation between individuals and variation between geographical units and multi-level studies are increasingly seen as a methodological advancement in the understanding of geographic variations in health care utilization (Moon et al. 2005;Subramanian et al. 2003).

With a high quality dataset covering the whole of the population of Norway we studied, within a multilevel statistical framework, associations between two municipality constructs, LTC and GP utilization, and individuals' likelihood of being hospitalized as an UMA by age. Several studies have argued that local practice (Sirovich et al. 2008) or supply differences (Fisher et al. 2003) between hospitals may be an additional driver of geographical variation in hospital utilization. Hence we also aimed to assess if there was substantial geographical variability in UMAs between municipalities and hospital regions.

# Methods

## Data

Our analysis was based on a dataset which possessed a three level hierarchical structure with individuals at the lowest level, which were nested within municipalities (second level) and in hospital regions (third level). The development and nature of this data structure is described below.

The Norwegian patient registry (NPR) provided individual level data on unplanned admissions for non-surgical procedures. This comprised all unplanned medical admissions (UMA), among individuals aged 65 years and above for the whole of 2009 (N=120,846). The registry only incorporated individuals admitted to a hospital and not the remaining elderly population, but based on Norwegian census information we were able to create an individual level data structure which represented admissions for the entire elderly population.

As an example of our methodology, if in a particular municipality (a small administrative unit described below) we knew from the census that there were 8 females aged between 65 and 69 years and from the NPR we knew that 2 women had at least one unplanned medical admission in this particular age group. Hence, we created a new data file in which 2 of these 8 municipality residents had at least one UMA event and the remaining 6 had not. This enabled us to arrive at a data structure which gave an exact representation of the elderly population in individual-level format. By implementing this procedure, our dataset consisted of 120,846 hospitalized individuals among 722,464 individuals where we had information about sex, age group and municipality of residence for the population in 2009.

Our second level of analysis consisted of Norwegian municipalities (N=430). These are governed by local politicians and they possess some autonomy in terms of welfare arrangements. We had two principal municipality-level predictors of interest. The first, the 'GP consultation rate' was the total number of municipality GP consultations per 1000 inhabitants/year including both day-time and out-of-hours service consultations. The second, (LTC-rate) refers to the number of recipients of municipality LTC (both in home care and community-based residential care homes and nursing homes) per 1000 inhabitants, counted on a specific day each year. Home care recipients make up to 75% of the LTC-users aged 67+ and get either practical help or nursing care or both (Huseby and Paulsen 2009). All LTC is publicly funded; however some services do require co-payments (Huseby & Paulsen 2009;Statistics Norway. 2011;The Commonwealth Fund 2012). Both predictors were used as proxies for the volume in their respective areas of PHC and they were recoded into quartiles ranging from 'high' to 'low'.

We gathered the additional information on municipality-level contextual constructs that may confound the association between our main predictors of interest and UMA. One of these was travel time, measured in minutes from the municipality centroid to the nearest hospital with a medical emergency department. This covariate was recoded into the following groups (1): 0 to 20 minutes, (2): 20 to 60 minutes, (3) 60 to 120 minutes and (4) over 120 minutes. A dummy variable indicating whether the municipality had a hospital with a medical emergency department was also constructed. Educational level was used as an indicator for area deprivation. This was measured as the mean proportion of the population aged 25 years and older with primary school as highest educational level in each municipality for the years

2000- 2009 and was recoded into quartiles. As no municipality level information on morbidity was available, we used the mean municipality rate of all-cause mortality rate for the years 2000- 2009 as a proxy for morbidity. Mortality is a measure which has been shown to be suitable for this purpose (Mays 1987). This was similarly recoded into quartiles. The municipality rate of recipients of disability benefits was also examined as an additional measure of need. The third level of our multilevel framework referred to the local hospital area (N=52) and contained no predictors.

This study is part of a larger project ("Analyses of patient trajectories") which has been approved by Regional Committee for Medical and Health Research Ethics (REC) in Northern Norway and the Norwegian Data Protection Authority.

### Statistical analysis

For the purposes of analytical efficiency we aggregated the individual level data to form cells cross-tabulated by age group and sex. The outcome for each cell was the proportion of hospitalized individuals for a given age and sex banding. To form this value the numerator was the number of emergency hospitalizations and the denominator was the total population used to calculate the proportion of hospitalizations in each cell. This rendered 10 (5 x 2) unique groups in which the cell predictor variables related to 5 age bandings in both males and females. These cells were nested within the 430 Norwegian municipalities and 52 local hospital areas. Treating the outcome variable in this way has been shown to produce models that are structurally identical but computationally more efficient than those that would be generated with individuals at level 1 (Goldstein 1991;Jones and Subramanian 2012;Moon et al. 2010;Subramanian et al. 2001;Subramanian et al. 2005;Suzuki et al. 2012a;Suzuki et al. 2012b).

Using this three level structure, we were applied multilevel models to estimate (1) the contingent relationship between the two municipality constructs (GP and LTC volume) and individual UMA (fixed parameters), (2) the between-municipality and between-hospital region variation that is unaccounted for after adjustment for municipality compositional (case-mix) factors (age and sex) and likely confounding covariates (random parameters), and finally (3) how the effect of municipality level of GP and LTC volume and varies by age (fixed cross-level interaction term). The latter construct was based on results from previous ecological studies suggesting that the association between long term care and use of hospital days may be age contingent (Deraas et al. 2011).

Our response variable, the proportion of the population with at least one UMA in each cell, was modelled using a three level binomial logit link model with allowances made for varying cell denominator populations (Goldstein 2003). Fixed and random parameter estimates for the model were calibrated with the Penalized Quasi Likelihood (PQL) second order Taylor series expansion routine as implemented within the MLwiN program (Rasbash et al. 2009). Allowance was made for extra-binomial variation at level 1 (the cell level) since proportions may exhibit more or less variation than a binomial distribution (Collett 1991). Fixed effects estimates are reported as odds ratios (OR) with 95% confidence intervals (95% CI) whereas random effects are reported as variances (on the log-odds scale) and Median Odds Ratios (MOR) (Larsen et al. 2000;Larsen and Merlo 2005). The MOR is defined as the median value of the odds ratio between the area at highest risk and the area at lowest risk. MOR may alternatively be conceptualized as the increased risk, on average, that would result from moving from a lower risk municipality to a higher risk municipality if two municipalities where chosen at random from the distribution within the estimated level 2 variance. We computed the MOR by

$$MOR_{HR} \approx exp\left(0.95\sqrt{\sigma_{HR}^2}\right) \qquad (1)$$

$$MOR_{M} \approx exp\left(0.95\sqrt{\sigma_{HR}^2 + \sigma_{M}^2}\right) \qquad (2)$$

where √ is the square root of the variance ($\sigma^2$) at the specific level, M = municipality, HR = Hospital Region. Models were fitted in a sequential manner whereby potential confounders were initially adjusted for, before the exposures of interest were added and their association with our outcome was tested both with and without adjustment for the confounders. Finally we examined cross-level interaction terms between age and the two primary predictors.

## *Results*

Due to missing covariate information in two of the 430 municipalities, we excluded 209 individuals, amongst whom 31 had been hospitalised. Hence our sample for analysis consisted of 120,815 hospitalized individuals among a total population of 722,464 individuals nested in 428 municipalities and 52 local hospital areas.

Overall a total of 167 per 1000 individuals had at least one UMA during the year (Table 1). Men had higher rates of UMA in all age-groups, and the rates increased with age for both sexes. Fixed effects estimates from multilevel models are depicted in Table 2 and we describe them in the order they were estimated. In Model 1, the odds of UMA were found to increase with age. There was an almost fivefold odds (OR=4.89, 95% CI=4.79-5.00) of UMA in the oldest age group (85+ years) compared to the youngest age and the odds were 29% higher for men compared to women (OR=1.29, 95% CI=1.27-1.30). There was a steady decrease in the odds of UMA by increasing travel time to hospital (Model 2). Compared to the reference category the odds were 8% lower for individuals living in municipalities with a travel time 20 to 60 minutes away from hospital and 13% lower for those in municipalities over 60 minutes away from hospital.

Municipality LTC level and the 'GP consultation rate' were not associated with UMA whether specified separately (Models 4 & 5) or combined (Model 6). When we specified models that included the municipality mortality and rates of recipients of disability benefits, the measures were not statistically significant and did not alter associations with our predictors of interest. Hence, for brevity, we do not show those results.

The odds ratios for the interaction term between age and LTC in Model 7 are visually depicted in Figure 1. It shows differences in log odds ratio for UMA by Municipality LTC-quartiles (Q) and Age groups. For the two youngest age groups (65-69 and 70-74) there was an increase in the probability of UMA by increasing level of long term care, whereas the middle age group (75-79) showed no consistent pattern in any direction. For the two oldest age groups there was a steady and significant decrease in the odds of UMA by increasing level of long term care. An interaction term between age and municipality 'GP consultation rate' was also specified although there was no evidence of any effect-measure modification (data not shown).

Random effects from the models in Table 2 are reported in Table 3 as variances (on the log odds scale) and Median Odds Ratios (MOR). The between-hospital-region variance and the between-municipality variance were somewhat similar, rendering median odds ratios of 1.09 and 1.12 respectively. The variances were significant in all models ($p<0.05$) and both the between-hospital-region variance and the between-municipality variance remained stable across models.

## *Discussion*

The main finding from this work was the lack of an association between the two municipality primary health care constructs and unplanned medical admissions. Overall, neither the municipality 'GP consultation rate' nor the LTC-rate were associated with the probability of UMAs occurring. However, the inclusion of the cross-level interaction term between age and LTC-rate provided some evidence to suggest that the level of LTC provision may be of importance in preventing UMAs amongst the oldest age groups, whereas the opposite pattern was found for the two youngest age groups. After adjustment the remaining geographical variability in UMAs was modest at both the municipality level as well as at the local hospital area level.

As discussed in the introduction to this article, findings from previous international studies are inconsistent regarding the association between LTC use and acute use of hospitals. Previous research is also ambiguous with respect to the effect GP volume may have on emergency hospitalizations. It may be that discrepancies between different welfare regime types in terms of their health and social care systems are limiting the generalizability of findings from one regime type to another. Indeed, one review has shown that studies from the US tend to be supportive of the assumption that more primary health care is associated with less hospitalization, while those from the UK are compatible with the present findings (RAND Europe, Ernst&Young, & University of Cambridge 2012;Roberts and Mays 1998). The authors of the review argue that in a universally accessible health care system, a 'ceiling' may be present beyond which additional primary care does not have the desired consequences in terms of reduced hospitalizations. In Norway, there is full GP coverage and fewer patients pr GP- than in UK (Gaardsrud 2012;Gulliford 2002), and the formal LTC-coverage is among the highest in Europe (Organisation for Economic Co-operation and Development 2011). Hence, our findings might indicate the presence of the same phenomenon.

We did find a distance decay effect between UMA rates and travel time to the nearest hospital, something others have noted. Indeed a distance decay effect is especially important for individuals with restricted physical mobility such as many elderly (Curtis 2004), and a Canadian study found a lower referral rate in rural areas (Chan 2003). We did not find different levels of UMAs for people from hospital municipalities versus those without a hospital. When we examined the effect of our proxies for morbidity, namely municipality rates of mortality and rates of recipients of disability benefits, we found no influence on the associations with primary care provision. Hence, it does not seem that the municipality level of need, at least based on our measures, is an important confounder. This conclusion is in line with a Dutch multi- level study where the municipality level characteristics did not influence emergency department utilization (Demaerschalk et al. 2012).

In terms of study strengths, we had data on all unplanned medical admissions in Norway through one year, amongst all Norwegians 65 years and older. The analyses were undertaken within a multilevel framework with an ecological perspective which allowed us to address our primary interest which concerned municipality contextual constructs and their influence in individuals' likelihood of being hospitalized at the same time as considering geographic variability between multiple levels of nesting (Greenland 2001). This is an advancement compared to a purely ecological, or aggregate, study which by definition conflates the compositional with the contextual (Moon, Subramanian, Jones, Duncan, & Twigg 2005). Our outcome measure, UMA, is used for financial reimbursements and is hence checked both by hospitals and the Norwegian Patient Registry. GP consultation data are obligate for financial reimbursement from Norwegian Health Economics Administration (HELFO). Therefore, we also believe we have almost complete consultation data. The private LTC-sector in Norway is minimal, so the data on municipal long-term care includes almost all recipients. The LTC-data has been through an internal quality check mainly based on comparison with previous year's data and internal consistency. As the Norwegian healthcare system has no private hospitals with emergency services, the relationship between PHC and UMA is studied in a homogeneous public financed health care system.

Our primary interest was to examine the association between the volume of PHC and the propensity for UMA. Other authors have limited similar analysis to unplanned admissions for "Ambulatory Care Sensitive Conditions" (ACSC). For several reasons, we are not convinced that such limitation is superior to our analysis which included unplanned admissions for all "non-surgical" conditions. The concept of ACSC was developed as an indirect indicator of local Primary Health Care *access* in the US (Billings et al. 1993) and is not consistently defined around the world. It is often linked both to the purpose and health care system it is studied in (Bardsley et al. 2013;Purdy et al. 2009). Further, analysing of admissions based on diagnoses at discharge without including information at admission might lead to misclassifications and erroneous conclusions about the potential role of PHC and enlarge the proportion of inappropriate admissions. In a recent American study, only 6% of those ED visits categorized as “primary-care treatable” visits were categorized as such when including information on main complaint presented at admission (Raven et al. 2013).

There are some limitations to our analysis. We have analysed all UMAs rather than only those amongst patients with frequent admission, and our outcome measure cannot differentiate between situations whereby many patients have few UMAs or a few patients have many. However, have no reason to believe that that the potentially preventive effect of the PHC would be different for people being hospitalized once compared to those being hospitalized several times, especially as it has been demonstrated that frequent users of ED also are heavy users of other health care services (Hansagi et al. 2001). Further, a recent review concluded that frequent users are heterogeneous, relatively few, and unlikely to be the main contributor to the growth in UA (LaCalle and Rabin 2010).

The cross-sectional design with data for a single year limits our ability to ascribe causality to the associations we observed. There is the possibility that we have been unable to capture all of the individual level factors that are associated with UMAs. Specifically, the unavailable individual data on marital status and morbidity may be important. In the oldest age groups more people are likely to be singleton households with less availability of informal care from spouses, and individuals living alone are more likely to be hospitalized (Aliyu et al. 2003).

It is possible to overcome some of the limitations in the present study, and this should be pursued in further research. Utilisation of total population health survey data (e.g. the HUNT and Tromsø studies (Jacobsen et al. 2012;Krokstad et al. 2012) with a linkage to existing hospital patient data and administrative registry data is possible since every citizen in Norway have a unique identification code. This would enable us to adjust for need at the individual level. Nevertheless, these population surveys are less heterogeneous because they only cover small regions, whilst the present work covers the entire country. Furthermore, linkage between individual primary health care data and specialist health care data is currently not possible.

## *Conclusion*

Our analyses did not support the assumption that a higher primary health care volume will reduce pressure on emergency departments in a universal health care system. However, higher municipality LTC volume was associated with less unplanned medical admissions among the oldest. A low level of variability among municipalities and hospital regions suggested that place of residence was of minor importance for the individual's risks for UMA.


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### Contributors

TSD and ERS designed the study and the analyses. ERS and TSD carried out the analysis and TSD drafted the first version of the paper and is the guarantor of the study. All the authors contributed to the interpretation and the writing of the paper and have seen and approved the final version. TSD and ERS had full access to all the data and take responsibility for the integrity of the data and the accuracy of the data analysis.

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***Figure 1:*** ***Predicted differences (log odds ratio) of unplanned medical admissions (UMA) by LTC-quartiles and age group (model 7). Men and women 65 years and older, Norway, 2009. Reference category in each age group are individuals living in municipalities with the lowest LTC-level (Q1=lowest) (log odds=0, dashed line), Q2=medium-low, Q3= medium-high, Q4= highest LTC-level.***

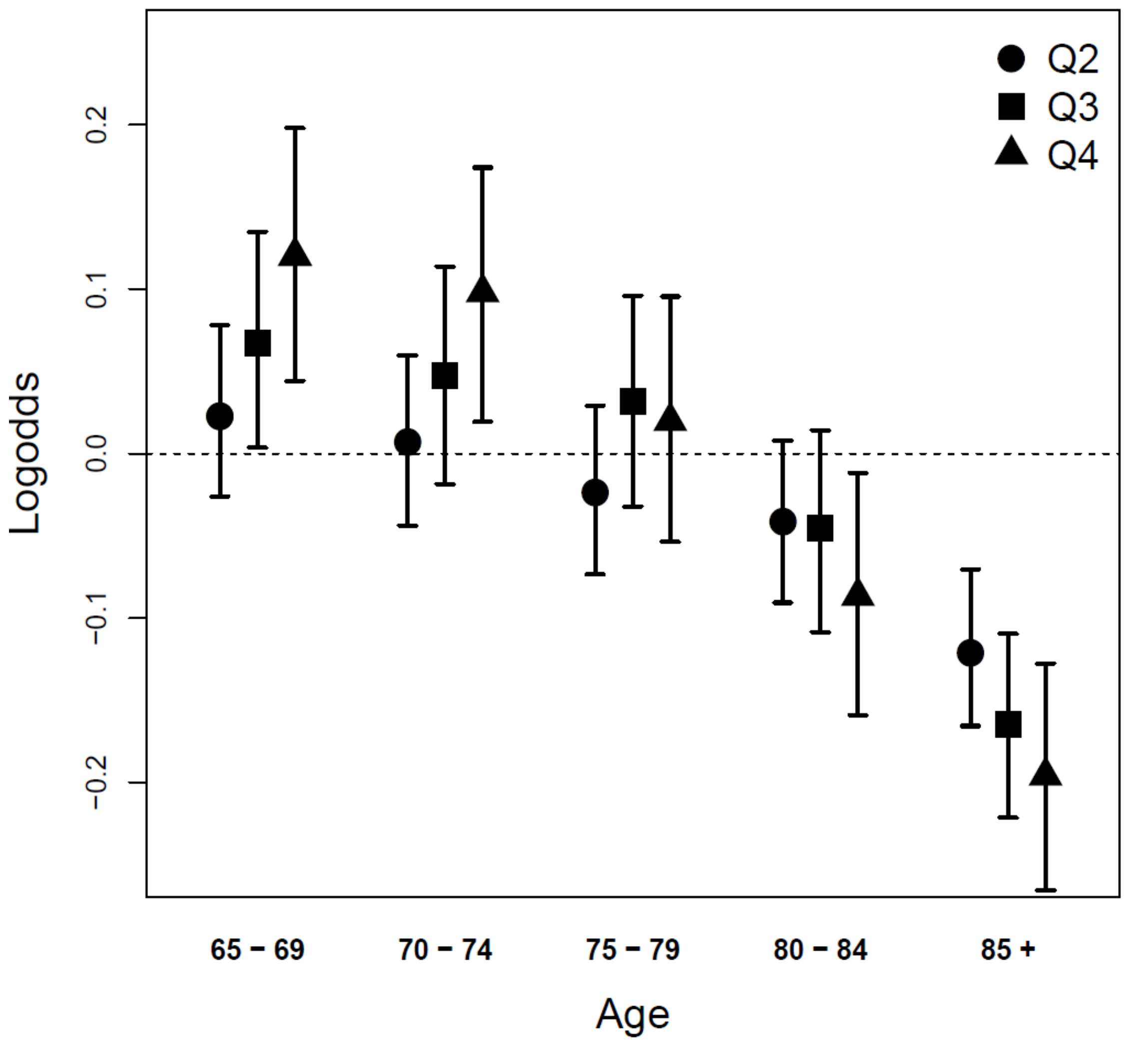

***Table 1:*** *Characteristics of the population aged 65 years or older in Norway. 2009.*

| Predictors | Number of cells | Number of individuals hospitalized | Population | Emergency hospitalization rate per 1000 |
|---|---|---|---|---|
| **Level 1: Cells (N=4280)** | | | | |
| **Males** | | | | |
| 65-69 y | 428 | 10670 | 104437 | 102 |
| 70-74 y | 428 | 9971 | 73812 | 135 |
| 75-79 y | 428 | 10797 | 58719 | 184 |
| 80-84 y | 428 | 11102 | 43713 | 254 |
| 85+ y | 428 | 12178 | 33903 | 359 |
| **Females** | | | | |
| 65-69 y | 428 | 8728 | 107567 | 81 |
| 70-74 y | 428 | 9152 | 83883 | 109 |
| 75-79 y | 428 | 11305 | 74094 | 153 |
| 80-84 y | 428 | 13760 | 65412 | 210 |
| 85+ y | 428 | 23152 | 76924 | 301 |
| **Total** | 4280 | 120815 | 722464 | 167 |
| **Level 2: Municipalities (N=428)** | | | | |
| **Travel time to hospital (min)** | | | | |
| 0-19 min | 1110 | 79791 | 465819 | 171 |
| 20-60 min | 1790 | 28718 | 177513 | 162 |
| 60+ min | 1380 | 12306 | 79132 | 156 |
| **Long Term Care (LTC)** | | | | |
| 1. Lowest 25% | 1070 | 66071 | 390986 | 169 |
| 2 | 1070 | 31030 | 189507 | 164 |
| 3 | 1080 | 14952 | 88427 | 169 |
| 4. Highest 25% | 1060 | 8762 | 53544 | 164 |
| **General Practitioner rate (GP)** | | | | |
| 1. Lowest 25% | 1060 | 14030 | 86837 | 162 |
| 2 | 1070 | 35013 | 212891 | 164 |
| 3 | 1060 | 48917 | 283533 | 173 |
| 4. Highest 25% | 1090 | 22855 | 139203 | 164 |
| **Educational level** | | | | |
| 1. Highest 25% | 1080 | 58768 | 344522 | 171 |
| 2 | 1060 | 26333 | 159290 | 165 |
| 3 | 1070 | 22984 | 141321 | 163 |
| 4. Lowest 25% | 1070 | 12730 | 77331 | 165 |
| **Mortality** | | | | |
| 1. Lowest 25% | 1040 | 20997 | 129722 | 162 |
| 2 | 1080 | 34623 | 209723 | 165 |
| 3 | 1080 | 33255 | 203236 | 164 |
| 4. Highest 25% | 1080 | 31940 | 179783 | 178 |
| **Recipients of disability benefits** | | | | |
| 1. Lowest 25% | 1110 | 47976 | 280541 | 171 |
| 2 | 1070 | 27367 | 164646 | 166 |
| 3 | 1040 | 28525 | 175244 | 163 |
| 4. Highest 25% | 1060 | 16947 | 102033 | 166 |
| **Municip w/hospital** | | | | |
| No | 3780 | 61973 | 387324 | 160 |
| Yes | 500 | 58842 | 335140 | 176 |
| **Level 3: Hospital regions** | | | | |

**(N=52)**