Does migration widen mortality inequalities between rural and urban areas? Long-term mortality risk among rural stayers, rural migrants, urban migrants, and returners in Norway

Abstract

In many countries, the main internal migration trend has been from rural to urban areas. However, there is little knowledge of whether internal migration from rural to urban areas contributes to widening geographical inequalities in health and survival. In the present study we investigated differences in long-term mortality risk among stayers (individuals who did not move from their rural municipality), rural migrants (individuals who moved to other rural municipalities), urban migrants (individuals who moved to urban municipalities), and returners (individuals who first moved to urban municipalities and then returned to rural municipalities).

Data from a population-based survey carried out among adults in Finnmark aged 30-62 years in 1987/88 was linked to the National Population Register and the Norwegian Cause of Death Registry to identify migration and deaths from recruitment to the health survey up to December 2017. Flexible parametric survival models were used to examine the age-varying associations between different migration careers and mortality.

For both men and women, the estimated mortality risk was lower for all internal migrant groups when compared to stayers. However, for men, the findings only applied to ages under 85 years for rural migrants, 81 years for urban migrants, and 71 years for returners, while for women, the findings applied to ages under 75 years for rural migrants, 78 years for urban migrants, and the age range 46-86 years for returners. The lower mortality risk observed among migrants contributes to widening health inequalities between rural depopulation areas and areas with increasing populations. Migrants to rural areas may limit this effect.

Keywords: mortality; internal migration; rural; urban; Norway

Introduction

In Norway, as in many other countries, the predominant internal migration trend has been from rural areas to urban centres. This has led to reductions in rural populations and rising urban populations (Leknes & Løkken, 2020; NOU 2020: 15). This trend influences the demographic structure, and population ageing, which is also a prevailing trend, occurs more rapidly in rural areas. When it comes to health, geographical disparities in morbidity rates and life expectancy between areas are well-documented (Clarsen et al., 2022; Norman et al., 2005; Skaftun et al., 2018), and studies have suggested that selective migration may contribute to these differences (Boyle, 2004; Connolly et al., 2007; Holmager et al., 2022; Norman et al., 2005). However, the long-term health outcomes of rural to urban migration and whether this contributes to enlarging urban-rural health and/or survival inequalities are not well understood (Lu, 2008; Rye, 2006; Vaalavuo & Sihvola, 2021; Wallace & Kulu, 2014).

In migration research, the 'healthy migrant hypothesis' is frequently discussed (Aldridge et al., 2018; Lu, 2008). When it comes to internal migration, this hypothesis posits that migration is challenging, and therefore migration usually attracts the most ambitious and competent persons and those with the best health, and these are people who also are prone to gain advantages from the migration (Lu, 2008). Another well-known hypothesis in migration research is the 'salmon bias' hypothesis, which suggests that individuals tend to return to their place of origin when their health deteriorates (Dunlavy et al., 2022). Returners thus generally tend to be in poorer health than other migrant groups. While the healthy migrant hypothesis has been bolstered in several studies, and in particular studies on international immigrants, fewer studies have supported the salmon bias hypothesis (Aldridge et al., 2018; Yi et al., 2019), and little research has been done on the salmon bias hypothesis in a within-country context (Lu & Qin, 2014). In addition, the salmon bias hypothesis, with its origin in research on immigration between countries, suggests that the decision to return when health deteriorates is influenced by cultural and family ties (Wallace & Kulu, 2014), but it is unclear to what degree these mechanisms apply to within-country migration.

Few studies have had specific focus on rural-urban within-country migration and health or mortality (Vaalavuo & Sihvola, 2021). According to a study from Finland, a larger proportion of rural migrants and a lower proportion of urban migrants used outpatient and inpatient healthcare services, compared to stayers (Vaalavuo & Sihvola, 2021). Further, a study from Denmark emphasised that migration may contribute to differences in mortality between rural and urban regions (Holmager et al., 2022). However, in this study, it was concluded that in-migration of working-age people on public benefits was the main contributor to the excess mortality in the investigated rural area, while the data could not be used to conclude concerning mortality risk among out-migrants (Holmager et al., 2022). Furthermore, in a study from Sweden, they did not find any association between mortality and migration from a rural community, but this study did not differentiate between rural and urban migrants (Tinghog et al., 2011).

In the present study, we used data from a population residing in the county of Finnmark on study recruitment to investigate differences in long-term mortality among ‘stayers' (individuals who did not move from their rural municipality), ‘rural migrants’ (individuals who moved to other rural municipalities), ‘urban migrants’ (individuals who moved to urban municipalities), and ‘returners’ (individuals who first moved to urban municipalities and then returned to rural municipalities). Studies based on the same health survey or a combination of the health survey and Norwegian Cause of Death Registry have previously been published, and showed urban-rural differences in educational attainment at baseline, and educational inequalities in self-rated health and long-term mortality (Fylkesnes & Førde, 1992; Fylkesnes et al., 2021). In the present study our hypotheses are that migrants, and in particular urban migrants, have a lower mortality risk than stayers, and that returners have a higher mortality risk than the other migration groups. Through our investigation of differences in long-term mortality among stayers and different migration groups, we aim to illuminate whether migration contributes to differences in mortality between rural and urban areas.

Materials and methods

We used data from the third Finnmark County Health Survey, which was conducted from March 1987 to June 1988 (Bjartveit et al., 1979; Westlund & Søgaard, 1993). Data from the health survey, which was carried out by the National Health Screening Programme, was linked to data from the Norwegian Cause of Death Registry and the National Population Register to identify deaths and migration in the period from enrolment to 1 December 2017.

All residents of Finnmark county aged 40-62 and a 20% representative sample of residents aged 30-39 were invited to participate in the health survey, which consisted of a physical examination and three self-administered questionnaires. These questionnaires were available in Sámi and Norwegian languages and included questions on health conditions, physical activity, sociodemographic factors, and diet. Among those invited, 88% of the women and 81% of the men attended the physical examination, and all those who attended the physical examination also answered the first questionnaire. This questionnaire was sent out together with the letter of invitation to the physical examination. For those who had not completed the questionnaire prior to the examination, it was filled out during the examination (Fylkesnes & Førde, 1992; Westlund & Søgaard, 1993). The second questionnaire was issued at the physical examination, to be returned by ordinary post, while the third questionnaire was sent to all invitees 3 weeks after the physical examination; and 73% and 79% of those who had responded to the first questionnaire also responded to questionnaires 2 and 3, respectively (Westlund & Søgaard, 1993).

The sample originally consisted of 17,554 participants. However, for individuals who emigrated from Norway to other countries, the National Population Register does not include information about the degree of rurality of the emigrants' places of residence in other countries. In addition, it cannot be excluded that some deaths in other countries are not reported to the Norwegian Cause of Death Registry. Therefore, persons who had moved abroad (290), were excluded from the analyses. In addition, we excluded 11 persons who were not registered with Finnmark as their first county of residence at baseline in 1986/1987. The study sample thus consisted of 17,253 persons, 8,473 women, 8,760 men, and 20 with missing values for sex.

Statistical analyses

In the raw data, centrality was registered in line with the Standard Classification of Centrality 1994 and 2008 (Statistics Norway, 2024). The municipalities were thus classified as either centrality 3 (urban municipalities), 2 (quite central municipalities), 1 (less central municipalities) or 0 (least central municipalities). Category 3, urban municipalities, usually have a population of at least 50,000 and function as regional centres (Statistics Norway, 2024). In the present study, we coded municipalities at levels 0, 1 and 2 as 'rural' and municipalities at level 3 as 'urban' municipalities. Finnmark is a rural county, and the municipalities in this county are classified at either level 0, 1 or 2, which means that none of the study participants lived in a municipality classified as urban at baseline.

Furthermore, the possible migration careers were divided into four categories: stayers (individuals who did not move from their rural municipality between study baseline and the end of the study), rural migrants (individuals who moved to other rural municipalities), urban migrants (individuals who moved to urban municipalities) and returners (individuals who first moved to urban municipalities and then returned to rural municipalities). For those who moved two or more times, their last location determined whether they were categorised as urban migrants or returners.

The covariates included were marital status (married, unmarried); education level (years of completed schooling: 0-7 (low), 8-10 (medium), ⩾11 (high); self-rated health (excellent, good (ref.), fair, poor); smoking (current ⩾median number of daily cigarettes, current <median number of daily cigarettes, former ⩾median number of daily cigarettes, former <median number of daily cigarettes, never (ref.)); and alcohol consumption. Alcohol consumption was based on the question 'In the last year, how often have you drunk the equivalent of at least 5 half-bottles of beer, one bottle of wine, or ¼ bottle of liquor?' Possible answers were '3 or more times a week', '1-2 times a week', '1-3 times a month', 'a few times', and 'never' (ref.). The covariates physical activity, body mass index, place of residence at baseline (coast, fjord, inland, town (ref.)) and labour market status were associated with a less than 10% change in the regression coefficients and were not included in the final models. All covariates were derived from the survey and were baseline data. For the 448 participants who did who not attend the physical examination but contributed data by filling in one or more questionnaires, no baseline date was registered. For these participants, we imputed a median baseline date of 1 November 1987.

Data was analysed using Stata version 17. Distribution of participants by migration career and mean age by migration career were described, as well as migration career by sex, marital status, education level and self-rated health. Probabilities of migrating by self-rated health adjusted for age was calculated using the Stata module Adjprop (Garrett, 1998). Crude and age-adjusted mortality rates by migration career were computed together with standardized mortality ratios based on Darlington-Pollock and Norman's counterfactual approach of 'putting people back" into their area of origin (Darlington-Pollock & Norman, 2022). We applied the age-specific rates of the entire study population as the reference, given that all participants originally resided in rural areas. The standardized mortality ratios are reported as percentages.

Initially, Cox proportional hazard regression models were applied. (Hazard ratios for the included covariates in these models are presented in Appendix 1.) Since the present study is an observational study with age as a strong determinant of mortality risk, attained age was used as the timescale (Kleinbaum & Klein, 2005; Thiébaut & Bénichou, 2004). Potential interactions between migration and education level, smoking and alcohol consumption, marital status and health, and education level and health, were tested by including product terms. The proportional hazards assumption was assessed graphically and tested with Schoenfeld residuals, which indicated that the assumption was violated for migration career for men. Thus, we fitted flexible parametric survival models using restricted cubic splines to estimate sex-specific age-varying hazard ratios of mortality by migration category (Dickman, 2021; Royston & Lambert, 2011). Bayesian and Akaike's information criterion were used to choose the number of spline variables providing the best fit. For both men and women, we modelled three cubic splines for the age-varying effect of migration category, and one for the cumulative baseline hazard function. Thus, the cumulative baseline hazard is modelled as linear on the log scale, which is reflected in the monotonically increasing hazard ratios, corresponding to a Weibull model. After running the spline model, we created a temporary time variable and saved the corresponding predicted hazard ratios for each migration category, and these variables were used to create line plots (Figures 1 and 2) (Dickman, 2021). We made line plots both based on age-adjusted models and multivariable-adjusted models. The latter was included to determine whether the observed associations were partly explained by health-related factors at baseline. Hazard ratios for an age in the lower age range (50) and an age in the upper age range (80) was presented. The hazard ratios presented were interpreted as estimates of mortality risks. Since there were missing values, in particular for questions from questionnaires 2 and 3 (education level, self-rated health and alcohol consumption), multiple imputation was performed, using the chained equations procedure in Stata. Twenty datasets were created, and the imputation procedure included all variables in the analysis model, as well as variables perceived as predictive of missing values (height, weight and place of residence).

We conducted six sensitivity analyses: Since deaths early in the follow-up period reduced the time available to undertake migration processes and had the potential to reduce the probability of migration, we compared the estimated mortality hazard ratios with models with a 10-year delayed baseline. We also compared our results with models where municipalities at both centrality levels 2 and 3 were coded as 'urban'. In addition, since Finnmark has a considerable Sami population, we compared our results with models where those who had ticked off for having Sami family were excluded. These comparisons were made with complete case data. We also compared the line plots based on imputed data with line plots based on complete-case data. In addition, we compared the characteristics of participants with complete data for the variables included in the flexible parametric survival model to those with missing data for these variables. Furthermore, we compared the estimated mortality hazard of participants with complete data for all the variables included in the flexible parametric survival model with those with data on migration, sex, age, marital status, and smoking, to investigate the possibility of distortion of associations due to missing data.

Results

During the 30 years of follow-up from baseline to December 2017, 18.5% of the participants had migrated to another municipality, and 10.0% of the participants were categorised as rural migrants, 6.0% as urban migrants and 2.5% as returners. The mean age at baseline for the sample was 48.0 years, and all migrant groups had a lower mean age at baseline than stayers. Mean ages for the different groups were as follows: rural migrants 45.5 years, urban migrants 45.5 years, returners 43.0 years, and stayers 48.7 years.

A higher proportion of women than men were urban migrants and returners (Table 1). Regarding educational attainment, 24.6% of the stayers had a high level of education, compared to 37.0% of the rural migrants, 50.2% of the urban migrants, and 45.8% of the returners. Further, Table 1 indicates that a larger proportion of the stayers reported poor or fair health, compared to the migrants. However, since stayers had a higher mean age than migrants, we adjusted for age, and this analysis showed small differences in probability of migrating for the different categories of self-rated health, except for men who reported poor health (Table 2). The probability of migrating was 0.09 for men with poor health and varied from 0.16 to 0.17 for the other health categories, while the probability of migrating varied from 0.17 to 0.19 for all health categories for women.

Table 1 Migration career by sex, marital status, education level, and self-rated health at baseline 1987/1988

	Stayers (N=14,056)	**Rural migrants (N=1,734)**	**Urban migrants (N=1,033)**	**Returners (N=430)**

Sex				
Women	6.819 (48.6)	854 (49.3)	574 (55.7)	226 (52.6)
Men	7.219 (51.4)	880 (50.7)	457 (44.3)	204 (47.4)
Marital status				
Married	10.376 (73.8)	1.124 (65.0)	752 (72.9)	272 (63.3)
Unmarried	3.680 (26.2)	606 (35.0)	280 (27.1)	158 (36.7)
Education level				
Low (0-7 years)	3.612 (38.2)	302 (26.5)	132 (18.8)	42 (15.3)
Medium (8-10 years)	3.514 (37.2)	416 (36.5)	217 (31.0)	107 (38.9)
High (11+ years)	2.328 (24.6)	421 (37.0)	352 (50.2)	126 (45.8)
Self-rated health				
Poor	416 (4.2)	31 (2.6)	12 (1.7)	9 (3.1)
Fair	2.346 (23.4)	249 (21.3)	142 (19.8)	58 (20.3)
Good	5.623 (56.1)	687 (58.7)	424 (59.0)	159 (55.6)
Excellent	1.631 (16.3)	204 (17.4)	140 (19.5)	60 (21.0)

Table 2. Estimated probabilities of migrating by health, adjusted for age, with 95% confidence intervals (CI)

	Men		**Women**	
Self-rated health	**Probabilities**	**95% CI**	**Probabilities**	**95% CI**
Poor	0.09	0.06-0.14	0.17	0.12-0.22
Fair	0.16	0.14-0.18	0.19	0.17-0.21

Good	0.17	0.15-0.18	0.18	0.17-0.19
Excellent	0.17	0.15-0.19	0.17	0.15-0.19

A total of 443,214 person-years were observed, and the mean observation time was 25.7 years. At the end of the study, 6,819 persons out of the sample consisting of 17.253 persons had died, and this constituted 39.5% of the entire sample; 45.8% of the men and 32.9% of the women. The crude all-cause mortality rate was 15.4 per 1,000 person-years; 18.6 for men and 12.3 for women. The age-adjusted mortality rate for men was 20.9 for stayers, 18.3 for rural migrants, 16.8 for urban migrants and 17.8 for returners, while the age-adjusted mortality rate for women was 15.0 for stayers, 14.6 for rural migrants, 12.3 for urban migrants and 8.6 for returners (Table 3).

Table 3. Crude and age-adjusted mortality rates by migration career

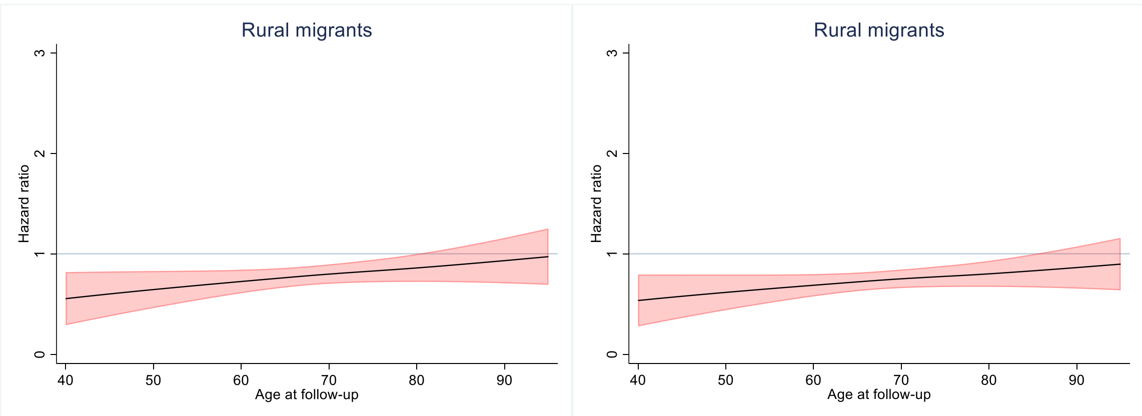
	Men		**Women**	
	Crude, %	**Age-adjusted, %**	**Crude, %**	**Age-adjusted, %**
Stayers	48.9	20.9 [20.4-21.4]	35.3	15.0 [14.6-15.5]
Rural migrants	33.4	18.3 [16.9-19.7]	26.0	14.6 [13.3-15.9]
Urban migrants	31.3	16.8 [14.9-18.7]	21.6	12.3 [10.6-13.9]
Returners	23.0	17.8 [15.0-20.6]	15.5	8.6 [6.3-11.0]

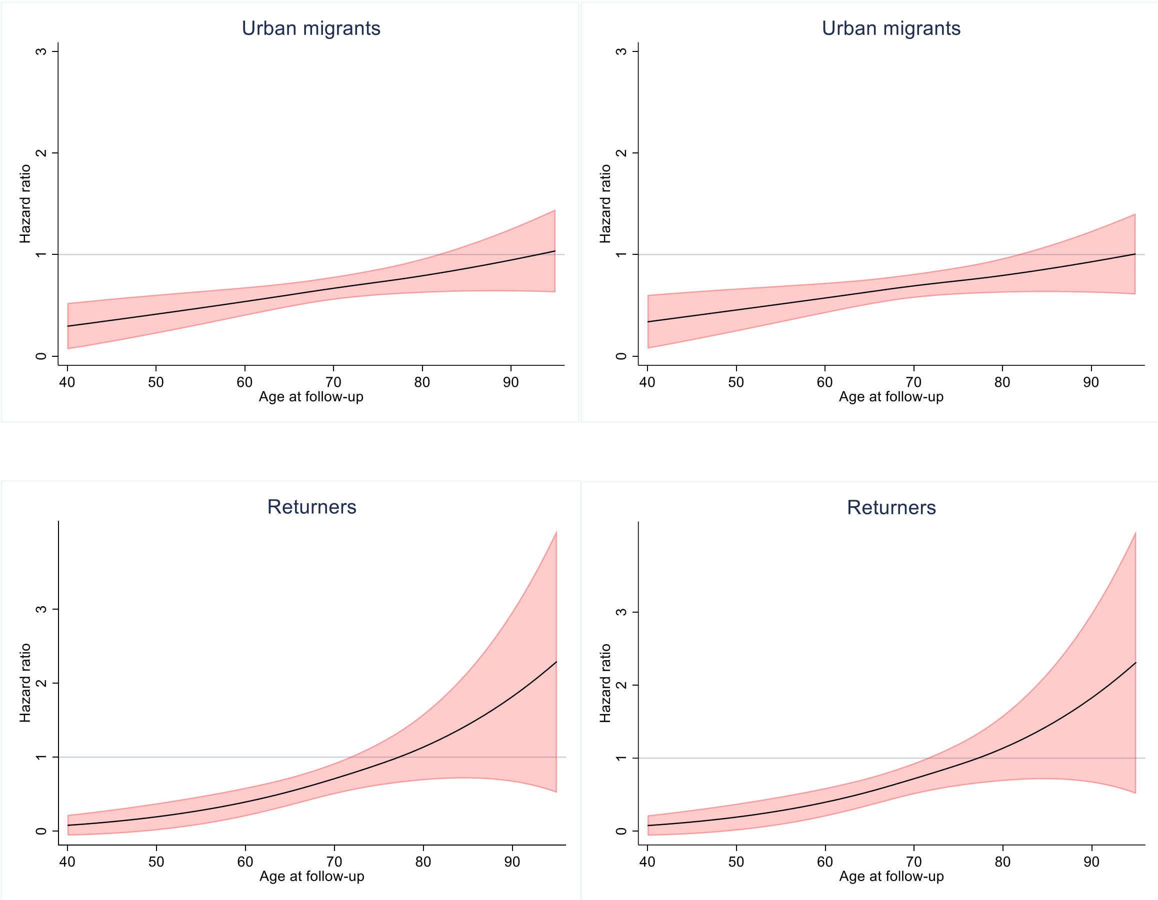
Standardised mortality ratios for men were 105.4 (95% CI 102.0-108.9) for stayers, 78.2 (95% CI 69.8-87.7) for rural migrants, 65.7 (95% CI 55.2-78.2) for urban migrants and 66.6 (95% CI 52.1-85.1) for returners, and the standardised mortality ratios for women were 103.7

(95% CI 99.6-107.9) for stayers, 90.7 (95% CI 79.5-103.5) for rural migrants, 75.4 (95% CI 62.8-90.5) for urban migrants and 64.0 (95% CI 47.5-86.3) for returners.

For men, the line plots showed that the estimated mortality risk was lower for rural migrants, urban migrants and returners compared with stayers (Figure 1). However, findings only applied to age below 85 years for rural migrants, 81 years for urban migrants and 71 years for returners. Adjustment for marital status, education level, self-rated health, smoking, and alcohol consumption resulted in marginal changes to estimates and confidence intervals. For the model which included covariates, hazard ratios for men aged 50 were 0.62 (95% CI 0.44-0.79) for rural migrants, 0.46 (95% CI 0.25-0.67) for urban migrants, and 0.19 (95% CI 0.01-0.38) for returners. The estimated hazard ratio increased with age, and hazard ratios for men aged 80 were 0.80 (95% CI 0.67-0.93) for rural migrants, 0.80 (95% CI 0.62-0.96) for urban migrants and 1.14 (95% CI 0.68-1.56) for returners.

Figure 1 Mortality hazard ratios by migrant career expressed as age-varying hazard ratios and 95% confidence intervals (reference: stayers). Men. (Left: included variables: age and migration career. Right: adjusted for marital status, education level, self-rated health, smoking and alcohol consumption.) Imputed data.

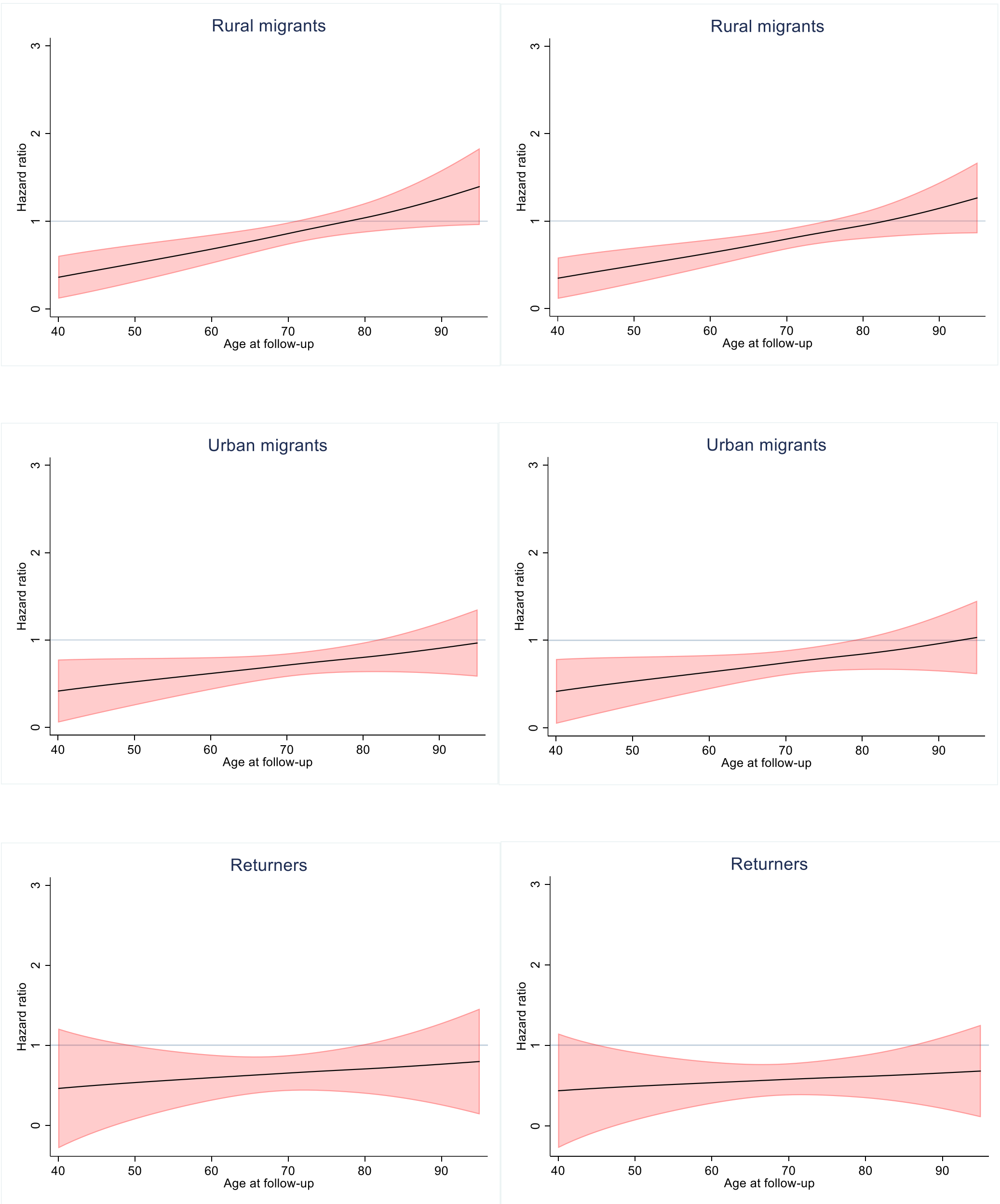




For women, the estimated mortality risk was lower for rural migrants, urban migrants and returners when compared with stayers (Figure 2). However, these findings only applied to age groups below 75 years for rural migrants and 78 years for urban migrants, and the age span of 46-86 years for returners (in models with covariates included). Adjustment for marital status, education level, self-rated health, smoking, and alcohol consumption resulted in small changes to hazard ratio estimates and confidence intervals.

For the model which included covariates, hazard ratios for women aged 50 years were 0.49 (95% CI 0.29-0.70) for rural migrants, 0.53 (95% CI 0.25-0.81) for urban migrants, and 0.49 (95% CI 0.07-0.91) for returners. The estimated hazard ratio increased with age, and hazard ratios for women aged 80 were 0.94 (95% CI 0.79-1.10) for rural migrants, 0.83 (95% CI 0.60-1.02) for urban migrants and 0.61 (95% CI 0.35-0.88) for returners.

Figure 2 Mortality hazard ratios by migration career expressed as age-varying hazard ratios and 95% confidence intervals (reference: stayers). Women. (Left: included variables: age and migration. Right: adjusted for marital status, education level, self-rated health, smoking, and alcohol consumption.) Imputed data.



Comparisons of estimated mortality hazard ratios with models with 10 years' delayed baseline, with models where municipalities at both centrality levels 2 and 3 were coded as 'urban', and with models where participants of Sami family were excluded, rendered small differences. Sensitivity analyses showed that those with complete data for the flexible parametric survival model where covariates were included differed from those without complete data. Fewer women than men, fewer in the oldest age groups, fewer never-smokers, fewer participants with low education level, and fewer participants with poor or fair self-rated health had complete data. However, the investigation of potential distortion of mortality risk estimates showed small differences. The comparison of line plots based on imputed data and complete case data rendered small differences. However, generally the complete case data figures had broader confidence intervals, reflecting the increase in statistical power provided by the multiple imputation of missing data.

Discussion

In the present study we aimed to investigate differences in long-term mortality risk among rural stayers, rural migrants, urban migrants, and returners. We found that for men and women, the estimated mortality risk was lower for all migrant groups when compared to stayers. However, the findings did not apply to the oldest age groups. There were small differences between the migration groups, and male returners in young age groups had the lowest estimated mortality risk. Adjustment for sociodemographic and lifestyle factors resulted in small changes in hazard ratios and confidence intervals. Our hypothesis that migrants have a lower mortality risk than stayers was confirmed, while the hypotheses that urban migrants had a lower mortality risk, and returners a higher mortality risk than other migration groups, were not confirmed. The present study also showed that migrants were younger than stayers, which is in line with other studies and reports (Hjort & Malmberg, 2006; Høydahl, 2024; Sørlie et al., 2012). In addition, persons with high education level were more prone to migrate, in particularly to urban areas, and this is in line with findings in a report concerning migration from Finnmark and adjacent rural municipalities in the neighbouring county of Troms (Høydahl, 2024).

The finding that internal migrants had a lower mortality risk than stayers is in line with the healthy migrant hypothesis, which suggests that healthy persons are more prone to migrate, and that healthy persons may be more likely to attain positive results or resources when they migrate (Lu, 2008). These are resources which may be used to promote health and reduce mortality risk. We do not know to what degree the first-mentioned mechanism (pre-migration health status) and last-mentioned mechanism (post-migration attainment) apply to our sample. However, the present study showed that men with poor self-rated health at baseline had a lower probability of migrating than men who reported fair, good or excellent health, indicating that the first-mentioned mechanism applies to men. Furthermore, a study by Rye et al. (2006) on migration within Norway concluded that people who migrate gain higher incomes than stayers, suggesting that the second mechanism may also apply. Our findings of a lower mortality risk among migrants are in accordance with two studies from China on within-country migration and a study on migration between England and Scotland, which all suggested that migrants were healthier than non-migrants (Lu & Qin, 2014; Wallace & Kulu, 2014; Yi et al., 2019). Also, a study from the Netherlands to investigate the relation between self-rated health and migration showed that migrants were healthier than non-migrants, although the health differences were not statistically significant after adjusting for demographic and socioeconomic factors (Dijkstra et al., 2015). In contrast, studies from Sweden did not find that within-country migrants had a lower mortality risk than stayers (Andersson & Drefahl, 2017; Tinghog et al., 2011). One of these studies had a relatively small sample size (Tinghog et al., 2011), while the other compared the mortality of migrants from

Northern to Southern Sweden with those who remained in either Northern or Southern Sweden (Andersson & Drefahl, 2017). Thus, the study did not investigate migrants within Northern or Southern Sweden, respectively.

The present study showed no substantial differences between urban migrants and other migration groups. These findings differ from the findings in a study from Finland by Vaalavuo et al. (2021) that described how a smaller proportion of urban migrants and a larger proportion of rural migrants used healthcare services when compared to stayers. However, the percentage differences in healthcare use between the groups were small, and when controlled for other variables, the effect sizes were small for both rural and urban migrants (Vaalavuo & Sihvola, 2021). As in many other countries, most rural areas in Norway experience depopulation (NOU 2020: 15), and a reduced mortality risk among migrants generally may thus contribute to a widening of geographical inequalities between rural depopulation areas and urban areas. On the other hand, internal migration to rural areas may limit this effect, regardless of whether the migrant comes from an urban or a rural municipality. Furthermore, the county of Finnmark has experienced depopulation over time (NOU 2023: 9). Using Darlington-Pollock and Norman's counterfactual approach, the high standard mortality ratio of stayers observed in this study suggests that areas with considerable depopulation have higher mortality than if no one had migrated. In addition, standard mortality ratio was low for urban migrants. This indicates that migration may have contributed to health inequalities between this rural county and urban areas experiencing population growth.

We found no support for the salmon bias hypothesis. This contrasts with findings in a study from Sweden which found elevated mortality of return migrants from Southern to Northern Sweden (Andersson & Drefahl, 2017). Andersson and Drefahl (2017) suggested that this return was related to a poor life situation in general. One possible explanation for the differences in findings may be related to the fact that Andersson and Drefahl (2017) had a regional approach in their study while the present study has a rural-urban approach. Our findings are however in line with Wallace et al. (2014), who investigated the association between health (through the variable ‘limiting long-term illness’) and migration between Scotland and England, and suggested that the lack of salmon bias effect they found might be due to the fact that England and Scotland operate under the same healthcare system, and that the cultural significance of dying at home is questionable. Wallace et al. (2014) also suggested that work was an important reason for both migration and remigration between Scotland and England, and studies have emphasised that work migrants generally represent a healthier proportion of the population than stayers (Lu, 2008; Wallace & Kulu, 2014). Sørlie et al. (2012) have explored migration motives in Norway, and they conclude that work, housing, location and family are the four main reasons for migrating, and that work is a particularly important reason for migration in areas with few work options. In our study area, Finmark county, there are relatively few work options compared to other Norwegian counties. In addition, the fisheries and fishing industry, which have represented the key work opportunity for a significant share of the population, have been highly vulnerable to fluctuations in both natural resources and national policies; and during our 30 years of study observation the population experienced several periods of high unemployment (Fylkesnes et al., 2021). This gives reason to believe that a considerable proportion of migrants from Finmark have been work migrants. Assuming that work migrants are particularly healthy, this may contribute to explaining the finding that migrants had a lower mortality risk than stayers. Sørlie et al. (2012) also emphasised that men more often than women state work as the reason for migrating. Thus, again assuming that work migrants are particularly healthy, this may explain the low mortality risk among male returners, that is men who had migrated more than once.

The present study showed age-varying mortality risk, and the lower mortality risk found in younger migrant groups compared to stayers did not apply to the oldest groups. Our finding concerning the oldest age group may be related to the fact that this group includes participants who migrated in older age, and studies indicate that migrants in older age are not necessarily healthier than stayers (Norman et al., 2005; Vaalavuo & Sihvola, 2021). In addition, the findings may be related to fact that older persons are more susceptible to disease and that mortality is high in older age groups. Consequently, large mortality differentials between groups, when measured in relative terms, are rarer at high ages (Guillot et al., 2018).

Strengths and limitations

All inhabitants of Finnmark aged 40-62, and a 20% representative sample of inhabitants in the 30-39 age group, were invited to participate in the baseline study. Strengths of the study are the high participation rate and the fact that all participants completed questionnaire 1. On the other hand, only 73% and 79% of participants completed questionnaires 2 and 3, respectively, and this can be seen as a weakness of the study. However, multiple imputation was conducted, using the chained equations procedure. In addition, our analyses to compare associations among participants with complete data in the flexible parametric survival model with those with data on migration, sex, age, marital status and smoking showed small differences. This is in accordance with former studies based on the same baseline data and data from the Norwegian Cause of Death Registry. These studies described that distortions were not of sufficient magnitude to substantially bias estimates (Fylkesnes & Førde, 1992; Fylkesnes et al., 2021; Jakobsen & Braaten, 2023).

In the present study, we used 30 years of follow-up mortality data, and there are very few previous studies of rural to urban migration long-term outcomes (Rye, 2006). Furthermore, a possible strength of the study is the examination of age-varying associations between migration and mortality risk. Few studies have investigated the age-varying associations between migration and mortality, and an analysis with standard time-constant estimates could have led to an overestimation of mortality risk in younger ages among migrants. In the present study, our sample comprised adults residing the rural county of Finnmark in 1987/1988. However, already some years before the baseline survey, Finnmark had experienced a crisis in Fisheries which led to workforce reductions and migration, which indicates a somewhat selective baseline population. Further, in the present study, we did not have access to urban to rural migrants (individuals who moved from urban to rural municipalities). Including such a group could have provided valuable insight into whether urban to rural migration reduces health inequalities between rural depopulation areas and other areas.

The salmon bias hypothesis generally suggests that individuals tend to return to their place of origin when their health deteriorates (Dunlavy et al., 2022). However, in the present paper, 'returners' were those who returned from urban areas to rural areas. Furthermore, one limitation of the study is that we only followed the participants for a portion of their lifespan. Consequently, some of the individuals who were categorised as 'stayers' may have migrated before baseline. Information about migration before baseline would thus have been of value. However, since the National Population Register had relatively low quality before 1987, we did not include data on migration before baseline. Additionally, older participants may have had more time to migrate before baseline than younger ones. One cannot rule out that this may have influenced the findings, in particularly for the oldest age groups. Assuming that migrants have a lower mortality risk than stayers, this may have led to an underestimation of the difference in mortality risk between stayers and migrants. Conversely, deaths early in the follow-up period may reduce the time available for migration, potentially leading to an overestimation of the mortality risk differences between stayers and migrants. However, our comparisons of estimated mortality hazard ratios with models with a 10-year delayed baseline rendered small differences.

Conclusions

The present study showed that within-country migrants have a lower mortality risk than stayers, a finding not applicable to the oldest age groups. Since many rural areas are depopulation areas, the lower mortality risk observed among migrants may contribute to widening urban-rural health inequalities. However, migrants to rural areas may limit this effect to some extent.

References

Aldridge, R. W., Nellums, L. B., Bartlett, S., Barr, A. L., Patel, P., Burns, R., . . . Abubakar, I. (2018). Global patterns of mortality in international migrants: a systematic review and meta-analysis. *Lancet, 392*(10164), 2553-2566. doi:10.1016/s0140-6736(18)32781-8

Andersson, G., & Drefahl, S. (2017). Long-Distance Migration and Mortality in Sweden: Testing the Salmon Bias and Healthy Migrant Hypotheses. *Population, Space and Place, 23*(4), e2032. doi:https://doi.org/10.1002/psp.2032

Bjartveit, K., Foss, P. O., Gjervig, T., & Lund-Larsen, P. (1979). The Cardiocascular Disease Study in Norwegian Counties. *Acta Medica Scandinavia*.

Boyle, P. (2004). Population geography: migration and inequalities in mortality and morbidity. *Progress in Human Geography, 28*(6), 767-776. doi:10.1191/0309132504ph518pr

Clarsen, B., Nylenna, M., Klitkou, S. T., Vollset, S. E., Baravelli, C. M., Bølling, A. K., . . . Knudsen, A. K. S. (2022). Changes in life expectancy and disease burden in Norway, 1990-2019: an analysis of the Global Burden of Disease Study 2019. *Lancet Public Health, 7*(7), e593-e605. doi:10.1016/s2468-2667(22)00092-5

Connolly, S., O'Reilly, D., & Rosato, M. (2007). Increasing inequalities in health: Is it an artefact caused by the selective movement of people? *Social Science & Medicine 64*(10), 2008-2015. doi:10.1016/j.socscimed.2007.02.021

Darlington-Pollock, F., & Norman, P. (2022). Establishing a framework of analysis for selective sorting and changing health gradients. *Population, Space and Place, 28*(3), e2359. doi:https://doi.org/10.1002/psp.2359

Dickman, P. (2021). *Graphing the HR as a function of time*. http://pauldickman.com/software/stata/sex-differences-cox/#graphing-the-hr-as-a-function-of-time

Dijkstra, A., Kibele, E. U., Verweij, A., van der Lucht, F., & Janssen, F. (2015). Can selective migration explain why health is worse in regions with population decline?: A study on migration and self-rated health in the Netherlands. *European journal of public health, 25*(6), 944-950. doi:10.1093/eurpub/ckv192

Dunlavy, A., Cederström, A., Katikireddi, S. V., Rostila, M., & Juárez, S. P. (2022). Investigating the salmon bias effect among international immigrants in Sweden: a register-based open cohort study. *European journal of public health, 32*(2), 226-232. doi:10.1093/eurpub/ckab222

Fylkesnes, K., & Førde, O. H. (1992). Determinants and dimensions involved in self-evaluation of health. *Soc Sci Med, 35*(3), 271-279. doi:https://doi.org/10.1016/0277-9536(92)90023-J

Fylkesnes, K., Jakobsen, M. D., & Henriksen, N. O. (2021). The value of general health perception in health equity research: A community-based cohort study of long-term mortality risk (Finnmark cohort study 1987–2017). *SSM - Population Health*, 100848. doi:https://doi.org/10.1016/j.ssmph.2021.100848

Garrett, J. M. (1998). ADJPROP: Stata module to calculate adjusted probabilities from logistic regression estimates. https://EconPapers.repec.org/RePEc:boc:bocode:s344804

Guillot, M., Khlat, M., Elo, I., Solignac, M., & Wallace, M. (2018). Understanding age variations in the migrant mortality advantage: An international comparative perspective. *PLOS ONE, 13*(6), e0199669. doi:10.1371/journal.pone.0199669

Hjort, S., & Malmberg, G. (2006). The attraction of the rural: Characteristics of rural migrants in Sweden. *Scottish Geographical Journal, 122*(1), 55-75. doi:10.1080/00369220600830870

Holmager, T., Lophaven, S., Mortensen, L., & Lynge, E. (2022). Selective migration and mortality by economic status in Lolland-Falster, Denmark, 1992-2018. *Sci Rep, 12*(1), 19970. doi:10.1038/s41598-022-24635-2

Høydahl, E. (2024). *Innenlandske flyttinger. En kohortanalyse av flytting til og fra storbyene, distriktskommunene og Tiltakssonen for Nord-Troms og Finnmark [Internal Migration. A Cohort Analysis of Migration to and from the Large Cities, District Municipalities, and The*

Action zone for North Troms and Finnmark]. https://www.ssb.no/befolkning/flytting/artikler/innenlandske-flyttinger/_/attachment/inline/9fda8ae4-5144-4bf0-a2d0-700e3704c969:aec6f44d38c4203ff7f249d29baa509e159c4901/RAPP2024-08.pdf

Jakobsen, M. D., & Braaten, T. (2023). Labour market status and mortality risk: the Finnmark cohort study 1987–2017. *SCANDINAVIAN JOURNAL OF PUBLIC HEALTH*, 14034948231174668. doi:10.1177/14034948231174668

Kleinbaum, D. G., & Klein, M. (2005). *Survival Analysis : A Self-Learning Text* (2nd ed.). New York. Springer.

Leknes, S., & Løkken, S. A. (2020). *Befolkningsframskrivinger for kommunene, 2020-2050 [Population projections for the municipalities, 2020-2050]*. Statistics Norway: https://www.ssb.no/befolkning/artikler-og-publikasjoner/_attachment/429172?_ts=173fc97ddf0

Lu, Y. (2008). Test of the 'healthy migrant hypothesis': A longitudinal analysis of health selectivity of internal migration in Indonesia. *Social Science & Medicine, 67*(8), 1331-1339. doi:https://doi.org/10.1016/j.socscimed.2008.06.017

Lu, Y., & Qin, L. (2014). Healthy migrant and salmon bias hypotheses: a study of health and internal migration in China. *Soc Sci Med, 102*, 41-48. doi:10.1016/j.socscimed.2013.11.040

Norman, P., Boyle, P., & Rees, P. (2005). Selective migration, health and deprivation: a longitudinal analysis. *Social Science & Medicine, 60*(12), 2755-2771. doi:https://doi.org/10.1016/j.socscimed.2004.11.008

NOU 2020: 15. *Det handler om Norge. Bærekraft i hele landet. Utredning om konsekvenser av demografiutfordringer i distriktene. Kommunal- og moderniseringsdepartementet*. https://www.regjeringen.no/contentassets/3b37c1baa63a46989cb558a65fccf7a1/no/pdfs/nou202020200015000dddpdfs.pdf

NOU 2023: 9. *Generalistkommunesystemet: Likt ansvar – ulike forutsetninger. Kommunal- og distriktsdepartementet. https://www.regjeringen.no/no/dokumenter/nou-2023-9/id2968517/*.

Royston, P., & Lambert, P. (2011). *Flexible Parametric Survival Analysis Using Stata: Beyond the Cox Model*. Stata Press.

Rye, J. F. (2006). Leaving the Countryside: An Analysis of Rural-to-Urban Migration and Long-Term Capital Accumulation. *ACTA SOCIOLOGICA, 49*(1), 47-65. Retrieved from http://www.jstor.org/stable/20459907

Skaftun, E. K., Verguet, S., Norheim, O. F., & Johansson, K. A. (2018). Geographic health inequalities in Norway: a Gini analysis of cross-county differences in mortality from 1980 to 2014. *INTERNATIONAL JOURNAL FOR EQUITY IN HEALTH, 17*(1), 64. doi:10.1186/s12939-018-0771-7

Statistics Norway. (2024). Classification of centrality. https://www.ssb.no/klass/klassifikasjoner/128/versjon/469/versjoner

Sørlie, K., Aure, M., & Langset, B. (2012). *Hvorfor flytte? Hvorfor bli boende? Bo- og flyttemotiver de første årene på 2000-tallet* https://oda.oslomet.no/oda-xmlui/bitstream/handle/20.500.12199/5515/2012-22.pdf?sequence=1&isAllowed=y

Thiébaut, A. C., & Bénichou, J. (2004). Choice of time-scale in Cox's model analysis of epidemiologic cohort data: a simulation study. *Stat Med, 23*(24), 3803-3820. doi:10.1002/sim.2098

Tinghog, P., Carstensen, J., Kaati, G., Edvinsson, S., Sjostrom, M., & Bygren, L. O. (2011). Migration and mortality trajectories: A study of individuals born in the rural community of Overkalix, Sweden. *Social Science & Medicine, 73*(5), 744-751. doi:10.1016/j.socscimed.2011.06.055

Vaalavuo, M., & Sihvola, M. W. (2021). Are the Sick Left Behind at the Peripheries? Health Selection in Migration to Growing Urban Centres in Finland. *European Journal of Population-Revue Europeenne De Demographie, 37*(2), 341-366. doi:10.1007/s10680-020-09568-8

Wallace, M., & Kulu, H. (2014). Migration and Health in England and Scotland: a Study of Migrant Selectivity and Salmon Bias. *Population, Space and Place, 20*(8), 694-708. doi:https://doi.org/10.1002/psp.1804

Westlund, K., & Søgaard, A. J. (1993). *Helse, livstil og levekår i Finnmark. Resultater fra Hjerte-karundersøkelsen i 1987-88. Finnmark III*. https://munin.uit.no/handle/10037/6419

Yi, Y., Liao, Y., Zheng, L., Li, M., Gu, J., Hao, C., & Hao, Y. (2019). Health Selectivity and Rural-Urban Migration in China: A Nationwide Multiple Cross-Sectional Study in 2012, 2014, 2016. *International journal of environmental research and public health, 16*(9). doi:10.3390/ijerph16091596