Tropical Medicine and International Health doi:10.1111/tmi.12615

VOLUME 20 NO 12 PP 1805–1814 DECEMBER 2015

Multimorbidity among registered immigrants in Norway: the role of reason for migration and length of stay

Esperanza Diaz[1,2], Bernadette N. Kumar[2,3], Luis-Andrés Gimeno-Feliu[4,5,6], Amaia Calderón-Larrañaga[4,7], Beatriz Poblador-Pou[4,7] and Alexandra Prados-Torres[4,5,7]

1 *Department of Global Public Health and Primary Care, University of Bergen, Bergen, Norway*
2 *Norwegian Centre for Minority Health Research, Oslo, Norway*
3 *Institute for Health and Society, University of Oslo, Oslo, Norway*
4 *EpiChron Research Group on Chronic Diseases, Aragón Health Sciences Institute (IACS), IIS Aragón, Miguel Servet University Hospital, Zaragoza, Spain*
5 *University of Zaragoza, Zaragoza, Spain*
6 *San Pablo Health Centre, Zaragoza, Spain*
7 *Red de Investigación en Servicios de Salud en Enfermedades Crónicas, Carlos III Health Institute, Madrid, Spain*

Abstract

OBJECTIVES International migration is rapidly increasing worldwide. However, the health status of migrants differs across groups. Information regarding health at arrival and subsequent periodic follow-up in the host country is necessary to develop equitable health care to immigrants. The objective of this study was to determine the impact of the length of stay in Norway and other sociodemographic variables on the prevalence of multimorbidity across immigrant groups (refugees, labour immigrants, family reunification immigrants and education immigrants).

METHODS This is a register-based study merging data from the National Population Register and the Norwegian Health Economics Administration database. Sociodemographic variables and multimorbidity across the immigrant groups were compared using Persons' chi-square test and ANOVA as appropriate. Several binary logistic regression models were conducted.

RESULTS Multimorbidity was significantly lower among labour immigrants (OR (95% CI) 0.23 (0.21–0.26) and 0.45 (0.40–0.50) for men and women, respectively) and education immigrants (OR (95% CI) 0.40 (0.32–0.50) and 0.38 (0.33–0.43)) and higher among refugees (OR (95% CI) 1.67 (1.57–1.78) and 1.83 (1.75–1.92)), compared to family reunification immigrants. For all groups, multimorbidity doubled after a five-year stay in Norway. Effect modifications between multimorbidity and sociodemographic characteristics across the different reasons for migration were observed.

CONCLUSIONS Multimorbidity was highest among refugees at arrival but increased rapidly among labour immigrants, especially females. Health providers need to ensure tailor-made preventive and management strategies that take into account pre-migration and post-migration experiences for immigrants in order to address their needs.

keywords emigrants and immigrants, multimorbidity, population register, chronic disease, primary health care, immigrant status

Introduction

In a globalised world, migration is unavoidable. People move to a new country to attain better education and work, to join their families or to escape from torture or tragedies [1]. We are unfortunately witnessing that the number of persons losing their lives while trying to cross the Mediterranean is steadily increasing. Even the risk of death is not a deterrent for migrants in hope of a better life [2, 3]. In countries with a relatively short immigration history like Norway, the numbers of immigrants have been rapidly increasing regardless of the reason for migration since the beginning of the 21st century [4]. More than 54 000 immigrants moved to Norway in 2014 [4], and immigrants made up 15% of the population in 2015 [5].

The impact of immigration on health begins in the migrant's country of origin, continues through the

migration journey and lasts the whole post-migration period in the host country [6, 7]. However, immigrants are heterogeneous, and the influence of each of these periods probably varies for the types of immigrants and the diseases [8]. To study the impact of migration on health, a general measure of health status including diseases impacted by migration and transition, such as diabetes, cardiovascular disease or mental health, is recommended [9]. Multimorbidity, the simultaneous occurrence of more than one chronic disease [10], is an increasingly used general measure of overall health status. The novelty of this approach relies on understanding the coexistence of multiple diseases as a consequence of environmental, social and personal risks contributing to increased vulnerability to various illnesses [10, 11]. Multimorbidity addresses the importance of biography, or life lived, on biology and attempts to holistically explain the health status of one person [12]. The presence of multimorbidity is associated, among others, with poor quality of life, low function levels, high levels of polypharmacy and adverse drug events, increased and inappropriate healthcare utilisation and mortality rates over and above the risk attributable to individual diseases [13–17].

To better understand and assess health disparities in immigrant and refugee communities, Edberg *et al.* have recommended a trajectory model, including nine domains [9]. The first domain is the *migration experience*. As compared to other classifications, the migration experience is, following this model and other authors, best accounted for by classifying immigrants according to their reason for migration, also called migrant status [18, 19]. *Social adjustment*, often measured by length of stay in the host country [20–23], is the second domain in the model and contributes to a life course perspective [6]. This perspective is especially relevant to capture the 'health paradox', according to which immigrants are often healthier than the average host populations on arrival to the host country, but lose this health status advantage after a number of years [9]. *Socioeconomic characteristics* and *social support* represent the third and fourth domains of Edberg's model [9]. The last domains are *neighbourhood characteristics, health status, health knowledge* and *practices* and *access to care*. Although all nine domains are mutually dependent, they probably interact differently for the various immigrant populations and differentially affect the health of the immigrants [22]. Adequate documentation of the interaction among domains would provide a solid framework to guide the planning, implementation and evaluation of interventions aimed at reducing health disparities [9]. Following this rationale, the first aim of this study was to explore the association between multimorbidity and reason for migration. We also aimed to compare the impact of length of stay in Norway and other sociodemographic variables on the prevalence of multimorbidity across immigrant groups.

Methods

This register-based study relies on merged data from the National Population Register and the Norwegian Health Economics Administration database (HELFO). The personal identification number assigned to all registered immigrants with legal residence in Norway for at least 6 months was used to link the registries. According to Statistics Norway, immigrants were defined as persons born abroad with both parents from abroad [24].

As a measure of the *migration experience*, the principal explanatory variable in this study was the reason for migration obtained from the National Population Register for each individual. All immigrants older than 14 years registered in Norway in 2008 as refugees, labour immigrants, family reunification immigrants or education immigrants were included in the analyses. Immigrants to Norway to reunite their families were classified as family reunification immigrants disregarding the status of the key person who first migrated to Norway. Reason for migration was first registered in Norway in 1990, and it is still not mandatory for Scandinavians to register a reason for migration when they move to Norway [25]. Thus, among all immigrants (389 807), only immigrants moving to Norway after 1990 and with any of the aforementioned reasons for migration registered were included in the study (251 995). Norwegian-born immigrants with one Norwegian parent, descendants of immigrants and immigrants staying in the country for less than 6 months were excluded from the study.

Also from the National Population Register, information on the explanatory sociodemographic variables gender, age, personal income level, civil status, length of stay in Norway and country of origin was obtained for all study subjects. Age was categorised into three groups: 15–44, 45–64 and 65 + years. Income level, defined as the sum of employee income and net income from self-employment during 2008, was used as a proxy of Edberg's *socioeconomic characteristics* and was categorised in four levels: low (under 50 000 NOK), medium (50 001–200 000 NOK), high (200 001–400 000 NOK) and very high (over 400 000 NOK). Civil status, a proxy for *social support* in this study, was categorised into never married, married and other (divorced, separated, widow, etc.). Length of stay, measuring *social adjustment*, was dichotomised into less than 5 years or longer time. This 5-year period is often used in the literature

[21, 26] and divided the migrants in this study into two approximately equally numerous groups (54.0% of men and 44.4% of women had lived in Norway for less than 5 years). To further differentiate the *migration experience*, the immigrant's country of origin was classified into three broad regions: (i) Western Europe and North America; (ii) Eastern Europe; and (iii) Asia, Africa and Latin America.

The HELFO database contains claims for all patient contacts within the public primary health care services, including general practitioners and emergency room services. Each claim contains at least one medical diagnosis based on the International Classification of Primary Care (ICPC-2) that the physician registers for reimbursement and administrative purposes. These diagnoses were grouped according to the Expanded Diagnostic Clusters (EDC) of the Johns Hopkins University Adjusted Clinical Groups (ACG®) Case-Mix System [14]. The 114 chronic EDCs included in the study were selected based on the list published by Salisbury *et al.* in 2011 [27]. A dichotomous multimorbidity variable was created, defined by at least two different chronic diagnoses registered for an individual in 2008 [28]. This measure of *health status* is the main dependent variable used in this study.

Analyses

Information about the regions of origin defined above together with the major five countries represented in each of the immigrant groups (i.e. refugees, labour, family reunification or education) was presented. Comparisons of sociodemographic variables and multimorbidity across the four immigrant groups were conducted using Persons' chi-square test and ANOVA as appropriate. Several models of binary logistic regression analyses were conducted. Firstly, and according to our first aim, regression analyses with multimorbidity as the dependent variable and reason for migration as the main explanatory variable were conducted for women and men separately. The first model was only adjusted for age; the second model was also adjusted for income level and civil status. In addition, the third model included length of stay in Norway dichotomised into less than 5 years or longer. Secondly, to answer to our second research question, binary logistic regression analyses were conducted for each immigrant group separately with multimorbidity as the dependent variable in order to disentangle possible effect modifications between multimorbidity and length of stay, socioeconomic status and other variables for the different reasons for migration. Analyses were conducted in IBM, SPSS 20.0.

This study is part of the project 'Immigrants' health in Norway', which was approved by the Regional Committee for Medical and Health Research Ethics, the Norwegian Data Inspectorate, the Norwegian Labour Welfare Service and the Norwegian Directorate of Health.

Results

A total of 67 398 refugees, 66 942 labour immigrants, 101 276 family reunification immigrants and 16 379 education immigrants, representing 1.8%, 1.8%, 2.7% and 0.4% of the population, respectively, were included in the study. Table 1 displays the high heterogeneity of geographic origin in all the defined immigrant groups in terms of both world regions and individual countries. Women were overrepresented among family reunification and education immigrants, while the opposite was true for labour immigrants and refugees, who also were the oldest (Table 2). As expected, the highest percentages of

Table 1 Distribution of geographic regions and major contributing countries of origin for 15 years or older immigrants in Norway according to their reason for migration

Reason for migration, *n*	Geographic region of origin, % of reason for migration		Major five countries, % of reason for migration	
Refugees 67 398	Western Europe and North America	0.3	Bosnia	16.3
	Eastern Europe	32.8	Iraq	14.6
	Asia, Africa and Latin America	66.9	Somalia	12.4
			Kosovo	8.3
			Iran	7.7
Labour 66 942	Western Europe and North America	29.9	Poland	42.0
	Eastern Europe	60.9	Germany	13.0
	Asia, Africa and Latin America	9.2	Lithuania	7.4
			Pakistan	6.1
			UK	5.0
Family reunification 101 276	Western Europe and North America	11.1	Thailand	7.9
	Eastern Europe	22.3	Poland	6.6
	Asia, Africa and Latin America	66.6	Iraq	5.8
			Pakistan	5.8
			Russia	5.5
Education 16 379	Western Europe and North America	17.1	Philippines	15.8
	Eastern Europe	29.2	Russia	8.0
	Asia, Africa and Latin America	53.7	China	7.5
			Germany	6.0
			Poland	3.6

Table 2 Comparison of the sociodemographic characteristics of immigrant groups according to their reason for migration

	Family reunification	Labour immigrants	Refugees	Education immigrants	*P*-value*
Number	101 276	66 942	67 398	16 379	
Gender, %					
Women	70.1	20.6	40.5	66.7	0.0001
Age in years					
Mean (SD)	34.1 (11.6)	35.9 (9.2)	36.2 (13.3)	29.3 (6.5)	0.0001
Age, %					
15–44	83.9	81.0	75.8	97.4	0.0001
45–64	14.2	18.8	20.7	2.6	
65+	1.9	0.2	3.4	0.0	
Civil status, %					
Never married	21.2	42.8	36.0	60.6	0.0001
Married	64.4	51.2	50.3	34.3	
Divorced, widows and other	14.4	6.0	13.7	5.1	
Income (in 1000 Norwegian crowns), %					
Very low (<50)	44.4	11.6	44.4	46.0	0.0001
Low (50–200)	20.1	21.3	17.7	20.2	
Medium (200–400)	26.8	44.2	27.6	21.1	
High (> 400)	8.8	22.9	10.2	12.8	
Length of stay in Norway					
Mean (SD)	6.9 (5.3)	2.2 (3.3)	9.0 (5.4)	4.2 (5.5)	0.0001
Multimorbidity, %					
Two or more chronic diseases	6.0	1.6	10.6	1.9	0.0001

*Chi-square test/ANOVA as appropriate.

married immigrants were in the family reunification category, and most education immigrants had never been married. Generally, immigrants had low incomes, with the exception of labour immigrants, although nearly half of this group was in the medium income group. Labour and education immigrants had significantly shorter lengths of stay in Norway than immigrants for family reunification and refugees. Multimorbidity levels were highest for refugees and lowest for labour and education immigrants. Figure 1 illustrates multimorbidity by gender and age, also showing highest multimorbidity burden for refugees followed by immigrants for family reunification for both genders, and increasing multimorbidity levels with age for all groups.

Logistic regression analyses with multimorbidity as the dependent variable and reason for migration as the main explanatory variable are presented in Table 3 for women and men separately. For both genders and in all models, the odds of multimorbidity were significantly lower for labour and education immigrants and higher for refugees than for family reunification immigrants. The association between older age and multimorbidity was more evident for men than for women in the first model. Compared to those earning a very low income, immigrants at higher income levels presented lower odds of multimorbidity, but this association was also more pronounced for men. Immigrants registered as separated, divorced or widowed had significantly higher multimorbidity than those married, while those who had never been married had lower odds of multimorbidity. Long stay in Norway was associated with doubled probability of multimorbidity for both genders.

Table 4 shows the full-adjusted models, including gender, age category, income level, civil status, region of origin and length of stay in Norway for the different reasons for migration separately. The associations between multimorbidity and both female gender and oldest ages were more pronounced for labour immigrants than for other immigrants, but with overlapping confidence intervals with education immigrants. Although higher level of income was associated with lower multimorbidity for refugees and immigrants for family reunification, this was not the case for labour immigrants, and education immigrants showed highest multimorbidity in the medium income group. Once categorised by their reason for migration, the association between multimorbidity and region of origin was of no or little significance for family and education immigrants. Labour immigrants from Eastern Europe had lower odds of multimorbidity than other labour immigrants. However, refugees from Eastern Europe had slightly but significantly higher odds of multimorbidity than refugees from other areas. Lastly,

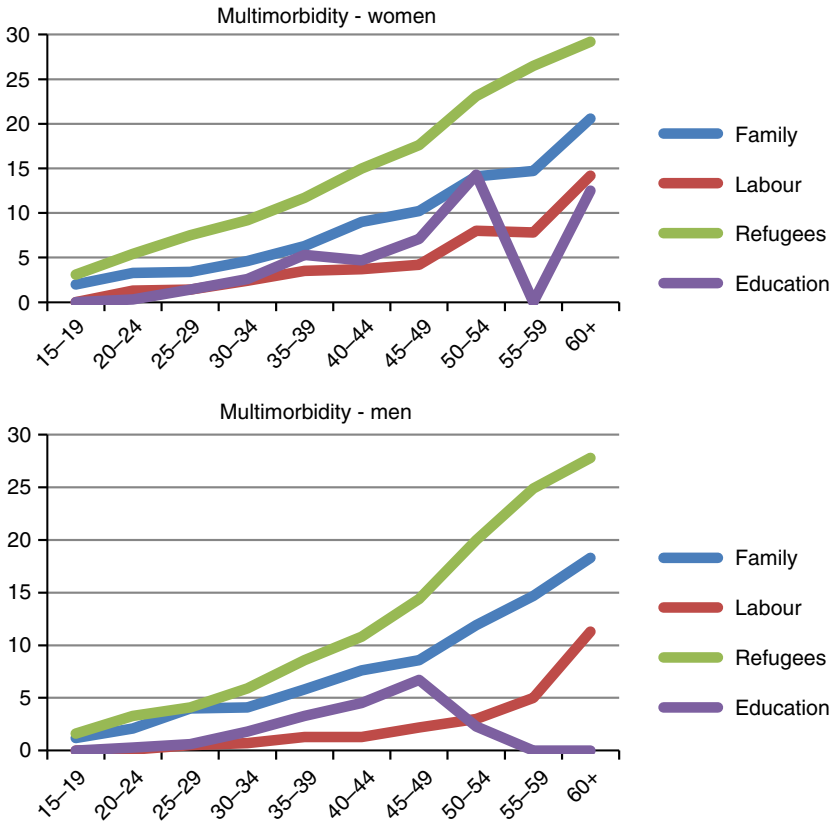

Figure 1 Percentage of multimorbidity for the different immigrant groups according to reason for migration by age and gender.

although longer stay in Norway increased the odds of multimorbidity for all groups, the association between multimorbidity and length of stay was statistically less important for refugees than for other groups.

Discussion

Our study shows clear associations between multimorbidity, reason for migration and length of stay in Norway. Multimorbidity was significantly lower among labour and education immigrants and higher among refugees than family reunification immigrants. For all groups, multimorbidity doubled after 5 years of living in Norway. Effect modifications between multimorbidity and sociodemographic characteristics across immigrant groups were observed.

Our results highlight the importance of including several approaches to categorise immigrants in order to untangle and target health disparities, and we will attempt to discuss some of these. Lower levels of multimorbidity among immigrants living in Norway compared to Norwegian-born have previously been described [29]. For the present study, we classified immigrants by their reason for migration in an attempt to differentiate the *pre-migration and migration experiences* of the immigrants [18, 19]. By additionally classifying immigrants thereafter geographically by region of origin, we aimed to further differentiate the *migration experience*. Surprisingly, after categorising by reasons for migration, the associations between multimorbidity and geographic region were of relatively little importance for family reunification and education immigrants. However, Eastern Europeans had highest odds of multimorbidity as refugees, but lowest as labour immigrants compared to immigrants from other regions. A possible explanation for these findings relates to the hegemony of Poland among labour migrants, as opposed to East European refugees originating from Bosnia and Kosovo. Eastern Europeans, despite being classified in the same broad geographic region, are heterogeneously evident by differential health status, cultural diversity and varying possibilities for medical care in their country of origin.

Social adjustment in this study was measured by length of stay in Norway, a commonly used proxy for acculturation in epidemiological studies [23]. Length of stay in the host country is an important predictor of health-related

Table 3 Association between multimorbidity, reason for migration and other sociodemographic characteristics by gender. Logistic regression analyses (odds ratios and 95% confidence intervals)

	Women			Men		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Reason for migration						
Family	1	1	1	1	1	1
Labour	0.45 (0.40–0.50)	0.57 (0.51–0.64)	0.83 (0.74–0.92)	0.23 (0.21–0.26)	0.28 (0.26–0.31)	0.45 (0.41–0.50)
Refugees	1.83 (1.75–1.92)	1.94 (1.85–2.04)	1.75 (1.66–1.84)	1.67 (1.57–1.78)	1.71 (1.61–1.83)	1.58 (1.48–1.68)
Education	0.38 (0.33–0.43)	0.49 (0.42–0.56)	0.56 (0.49–0.64)	0.40 (0.32–0.50)	0.45 (0.36–0.56)	0.54 (0.44–0.67)
Age						
15–44	1	1	1	1	1	1
45–64	2.8 (2.7–3.0)	2.4 (2.2–2.5)	2.1 (2.0–2.2)	3.4 (3.2–3.6)	2.6 (2.4–2.8)	2.4 (2.2–2.5)
65+	4.8 (4.4–5.3)	3.3 (3.0–3.6)	2.8 (2.5–3.1)	6.6 (5.9–7.5)	3.8 (3.4–4.4)	3.3 (2.9–3.7)
Income						
Very low	–	1	1	–	1	1
Low	–	0.9 (0.8–0.9)	0.8 (0.7–0.9)	–	0.6 (0.6–0.7)	0.6 (0.6–0.7)
Medium	–	1.0 (0.9–1.0)	0.8 (0.8–0.8)	–	0.6 (0.6–0.7)	0.6 (0.5–0.6)
High	–	0.8 (0.7–0.9)	0.6 (0.5–0.7)	–	0.6 (0.5–0.6)	0.5 (0.4–0.5)
Civil status						
Married	–	1	1	–	1	1
Never married	–	0.6 (0.5–0.6)	0.5 (0.5–0.6)	–	0.5 (0.5–0.6)	0.5 (0.5–0.5)
Other	–	1.6 (1.5–1.7)	1.4 (1.4–1.5)	–	1.3 (1.2–1.4)	1.2 (1.1–1.3)
Length of stay in Norway						
Under 5 years	–	–	1	–	–	1
5 or more years	–	–	2.3 (2.2–2.4)	–	–	2.3 (2.1–2.5)
Nagelkerke R square	0.085	0.099	0.115	0.136	0.150	0.162

Model 1: age (categorised).
Model 2: age (categorised), income and civil status.
Model 3: age (categorised), income and civil status and length of stay in Norway.

outcomes [23]. Generally, it is associated with worsening in health for immigrants, who often converge to the health status of the host population [21, 22, 30]. To our knowledge, no study to date has explored the association between length of stay, multimorbidity and its differential effect by reason for migration. Our study confirms the association between length of stay and increased multimorbidity, in particular for labour immigrants in Norway. Despite not being able to infer causality, there is evidence that immigrants are overrepresented among the low-qualified [31] and high-risk occupations [1]. The increase in multimorbidity with length of stay could also be attributed to more appropriate use of health services in the host country over time, reduction in use of health services in the country of origin and reduction in the 'salmon bias' [32], defined as remigration of the immigrants who become sick, as time goes by. In addition, increased burden of disease due to chronic stress [33, 34], discrimination [35] or other factors associated with the post-migration experience might explain our findings.

In our study as with existing literature [29, 36], multimorbidity increased with age and was significantly higher among women in all groups. Therefore, all models were adjusted for age and some analyses conducted separately by gender. Our analyses showed different degrees of association between multimorbidity and reason for migration for men and women, but in the same direction. As expected regarding the *socioeconomic characteristics* [36], immigrants with higher income presented lower odds of multimorbidity. This association was more pronounced for men than for women as immigrant women often depend on the family's income as opposed to personal work income [37]. This information was unfortunately not available in our study. When analysing the data separately by reason for migration, however, higher income levels were not associated with multimorbidity for labour immigrants, a group generally characterised by the 'healthy immigrant effect' [38]. For this group, females showed a significantly higher risk of multimorbidity than both male labour workers and other immigrant women. As such, this group of female working immigrants might be in an especially vulnerable situation and should be further studied and targeted in health interventions. On the other hand, among education

Table 4 Association between multimorbidity and sociodemographic characteristics conducted separately according to reason for migration. Logistic regression. Full model including gender, age, income level, civil status, region of origin and length of stay in Norway (odds ratios and 95% confidence intervals)

	Family reunification	Labour immigrants	Refugees	Education immigrants
Number included	101 269	66 939	67 395	16 379
Gender				
Men	1	1	1	1
Women	1.1 (1.0–1.2)	1.9 (1.6–2.1)	1.2 (1.1–1.2)	1.2 (0.9–1.6)
Age				
15–44	1	1	1	1
45–64	2.1 (2.0–2.3)	2.5 (2.2–2.9)	2.3 (2.1–2.4)	2.1 (1.4–3.2)
65+	3.5 (3.1–3.9)	7.8 (4.9–12.5)	2.5 (2.3–2.9)	6.7 (0.7–60.8)
Income				
Very low	1	1	1	1
Low	0.8 (0.7–0.9)	0.9 (0.7–1.1)	0.7 (0.6–0.7)	1.5 (1.0–2.2)
Medium	0.8 (0.6–0.9)	1.1 (0.9–1.4)	0.6 (0.5–0.6)	2.2 (1.5–3.2)
High	0.6 (0.5–0.6)	0.8 (0.7–1.0)	0.4 (0.4–0.5)	1.3 (0.8–2.0)
Civil status				
Married	1	1	1	1
Never married	0.5 (0.4–0.5)	0.9 (0.8–1.1)	0.5 (0.4–0.5)	0.5 (0.4–0.6)
Other	1.5 (1.4–1.6)	1.4 (1.2–1.7)	1.2 (1.1–1.2)	1.0 (0.7–1.7)
World region of origin				
Eastern Europe	1	1	1	1
Western Europe and North America	1.0 (0.9–1.1)	2.0 (1.7–2.3)	0.4 (0.2–0.8)	1.2 (0.8–1.6)
Asia, Africa and Latin America	1.2 (1.1–1.2)	2.2 (1.8–2.7)	0.9 (0.8–0.9)	1.0 (0.7–1.3)
Length of stay in Norway				
Under 5 years	1	1	1	1
5 or more years	2.4 (2.2–2.5)	3.0 (2.6–3.4)	1.7 (1.6–1.8)	2.7 (2.0–3.7)
Nagelkerke R square	0.080	0.102	0.106	0.094

immigrants, those in the medium income group showed highest multimorbidity. Although we cannot explain this finding, these immigrants moved originally to Norway in order to study and their income level in Norway might only represent a part of their wealth, as those with lowest registered income are probably subject of grants or help from their family at home. However, given that education immigrants are a heterogeneous group and the smallest group in our study, the findings must be interpreted cautiously.

The associations between multimorbidity and *social support*, as measured by civil status, were similar for all immigrants regardless of reason for migration. According to the literature [36], immigrants with little social support (separated, divorced or widows) had significantly higher multimorbidity than those married, while those who had never been married had lower odds of multimorbidity.

Although a vast literature describes high levels of mental [39, 40] and physical disease burden [18, 41, 42] among refugees and asylum seekers, the prevalence of diseases for migrants with other status differs depending on the diseases chosen and the countries studied [42–45]. Following Edberg's trajectory model [9], a general measure of *health status* was used in this study. Multimorbidity includes physical and mental health conditions and allows a holistic approach to diseases. As multimorbidity has also been defined as more than two chronic conditions [46], analyses were conducted for multimorbidity defined as three or more chronic diseases for the full models, showing similar results for both genders and all independent variables (results not shown). To our knowledge, the only published study on multimorbidity among immigrants was conducted in Switzerland among young asylum seekers, showing a relatively higher prevalence of multimorbidity [47], and our study concurs singling out refugees as an especially vulnerable group compared to other immigrants.

This study has several strengths, including the quality and quantity of the sociodemographic information, the inclusion of all registered immigrants as opposed to the self-selection bias that is common when studying this population group and the possibility of linking all diagnoses registered in primary health care for each individual patient.

However, the study has also limitations. Multimorbidity was based on diagnoses assigned in primary care. Our

previous research on primary healthcare utilisation among immigrants showed a general lower use of primary care for most immigrant groups [48]. However, once in contact with primary care, immigrant groups became frequent attenders more often than Norwegians [49]. While we cannot rule out the bias that some immigrants with multimorbidity might not have visited the GP, we have no evidence to suggest that this was differential according to the reason of migration. Another limitation regarding health status measurement is that diagnoses were based on routine data for administrative purposes, as compared to complete electronic medical records, as these are unavailable in Norway for epidemiological studies. Nevertheless, ICPC-2 data from administrative claims are validated for group comparisons [50, 51], which was our aim. To reduce potential misclassification of diagnoses by the physicians, we used the EDCs created by the ACG system [14, 52] and selected the chronic diagnoses included in Salisbury's list [27] in accordance with previous multimorbidity studies [53, 54]. Incomplete registration of diagnoses is another potential limitation, as the physicians may choose only one diagnosis in a given consultation despite the presence of several diseases.

We adapted Edberg's trajectory model [9] in this study using the variables available through register data. Information on neighbourhood, health knowledge and access to health was unfortunately not available. Education level, although available from the register, was missing for half the immigrants selected, and therefore, only income level was used as a proxy for socioeconomic characteristics. However, analyses using education showed similar results (not shown). Generally, the use of other variables to measure each of the other domains could have given different results, although most of the associations we find concur with the previous literature. Lastly, as explained above, despite our efforts to classify immigrants according to several characteristics, heterogeneity of groups is unavoidable in epidemiological studies.

Conclusion

Our findings confirm that the effects of pre-migration and migration on health extend throughout the remaining phases of the migratory process. Multimorbidity was highest among refugees at arrival but rapidly increased with length of stay among labour immigrants, especially females. Refugees and female working immigrants might be in an especially vulnerable situation, and a better understanding of the reasons for this should be further studied. A multipronged approach to categorise immigrants, untangling health disparities, as indicated by interactions between immigrants' sociodemographic characteristics and their health status over time by the reason for migration is required. Health providers need to ensure tailor-made preventive and management strategies that take into account pre-migrations and post-migration experiences for immigrants in order to address migrant needs.

References

1. Oberoi P, Sotomayor J, Pace P, Weekers J, Walilegne YT. *International Migration, Health and Human Rights*. International Organization for Migration: Switzerland, 2013.
2. Akkoc R, Winch J, Squires N. Mediterranean migrant death toll '30 times higher than last year': as it happened, 2015. (Available from: http://www.telegraph.co.uk/news/worldnews/europe/italy/11548995/Mediterranean-migrant-crisis-hits-Italy-as-EU-ministers-meet-live.html.)
3. Migration IOf. IOM Welcomes European Commission Proposals on Migration, 2015. (Available from: http://www.iom.int/news/iom-welcomes-european-commission-proposals-migration.)
4. Statistics Norway S. Innvandrere etter innvandringsgrunn, 1 January 2014 (Immigrants according to reason for migration, January 2014), 2015. (Available from: http://www.ssb.no/innvgrunn/.)
5. Statistics Norway S. Innvandrere og norskfødte med innvandrerforeldre, 1. January 2015 (Immigrants and Norwegian-born with immigrant parents, 1st January 2015), 2015. (Available from: https://ssb.no/befolkning/statistikker/innvbef.)
6. Spallek J, Zeeb H, Razum O. What do we have to know from migrants' past exposures to understand their health status? A life course approach. *Emerg Themes Epidemiol* 2011: **8**: 6.
7. Zimmerman C, Kiss L, Hossain M. Migration and health: a framework for 21st century policy-making. *PLoS Med* 2011: **8**: e1001034.
8. Loue S, Sajatovic M (eds). *Encyclopedia of Immigrant Health*. Springer: USA, 2012.
9. Edberg M, Cleary S, Vyas A. A trajectory model for understanding and assessing health disparities in immigrant/refugee communities. *J Immigr Minor Health* 2011: **13**: 576–584.
10. Starfield B, Kinder K. Multimorbidity and its measurement. *Health Policy* 2011: **103**: 3–8.
11. Prados-Torres A, Calderon-Larranaga A, Hancco-Saavedra J, Poblador-Plou B, van den Akker M. Multimorbidity patterns: a systematic review. *J Clin Epidemiol* 2014: **67**: 254–266.
12. Tomasdottir MO, Getz L, Sigurdsson JA, Petursson H, Kirkengen AL, Krokstad S *et al.* Co- and multi-morbidity patterns in an unselected Norwegian population: cross-sectional analysis based on the HUNT Study and theoretical reflections concerning basic medical models. *Eur J Pers Cent Health* 2013: **2**: 335–345.

13. Kuwornu JP, Lix LM, Shooshtari S. Multimorbidity disease clusters in Aboriginal and non-Aboriginal Caucasian populations in Canada. *Chronic Dis Inj Can* 2014: **34**: 218–225.
14. Huntley AL, Johnson R, Purdy S, Valderas JM, Salisbury C. Measures of multimorbidity and morbidity burden for use in primary care and community settings: a systematic review and guide. *Ann Fam Med* 2012: **10**: 134–141.
15. Calderon-Larranaga A, Poblador-Plou B, Gonzalez-Rubio F, Gimeno-Feliu LA, Abad-Diez JM, Prados-Torres A. Multimorbidity, polypharmacy, referrals, and adverse drug events: are we doing things well? *Br J Gen Pract* 2012: **62**: e821–e826.
16. Wallace E, Salisbury C, Guthrie B, Lewis C, Fahey T, Smith SM. Managing patients with multimorbidity in primary care. *BMJ* 2015: **350**: h176.
17. Quinones AR, Liang J, Bennett JM, Xu X, Ye W. How does the trajectory of multimorbidity vary across Black, White, and Mexican Americans in middle and old age? *J Gerontol B Psychol Sci Soc Sci* 2011: **66**: 739–749.
18. Nørredam M. Migration and health. *Danish Med J* 2015: **62**: B5068.
19. Gushulak BD, MacPherson DW. Health aspects of the pre-departure phase of migration. *PLoS Med* 2011: **8**: e1001035.
20. Urquia ML, O'Campo PJ, Heaman MI. Revisiting the immigrant paradox in reproductive health: the roles of duration of residence and ethnicity. *Soc Sci Med* 2012: **74**: 1610–1621.
21. Nørredam M, Agyemang C, Hoejbjerg Hansen OK, Petersen JH, Byberg S, Krasnik A *et al.* Duration of residence and disease occurrence among refugees and family reunited immigrants: test of the 'healthy migrant effect' hypothesis. *Trop Med Int Health* 2014: **19**: 958–967.
22. Jatrana S, Pasupuleti SS, Richardson K. Nativity, duration of residence and chronic health conditions in Australia: do trends converge towards the native-born population? *Soc Sci Med* 2014: **119**: 53–63.
23. Urquia ML, Gagnon AJ. Glossary: migration and health. *J Epidemiol Community Health* 2011: **65**: 467–472.
24. Daugstad G. Innvandrer og innvandring 2008 (Immigrants and immigration 2008). Sattistisk sentralbyrå: Oslo, 2008.
25. Statistics Norway S. Immigrants by reason for immigration, 2015 [1 Jan 2015].
26. Beiki O, Allebeck P, Nordquist T, Moradi T. Cervical, endometrial and ovarian cancers among immigrantsin Sweden: Importance of age og migration and duration of residence. *Eur J Cancer* 2009: **45**: 107–118.
27. Salisbury C, Johnson L, Purdy S, Valderas JM, Montgomery AA. Epidemiology and impact of multimorbidity in primary care: a retrospective cohort study. *Br J Gen Pract* 2011: DOI: 10.3399/bjgp11X548929.
28. Harrison C, Britt H, Miller G, Henderson J. Examining different measures of multimorbidity, using a large prospective cross-sectional study in Australian general practice. *BMJ Open* 2014: **4**: e004694.
29. Diaz E, Poblador-Pou B, Gimeno-Feliu L-A, Calderón-Larrañaga A, Kumar BN, Prados-Torres A. Differences in multimorbidity patterns in Norway according to immigrant status. A Nationwide Register-based Study. In press.
30. Gimeno-Feliu LA, Calderón-Larrañaga A, Diaz E, Poblador-Plou B, Macipe-Costa R, Prados-Torres A. The healthy migration effect in primary care. *Gac Sanit* 2015: **29**: 15–20.
31. Liebig T. *Jobs for Immigrants. Labour Market Integration in Norway*. Directorate for Employment, Labour and Social Affairs. International Migration Division: Report from the Organisation for Economic Cooperation and Development, 2010.
32. Razum O. Commentary: of salmon and time travellers-musing on the mystery of migrant mortality. *Int J Epidemiol* 2006: **35**: 919–921.
33. Doamekpor LA, Dinwiddie GY. Allostatic load in foreign-born and US-born blacks: evidence from the 2001–2010 National Health and Nutrition Examination Survey. *Am J Public Health* 2015: **105**: 591–597.
34. McEwen BS. Protection and damage from acute and chronic stress: allostasis and allostatic overload and relevance to the pathophysiology of psychiatric disorders. *Ann N Y Acad Sci* 2004: **1032**: 1–7.
35. Integrerings- og mangfoldsdirektoratet IadD. Integreringsbarometeret 2013/2014. Innvandring og integrering - holdninger og erfaringer blant personer med innvandrerbakgrunn (Integration barometer 2013/2014. Imigration and integration - attitides and experiences among immigrants). Oslo, Norway, 2015.
36. Violan C, Foguet-Boreu Q, Flores-Mateo G, Salisbury C, Blom J, Freitag M *et al.* Prevalence, determinants and patterns of multimorbidity in primary care: a systematic review of observational studies. *PLoS ONE* 2014: **9**: e102149.
37. Kitterød RH, Rønsen M. *Housewives in a Dual-Earner Society. Who is a Housewife in Contemporary Norway?* Discussion Papers No. 659, 2011 Statistics Norway, Research Department 2011.
38. Razum O, Zeeb H, Rohrmann S. The 'healthy migrant effect'- not merely a fallacy of inaccurate denominator figures. *Int J Epidemiol* 2000: **29**: 191–192.
39. Rew KT, Clarke SL, Gossa W, Savin D. Immigrant and refugee health: mental health conditions. *FP Essent* 2014: **423**: 19–23.
40. Hollander AC, Bruce D, Burstrom B, Ekblad S. Gender-related mental health differences between refugees and non-refugee immigrants–a cross-sectional register-based study. *BMC Public Health* 2011: **11**: 180.
41. Yun K, Fuentes-Afflick E, Desai MM. Prevalence of chronic disease and insurance coverage among refugees in the United States. *J Immigr Minor Health* 2012: **14**: 933–940.
42. Nørredam M, Olsbjerg M, Petersen JH, Bygbjerg I, Krasnik A. Mortality from infectious diseases among refugees and immigrants compared to native Danes: a historical prospective cohort study. *Trop Med Int Health* 2012: **17**: 223–230.

43. Dassanayake J, Gurrin L, Payne WR, Sundararajan V, Dharmage SC. Cardiovascular disease risk in immigrants: what is the evidence and where are the gaps? *Asia Pac J Public Health* 2011: **23**: 882–895.
44. Hemminki K, Forsti A, Khyatti M, Anwar WA, Mousavi M. Cancer in immigrants as a pointer to the causes of cancer. *Eur J Public Health* 2014: **24** (Suppl. 1): 64–71.
45. Vandenheede H, Deboosere P, Stirbu I, Agyemang CO, Harding S, Juel K *et al.* Migrant mortality from diabetes mellitus across Europe: the importance of socio-economic change. *Eur J Epidemiol* 2012: **27**: 109–117.
46. Fortin M, Stewart M, Poitras ME, Almirall J, Maddocks H. A systematic review of prevalence studies on multimorbidity: toward a more uniform methodology. *Ann Fam Med* 2012: **10**: 142–151.
47. Pfortmueller CA, Stotz M, Lindner G, Muller T, Rodondi N, Exadaktylos AK. Multimorbidity in adult asylum seekers: a first overview. *PLoS ONE* 2013: **8**: e82671.
48. Diaz E, Calderón-Larrañaga A, Prado-Torres A, Poblador-Plou B, Gimeno-Feliu L-A. How do immigrants use primary healthcare services? A register-based study in Norway. *Eur J Public Health* 2015: **25**: 72–78.
49. Diaz E, Gimeno-Feliu LA, Calderón-Larrañaga A, Prados-Torres A. Frequent attenders in general practice and immigrant status in Norway: A nationwide cross-sectional study. *Scand J Prim Health Care* 2014: **32**: 232–240.
50. Information CfH. *International Classification of Primary Care Second Edition (ICPC-2): Literature Review*. Research and Development Division, 2006.
51. Frese T, Herrmann K, Bungert-Kahl P, Sandholzer H. Inter-rater reliability of the ICPC-2 in a German general practice setting. *Swiss Med Wkly* 2012: **142**: w13621.
52. Carlsson L, Borjesson U, Edgren L. Patient based 'burden-of-illness' in Swedish primary health care. Applying the Johns Hopkins ACG case-mix system in a retrospective study of electronic patient records. *Int J Health Plann Manage* 2002: **17**: 269–282.
53. Prados-Torres A, Poblador-Plou B, Calderon-Larrañaga A, Gimeno-Feliu LA, Gonzalez-Rubio F, Poncel-falco A, *et al.* Multimorbidity patterns in primary care: interactions among chronic diseases using factor analysis. *PLoS ONE* 2012: **7**: e32190.
54. Poblador-Plou B, van den Akker M, Vos R, Calderon-Larranaga A, Metsemakers J, Prados-Torres A. Similar multimorbidity patterns in primary care patients from two European regions: results of a factor analysis. *PLoS ONE* 2014: **9**: e100375.

Corresponding Author **Esperanza Diaz**, Department of Global Public Health and Primary Care, University of Bergen, Norway. E-mail: esperanza.diaz@uib.no