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Avoidable hospitalisation for diabetes mellitus among immigrants and natives: Results from the Italian Network for Longitudinal Metropolitan Studies

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Abstract *Background and aims:* Italy has experienced a relevant increase in migration inflow over the last 20 years. Although the Italian Health Service is widely accessible, immigrants can face many barriers that limit their use of health services. Diabetes mellitus (DM) has a different prevalence across ethnic groups, but studies focusing on DM care among immigrants in Europe are scarce. This study aimed to compare the rates of avoidable hospitalisation (AH) between native and immigrant adults in Italy.

Methods and results: A multi-centre open cohort study including all 18- to 64-year-old residents in Turin, Venice, Reggio-Emilia, Modena, Bologna and Rome between 01/01/2001 and 31/12/2013 −14 was conducted. Italian citizens were compared with immigrants from high migratory pressure countries who were further divided by their area of origin. We calculated age-, sex- and calendar year-adjusted rate ratios (RRs) and 95% confidence intervals (95% CIs) of AH for DM by citizenship using negative binomial regression models. The RRs were summarized using a random effects meta-analysis. The results showed higher AH rates among immigrant males (RR: 1.63, 95% CI: 1.16–2.23), whereas no significant difference was found for females (RR: 1.14, 95% CI: 0.65–1.99). Immigrants from Asia and Africa showed a higher risk than Italians, whereas those from Central-Eastern Europe and Central-Southern America did not show any increased risk.

Conclusion: Adult male immigrants were at higher risk of experiencing AH for DM than Italians, with differences by area of origin, suggesting that they may experience lower access to and lower quality of primary care for DM. These services should be improved to reduce disparities.

Acronyms: ACSC, Ambulatory Care Sensitive Conditions; AH, Avoidable Hospitalisation; AHRQ, Agency for Healthcare Research and Quality; CE, Central-Eastern (Europe); CHR, Crude Hospitalisation Rate; CI, Confidence Interval; CS, Central-Southern (America); DM, Diabetes Mellitus; EU, European Union; HbA1c, Glycosylated haemoglobin; HMPC, High Migratory Pressure Countries; IN-LiMeS, Italian Network of Longitudinal Metropolitan Studies; IPD, Individual Participant Data; ISTAT, National Institute of Statistics; LMPC, Low Migratory Pressure Countries; PHC, Primary Health Care; PY, Person-year; RR, Rate Ratios; SHR, Standardised Hospitalisation Rate; US, United States.

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Introduction

The unprecedented flow of immigrants towards Europe in the last few decades has turned most European countries into multi-ethnic societies. In 2018, 4.4% of the total population of the European Union (EU) was citizens of countries outside the EU [1]. Italy, like other South European countries, has experienced a relevant increase in this phenomenon in the last 20 years, with the percentage of the immigrant population increasing from 1.7% of the resident population in 1998 [2] to 8.5% in 2018 [3]. Once in the host country, immigrants are vulnerable to a number of threats to their physical and mental health, and their health needs may be poorly met. Moreover, the accessibility of health services for immigrants is often undermined by cultural and language barriers, creating new challenges for health systems [4].

Diabetes mellitus (DM) has been widely shown to be differently distributed among ethnic groups in Europe, with prevalence, incidence and mortality rates for such conditions being generally higher among immigrants than those among natives [5]. Furthermore, the age at onset of DM is lower, and chronic complications are more common amongst immigrant populations [5]. In Italy, recent large population-based studies confirmed these figures [6–8] and reported a 55% higher risk of developing DM in immigrants than in natives [8]. Diabetes-related hospitalisations have also been reported to vary among different ethnic groups [9–14]. Many studies, mainly from the US, have shown higher rates of hospitalisation for DM among ethnic minorities compared with their white counterparts [9–11], whereas in the European setting, the evidence is still scarce, and the results are mixed [12–14]. Differences in hospitalisation between immigrants and natives can be partially explained by different accessibility to primary health care (PHC) for the management of DM. A recent review focusing on hospitalisation rates among people with DM highlighted that patients with access to a regular source of primary care and those with well-controlled glycosylated haemoglobin (HbA1c) levels were less likely to be admitted to the hospital [15].

An effective indicator for evaluating the accessibility and overall effectiveness of PHC is the hospitalisation for Ambulatory Care Sensitive Conditions (ACSCs), hereafter called avoidable hospitalisation (AH) [16–18]. ACSCs are defined as conditions for which the provision of timely and effective outpatient care can help to reduce the risks of hospitalisation by preventing the onset of an illness or condition, controlling an acute episodic illness or condition or managing a chronic disease or condition [19]. AH rates have been extensively used to compare the accessibility and quality of PHC among different socioeconomic groups, including different ethnic groups, or between immigrants and natives. Among chronic conditions, almost all definitions of ACSCs for the adult population include admissions for complications of DM [19–23], usually consisting of short- and long-term complications, uncontrolled DM and lower-extremity amputations due to DM. A recent review on overall AH among immigrants and ethnic minority groups [24] found that all of the studies that analysed the AH for DM, disaggregated from other diseases, in different ethnic groups were conducted in the United States (US). All of these studies reported higher rates of AH for DM in African Americans and Hispanics compared with Caucasians [10,11,25–30]. Mixed findings were reported for those of Asian ethnicity. To the best of our knowledge, no studies have been published in Europe, and none have considered "immigrant status" as an exposure variable.

Aim of the study

The aim of this study was to compare AH rates for diabetes mellitus among Italian and immigrant adults from different geographic macro-areas of origin using open metropolitan-based cohorts of six Italian cities participating in the Italian Network of Longitudinal Metropolitan Studies (IN-LiMeS) and pooling them together through an individual participant data meta-analysis.

Methods

Study population

Six of the nine metropolitan cohorts of the IN-LiMeS network, a multi-centre and multi-purpose pool of population cohorts [31], were included in this study: Turin, Venice, Reggio-Emilia, Modena, Bologna and Rome. Subjects between 18 and 64 years of age who resided in one of the six cities for at least one day between January 1, 2001 and December 31, 2013 were enrolled (except Venice, whose enrolment and follow-up periods were extended through 2014). All included cohorts had an open cohort design. In each cohort, data from municipal population registries were linked through a specific set of keys to the archive of the 2001 population census from the National Institute of Statistics (ISTAT) and to the mortality registers and hospital discharge archives. Each of the studies included in the IN-LiMeS network was part of the Italian National Statistical Program for at least the years 2017–2019 and received a positive review by the Italian Data Protection Authority. The patients' data were completely anonymised and managed in aggregate form before the analysis.

Avoidable hospitalisation for diabetes mellitus

The AH for DM during inpatient care episodes occurring within or outside of the area of residence between January 1, 2001, and December 31, 2013 (or 2014 for the Venetian cohort) were considered. The source of data was the Hospital Discharge Records database collected in the Hospital Information System of the region where each city is located. Only ordinary admissions for acute care were selected (day hospitals, rehabilitation and long-term care were excluded); moreover, we excluded all admissions related to childbearing as well as transfers from another hospital.

Conditions related to DM that were considered avoidable through good outpatient care were those defined by the Agency for Healthcare Research and Quality (AHRQ) [23]: DM short-term complications (250.1–250.3 ICD9 CM, principal diagnosis), DM long-term complications (250.4–250.9, principal diagnosis), uncontrolled DM (250.02, 250.03, principal diagnosis) and lower-extremity amputation among patients with DM (841.0–841.9 principal or secondary diagnoses AND a DM code in principal or secondary diagnoses).

Definition of immigrant status

The exposure variable was the immigrant status defined by citizenship as a proxy; citizenship data were retrieved from the municipal population registry. The only exception was in the Roman cohort; because information about citizenship was not available before 2007, for all subjects who left the cohort before this year the country of birth was used as a proxy of immigrant status.

Subjects were grouped into three categories according to their citizenship: 1) Italians; 2) immigrants coming from low migratory pressure countries (LMPC): Western Europe, North America, Oceania, Israel and Japan; and 3) immigrants coming from high migratory pressure countries (HMPC): Central-Eastern (CE) Europe, Central and Southern (CS) America, North Africa, Sub-Saharan Africa and Asia (except for Israel and Japan) [32]. Stateless people and those with missing data were included in the "immigrants from HMPC" group. The analyses focused on the comparison between Italians and immigrants from HMPCs because the latter represented the majority of vulnerable immigrants and because the percentage of migrants from LMPCs was very low (it ranged from 0.4% in Reggio-Emilia to 1.8% in Rome).

Statistical analyses

Analyses were first conducted in each of the six cohorts separately. Person-years at risk were calculated with the total follow-up time being the sum of each subject's residence periods (one or more) in the corresponding city at the ages of 18–64 years during the follow-up period.

Direct age-standardised rates were calculated, overall and stratified by sex, using the 2011 Italian census population as the standard population. Negative binomial regression models, suitable in the presence of overdispersion, were used to estimate the hospitalisation rate ratios (RRs) and their 95% confidence intervals (95% CIs) for AH for DM among immigrants from HMPCs (overall and by geographical macro-area) compared with Italian citizens. The RRs were adjusted for age, calendar year (treated as time-dependent covariates) and sex, which was also a stratification variable. Finally, to provide a global measure of effect, RRs for all immigrants from HMPC, stratified by geographical macro-areas, were analysed through a random effects individual participant data (IPD) meta-analysis [33] to estimate the meta-analysis hospitalisation RR and 95% CI. To assess whether the observed differences in the effect measures of each cohort were due to chance, the Cochrane heterogeneity test was performed, and to quantify such heterogeneity, the I^2 statistic was calculated [34].

Results

Description of the study population

Overall, 4 595 984 subjects aged between 18 and 64 years were enrolled in the study, for a total of 38 510,750 person-years. The cohort of Rome was the largest (58.2% of the whole study population), followed by Turin (19.6%), Bologna (8.8%), Venice (5.7%), Modena (4.1%) and Reggio-Emilia (3.6%). The overall percentage of immigrants from HMPC was 18.5%, ranging from 14.7% in Rome to 22.2% in Reggio-Emilia. Most immigrants came from Central-Eastern Europe (7.7%), followed by Asia (6%) and Central-Southern America (2.9%); however, the percentages were heterogeneously distributed among the cohorts (Table 1). In particular, the proportion of immigrants from Africa (North + Sub-Saharan Africa) was higher in Reggio-Emilia and Bologna (35%, 38%) and lower in Venice and Rome (8%, 16%), with a similar pattern observed in males and females. Of interest, in Venice, Bologna and Rome, the proportion of immigrants from Asia was above 30%, with a higher proportion among males (41%, 43% and 36%) than among females (24%, 26% and 26%, respectively) (Table 1).

Description of hospitalisation and hospitalisation rates

During the follow-up period, 12 678 AHs for DM were recorded in the study population: 11 738 among Italians (92.6%) and 940 (7.4%) among immigrants from HMPCs. The age-standardised rates (per 1000 PYs) ranged from 0.17 in Turin to 0.48 in Venice among Italians and from 0.15 (Turin) to 0.63 (Bologna) among immigrants. The rates

Table 1 Study population by immigrant status, cohort and gender.

Immigrant status		Turin[a]			Venice[b]			Reggio Emilia			Modena			Bologna			Rome[c]		
		Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total	Males	Females	Total
Italy	*n*	346 760	339 740	686 500	110 533	108 582	219 115	65 997	63 647	129 644	76 910	74 975	151 885	168 093	167 663	335 756	1 101 201	1 130 723	2 231 924
	column %	81.85	80.82	81.33	84.02	82.02	83.02	77.51	77.24	77.38	80.87	80.42	80.65	83.83	82.69	83.25	83.68	83.25	83.46
LMPC	*n*	5581	6819	12 400	907	1680	2587	266	468	734	668	743	1411	1753	2359	4112	21 612	27 672	49 284
	column %	1.32	1.62	1.47	0.69	1.27	0.98	0.31	0.57	0.44	0.7	0.8	0.75	0.87	1.16	1.02	1.64	2.04	1.84
HMPC	*n*	71 336	73 830	145 166	20 120	22 123	42 243	18 885	18 285	37 170	17 521	17 506	35 027	30 669	32 750	63 419	193 099	199 886	392 985
	column %	16.84	17.56	17.20	15.29	16.71	16	22.18	22.19	22.18	18.42	18.78	18.60	15.3	16.15	15.73	14.67	14.72	14.70
Central-Eastern Europe	*n*	32 947	38 899	71 846	8660	13 955	22 615	5155	7977	13 132	5412	9149	14 561	9107	17 651	26 758	60 863	89 413	150 276
	column %	46.19	52.69	49.49	43.04	63.08	53.54	27.30	43.63	35.33	30.89	52.26	41.57	29.69	53.90	42.19	31.52	44.73	38.24
North Africa	*n*	17 675	10 694	28 369	1196	545	1741	5128	2450	7578	4543	2131	6674	4860	2322	7182	17 064	6938	24 002
	column %	24.78	14.48	19.54	5.94	2.46	4.12	27.15	13.40	20.39	25.93	12.17	19.05	15.85	7.09	11.32	8.84	3.47	6.11
Sub-Saharan Africa	*n*	5334	5038	10 372	1216	609	1825	3143	2170	5313	3948	2544	6492	2246	2075	4321	22 435	15 264	37 699
	column %	7.48	6.82	7.14	6.04	2.75	4.32	16.64	11.87	14.29	22.53	14.53	18.53	7.32	6.34	6.81	11.62	7.64	9.59
Central-Southern America	*n*	8709	13 014	21 723	774	1646	2420	534	1085	1619	536	1061	1597	1279	2217	3496	22 911	36 700	59 611
	column %	12.21	17.63	14.96	3.85	7.44	5.73	2.83	5.93	4.36	3.06	6.06	4.56	4.17	6.77	5.51	11.86	18.36	15.17
Asia	*n*	6646	6149	12 795	8259	5357	13 616	4919	4592	9511	3081	2621	5702	13 159	8476	21 635	69 826	51 571	121 397
	column %	9.31	8.33	8.81	41.05	24.21	32.23	26.05	25.11	25.59	17.58	14.97	16.28	42.90	25.88	34.11	36.16	25.80	30.89
Stateless and missing	*n*	25	36	61	15	11	26	6	11	17	1	0	1	18	9	27	0	0	0
	column %	0.04	0.05	0.04	0.07	0.05	0.06	0.03	0.06	0.00	0.01	0.00	0.00	0.06	0.03	0.04	0.00	0.00	0.00
Total		**423 677**	**420 389**	**844 066**	**131 560**	**132 385**	**263 945**	**85 148**	**82 400**	**167 548**	**95 099**	**93 224**	**188 323**	**200 515**	**202 772**	**403 287**	**1 315 912**	**1 358 281**	**2 674 193**

[a] Turin: entry in the cohort: October 21, 2001.
[b] Venice: end of follow-up: December 12, 2014.
[c] Rome: Birthplace for individuals residing in Roma until 2007.

were higher among males than females in all cohorts irrespective of immigrant status (Table 2).

Rate ratios and meta-analysis results

Overall, the risk of AH in immigrants compared with Italians approached statistical significance (RR 1.46, 95% CI: 0.99–2.14) (Fig. 1C). The cohort-specific results are presented in Supplementary Table 1. The meta-analysis results showed higher AH rates among immigrant males than among Italians (RR 1.62, 95% CI: 1.16–2.28) (Fig. 1A). This pattern was common to all cohorts except for Rome (RR: 0.97 95% CI: 0.86–1.09). Among women, there were no significant differences overall (RR: 1.14, 95% CI: 0.65–1.99). However, the analysis by cohort highlighted a heterogeneous situation, with increased rates for immigrant females in Bologna (RR: 1.89, 95% CI: 1.45–2.47), Reggio-Emilia (RR: 2.04, 95% CI: 1.33–3.12) and Modena (RR: 2.92, 95% CI: 1.97–4.32) and a lower risk in Venice (RR: 0.26, 95% CI: 0.11–0.58) and Rome (RR: 0.77, 95% CI: 0.66–0.91) (Fig. 1B). The I^2 statistic showed a high level of heterogeneity across cohorts for both males and females (91.6% and 94%, respectively) (Fig. 1A and B).

The analyses disaggregated by geographical macro-areas showed that immigrants from CE Europe as well as those from CS America did not have a significantly different risk of AH compared with Italians. On the other hand, for immigrants from Asia, Sub-Saharan Africa and North Africa, increases of AH for DM of 46%, 141% and 159%, respectively, were found (Table 3). Significant heterogeneities were found for all groups, but they were slightly less for immigrants from CE Europe (I^2: 67%; $p = 0.01$) (Table 3).

Discussion

Overall, using a meta-analytic approach, higher AH rates for DM were found among adult immigrants from HMPC than Italians in six metropolitan Italian cohorts between 2001 and 2014. The differences in AH for DM rates, compared with Italians, were higher among men and among immigrants coming from Africa (North and Sub-Saharan) and Asia; however, the results had a high level of heterogeneity. In the cohort-specific results, women from HMPC in Rome and Venice represented an exception, showing lower AH rates compared with their Italian counterparts.

Many reasons can contribute to the increase in the risk of being hospitalised for a DM-related avoidable condition among immigrants. Their newly adopted lifestyles might play a major role [35]. A study that compared Ghanaian immigrants residing in Europe with their compatriots both living in urban and rural contexts showed that the DM prevalence in immigrants was higher than the prevalence among those from rural contexts but similar to the prevalence among those living in an urban environment [36]. This is probably a consequence of the process of urbanisation, where calorie-dense/low-fibre foods are available and abundant, sedentary lifestyles are more frequently adopted [36], and the same processes of urbanisation and/or westernisation are associated with migration, especially among younger immigrants [37]. Genetic factors can also contribute to a greater prevalence of DM in the immigrant population, but the evidence is not conclusive [5]. In this scenario, reduced access to prevention education, early diagnosis, or disease control during the early stages of the diseases—all tasks of the PHC services—might widely contribute to the higher rates of AH for complications of DM. It has already been demonstrated that immigrants are more prone to using emergency services than PHC [38–40], and recent studies conducted in Italy have demonstrated that diabetic immigrants have a lower probability of HbA1C testing, annual renal function tests and lipid profile analyses [7] and a higher risk of having high levels of HbA1C [41] than Italians. Furthermore, among treated diabetic patients, immigrants have lower

Table 2 Discharges, person-years (PYs), crude and age-standardized hospitalization rates by immigrant status, cohort and gender.

Cohort	Immigrant status	Males				Females				Total			
		n	PYs	CHR	SHR	*n*	PYs	CHR	SHR	*n*	PYs	CHR	SHR
Turin[a]	Italy	863	2 988 124	0.29	0.23	437	3 023 196	0.14	0.11	1300	6 011 320	0.22	0.17
	HMPC	82	408 729	0.20	0.25	22	410 588	0.05	0.07	104	819 317	0.13	0.15
Venice[b]	Italy	854	1 023 032	0.83	0.63	493	1 025 914	0.48	0.35	1347	2 048 947	0.66	0.48
	HMPC	45	105 305	0.43	0.31	6	115 388	0.05	0.08	51	220 693	0.23	0.19
Reggio Emilia	Italy	245	561 514	0.44	0.38	134	554 752	0.24	0.20	379	1 116 266	0.34	0.29
	HMPC	43	101 063	0.43	0.60	32	96 484	0.33	0.41	75	197 547	0.38	0.50
Modena	Italy	249	637 748	0.39	0.31	155	644 649	0.24	0.18	404	1 282 397	0.32	0.25
	HMPC	53	87 870	0.60	0.97	38	90 882	0.42	0.40	91	178 752	0.51	0.59
Bologna	Italy	732	1 308 519	0.56	0.45	468	1 345 591	0.35	0.26	1200	2 654 109	0.45	0.35
	HMPC	84	148 764	0.56	0.86	75	160 390	0.47	0.52	159	309 154	0.51	0.63
Rome[c]	Italy	4352	10 189 240	0.43	0.36	2756	10 626 063	0.26	0.21	7108	20 815 304	0.34	0.28
	HMPC	303	1 149 835	0.26	0.30	157	1 243 036	0.13	0.15	460	2 392 871	0.19	0.22

CHR: Crude Hospitalisation Rate, SHR: Standardized Hospitalisation Rate. Ratios are reported × 1000.
[a] Turin: entry in the cohort: October 21, 2001.
[b] Venice: end of follow-up: December 31, 2014.
[c] Rome: Birthplace for individuals residing in Roma until 2007.

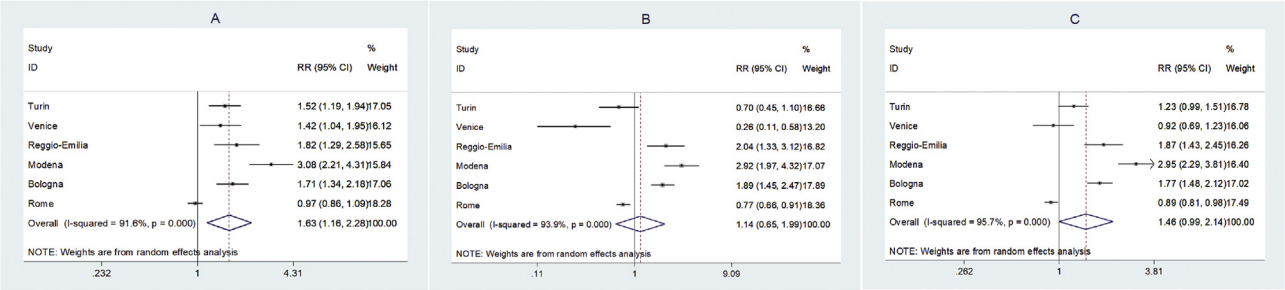

Figure 1 Age and calendar year-adjusted hospitalisation rate ratios (HMPC immigrants vs Italians) by cohort and gender and meta-analytic results by cohort (A: adults males, B: adult females, C: adults overall).

treatment costs [8]. Given the predisposition and vulnerability of immigrant people, cultural, socioeconomic and linguistic barriers that hamper access to care should be identified, and targeted strategies should be implemented. PHC services should not only be offered equally to immigrants and natives but should also provide interventions targeted towards the populations at higher risk.

To the best of our knowledge, only two studies have been conducted in Europe comparing overall AH in immigrants and natives [42,43], and this is the first one to analyse the subgroup of AH for DM. As already mentioned, some studies have been conducted in the US context; they have highlighted that ethnic minorities showed higher rates of DM compared with their white/Caucasian counterparts and suggested the persistence of inequalities [14,24]. Regardless, the results found in other settings, such as the US, are scarcely comparable because they appraise ethnic differences rather than differences by immigrant status. Furthermore, the US Health System, based on private insurance and out-of-pocket fees, would probably have a different effect on the health outcomes of patients compared with the universalistic nature of the Italian National Health Service.

Among the different geographical macro-areas, immigrants from CE Europe presented similar rates to those of their Italian counterparts, probably due to the higher cultural closeness of this group of immigrants and Italians, which facilitates access to health services. On the other hand, immigrants from North and Sub-Saharan Africa and from Asia showed a higher risk of AH for DM. These populations have also been shown to have a higher prevalence of DM at a younger age [6,35,41,44] and a higher risk of for other cardiovascular diseases than Italians [45,46]. Genetic studies have confirmed a role of ethnic background in the higher prevalence of DM in South Asian people [47–49], and some authors have suggested that hypovitaminosis D, particularly relevant among people with darker skin pigmentation, increases the risk of DM [50,51]. Furthermore, a study conducted in Italy in 2015 found that diabetic people of African and Asian origin had worse disease follow-up [41]. Specifically, diabetic people from North Africa were at a higher risk of not being cared for in diabetic clinics and not being tested for HbA1C, and African, South Asian and other Asian immigrants were all at higher risk of having HbA1C > 9% [41]. These immigrants are the least rooted and stable foreign populations; therefore, they are less oriented towards addressing the health services and consequently more inclined towards avoidable hospitalisations. Furthermore, the cultural background and health practices of immigrants from Africa and Asia may be dissimilar to those of European people and health professionals, and it is essential to take particular care when dealing with these patients. For example, Muslim patients should be informed by a health care provider about Ramadan fasting and DM and about medication use during this period, but studies conducted in Europe have shown that only slightly more than half received this advice [35]. All this attention is needed to act early and reduce expensive and harmful emergency interventions such as AH for DM. Our results were very heterogeneous among the different metropolitan cohorts, especially among women. One explanation may lie in the different compositions of the "immigrants from HMPC" groups in the different cities. In Venice and Rome, where immigrant women have a lower risk of AH for DM compared with their Italian counterpart, the proportions of immigrant women from Africa (over the total number of immigrants from HPMC) were 5% and 11%, respectively. These proportions were lower than those of immigrant males in the same cohorts and lower than those of African females in the other cohorts. As immigrants from Africa have the highest risk of AH for DM, this could explain the differences between cohorts. Another explanation may arise in differential care pathways for diabetic patients. Studies conducted on diabetic patients in Turin showed that a DM care model that integrates primary and specialty care was associated with a reduction in all-cause mortality and hospitalisations compared with less structured

Table 3 Random effect age- and calendar year-adjusted meta-analytic hospitalization rate ratios (reference: Italy).

Geographical macro-area	RR (95% CI)	I^2	Cochran *p*-value
CO Europe	0.77 (0.58–1.01)	67%	0.01
N. Africa	2.59 (1.73–3.86)	85%	<0.01
SS Africa	2.41 (1.30–4.45)	90%	<0.01
CS America	1.45 (0.53–3.97)	93%	<0.01
Asia	1.46 (1.00–2.14)	85%	<0.01

models [50]. Furthermore, integrated care models were able to reduce health inequalities among diabetic patients compared with care by a general practitioner only [52].

Immigrant males also showed higher risks of being hospitalised than immigrant females when compared with their Italian counterparts. The two groups of immigrants probably have different attitudes towards unhealthy lifestyles, health services and preventive measures. Through services for pregnant mothers, for example, women of fertile age can benefit from PHC counselling and be empowered in relation to their health. According to the AHRQ definition, any discharge related to childbearing was excluded. Thus, with this analysis, we could not highlight any difference in hospitalisation relative to higher gestational diabetes prevalence, which has already been noted in some migrant groups in Europe, such as Asian women [53]. Given all of these results, it is clear that when analysing the health outcomes of the immigrant population, immigrants must not be considered as a homogeneous group. Moreover, sex and the area of origin must be analysed more thoroughly to better understand the subjects who have a higher risk.

Our study has some limitations that should be noted. We used citizenship (and the birthplace in one cohort) as a proxy for immigrant status. Immigration in Italy is a quite recent phenomenon, and most adult foreigners are first-generation immigrants. Moreover, most of them still retain the citizenship of the country of origin because of the strict law in place for obtaining Italian citizenship, which requires a long and continuous stay in the country and can be acquired only after reaching the age of 18 [54]. For these reasons, we believe that citizenship could still be a good proxy of immigrant status in Italy. Another limitation is that in our study only those who are officially residents and registered can be tracked and followed up. Therefore, two categories of immigrants were inherently left out: people regularly present in Italy who are not formally enrolled in any population registry (e.g., seasonal workers) and undocumented immigrants. Therefore, our results cannot be applied to the whole immigrant population. Regardless, irregular immigrants are estimated to be a minor portion of the total number of immigrants living in Italy (approximately 8%) [55].

Furthermore, we could not include other risk factors in our analysis such as the length of residence which can modify immigrants' attitudes towards health services and their lifestyles [56]. The PHC services in Italy are widely accessible and free at the point of use; however, different economic resources might give access to some private services, and different levels of education might affect people's approach when managing their health problems [56]. Finally, considering that the prevalence of the disease is higher among immigrants [6,35], future studies should focus on cohorts of subjects with DM.

In conclusion, this study on AH for DM is the first to compare immigrants and Italians; the results showed that adult immigrants are at higher risk of AH for DM than their Italian counterparts, especially men and those from Africa and Asia. These inequalities may be reduced through an adequate and comprehensive PHC service. Further studies in the Italian and European setting accounting for other socioeconomic variables and previous DM diagnosis are needed to better understand these trends.

Declaration of Competing Interest

There are neither financial nor other relationships that might lead to a conflict of interest.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.numecd.2020.05.006.

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