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Title	International comparison of glycaemic control in people with type 1 diabetes: an update and extension
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Novelty statement

What is already known?

- Glycaemic control of type 1 diabetes varies widely within and between countries
- There have been many advances in treatment of diabetes in recent years

What has this study has found?"

- In general glycaemic control has improved over time, particularly among children and adolescents but marked variation in patterns of glycaemic control among people with type 1 diabetes remains

What are the implications of the study?

- Reducing variation between settings requires better understanding of the complex factors affecting management of type 1 diabetes including health care systems and their interaction with patients and families

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Abstract

Aims: To update and extend a previous cross-sectional international comparison of glycaemic control in people with type 1 diabetes.

Methods: Data were obtained for 520,392 children and adults with type 1 diabetes from 17 population and five clinic-based data sources in countries or regions between 2016 and 2020. Median HbA_{1c}(IQR) and proportions of individuals with HbA_{1c}<58mmol/mol (<7.5%), 58 – 74 mmol/mol (7.5 – 8.9%) and ≥ 75 mmol/mol (≥ 9.0%) were compared between populations for individuals aged <15, 15 – 24 and ≥ 25years. Logistic regression was used to estimate the odds ratio (OR) of HbA_{1c}< 58 mmol/mol (< 7.5%) relative to ≥ 58 mmol/mol (≥ 7.5%), stratified and adjusted for sex, age, and data source. Where possible, changes in the proportion of individuals in each HbA_{1c} category compared to previous estimates were calculated.

Results: Median HbA_{1c} varied from 55 to 79 mmol/mol (7.2 to 9.4%) across data sources and age groups so a pooled estimate was deemed inappropriate. OR (95% CI) for HbA_{1c}< 58 mmol/mol (<7.5 %) were 0.91 (0.90 – 0.92) for women compared to men, 1.68 (1.65 – 1.71) for people aged < 15 years and 0.81 (0.79 – 0.82) aged15 – 24 years compared to those aged ≥ 25 years. Differences between populations persisted after adjusting for sex, age, and data source. In general, compared to our previous analysis, the proportion of people with an HbA_{1c}<58 mmol/l (<7.5%) increased and proportions of people with HbA_{1c}≥ 75 mmol/mol (≥ 9.0%) decreased.

Conclusions: Glycaemic control of type 1 diabetes continues to vary substantially between age groups and data sources. While some improvement over time has been observed, glycaemic control remains sub-optimal for most people with Type 1 diabetes.

Key words

Type 1 diabetes. Glycaemic control. HbA_{1c}. Registers of people with diabetes

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Introduction

It is widely recognised that lower HbA_{1c} in people with type 1 diabetes reduces the risk of microvascular and macrovascular complications [1]. During the last ten years international guidelines have recommended a target $HbA_{1c}$of 48 – 58 mmol/mol (6.5 – 7.5%) for most people with type 1 diabetes, allowing for clinical judgement to relax these targets for people with severe hypoglycaemia, short life expectancy, severe comorbidity or complications [2-4]. The current International Society of Pediatric and Adolescent Diabetes (ISPAD) and American Diabetes Association (ADA) guidelines recommend HbA_{1c}targets of <53 mmol/mol (<7.0%) for children/adolescents and most non-pregnant adults and a target of <48 mmol/mol (< 6.5%) for other adults, if it can be safely achieved without significant hypoglycaemia [5, 6]. Less stringent goals are recognized to be appropriate for people with a history of severe hypoglycemia, severe co-morbidities or limited life expectancy. The changes in recommended glycaemic targets for people with type 1 diabetes relate in part to evidence of cardiovascular risk reduction from lower targets [7] and also to the availability of new technologies of glucose monitoring, the increasing use of continuous subcutaneous insulin infusion (CSII also known as pump) therapy and their combination.

Type 1 diabetes is a condition which is difficult to manage with current therapies and recommended glycaemic targets are often not achieved. We have previously investigated how well these targets are achieved by analysing HbA_{1c} data from 324,501 people with type 1 diabetes with information derived from population or clinic-based registers from 19 countries or regions [8]. The results revealed substantial variation in glycaemic control among people with type 1 diabetes and room for significant improvement, particularly in young adults. A recent publication describing this pattern among children has also noted significant variation [9]. The HbA_{1c} data in our previous publication were mostly from the years 2010 to 2012. Since then, there has been increasing use of insulin analogues and test strips, improved education and psychological support for patients in some regions and increasing use of the new technologies such as CSII and glucose sensor technology including flash/intermittent glucose monitoring (is-CGM) or continuous/real time glucose monitoring systems (rt-CGM) [10]. Our hypothesis is that the sum of these changes will have had a significant impact on HbA_{1c} in the wider population

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with type 1 diabetes. To our knowledge, this hypothesis has not been tested within and across all age groups across countries/regions.

We therefore set up a further collaboration with colleagues who have access to relevant data to reassess current patterns of glycaemic control in children and adults with type 1 diabetes. Our aim was to update and extend the previous international comparison of glycaemic control in people with type 1 diabetes, and to describe the change in HbA_{1c} profiles in those countries that had contributed to our previous analysis.

Methods

Data source

All collaborators were asked to supply descriptive data and counts of patients within HbA_{1c} categories for the updated analysis of their most recently available data between 2016 and 2020, by sex, age at date of HbA1c measurement, and, where available, diabetes duration and CSII use. In addition, they were asked to provide median HbA_{1c} values for their population over the time period of data included, separately for children aged <15 years, young adults aged 15 – 24 years, and adults aged ≥ 25 years. These age groups were chosen to provide data for children, adolescents/young adults and older adults and to be consistent with our previous study.

We received data from collaborators in 22 different countries. We characterised the datasets as 'national' if they were deemed by the local clinical and data analyst team, to be representative of the population of the country of origin, 'regional' if they were representative of the population within a region, or regions, and 'clinic' if they were from a single or group of clinics that might not represent the breadth of the regional or national population with type 1 diabetes. Details for each data source are given in the supplementary material as Supplementary Text: narrative description of data sources.

Statistical analyses

Descriptive statistics

We performed analyses using R version 3.6.2. Median HbA_{1c} (IQR), sex, CSII use, duration of type 1 diabetes, and the proportions of individuals with no measurement of HbA_{1c} during the study

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period were compared between data sources in three age groups (< 15 years, 15 – 24 years, ≥ 25 years). In keeping with our previous report, proportions of individuals with HbA_{1c}< 58mmol/mol(< 7.5%), 58 – 74 mmol/mol (7.5 – 8.9%) and ≥ 75mmol/mol (≥ 9.0%) were compared between data type of source (national or regional population-based vs. clinic-based) in each of the three age groups. Furthermore, we compared the proportion of people in each HbA_{1c} category by age and sex, and we investigated the proportion of people using CSII in each HbA_{1c} category by data source. To incorporate the latest 2020 American Diabetes Association guideline [5], we additionally show the proportions of people meeting the new HbA_{1c} targets of < 53mmol/mol (< 7.0%) and < 48 mmol/mol (< 6.5%) in each of the three age groups by countries and data sources where data were available.

Logistic regression analysis

Logistic regression was used to estimate the odds of HbA_{1c}< 58mmol/mol (< 7.5%) relative to HbA_{1c}≥ 58mmol/mol (≥7.5%) using a complete case analysis (that is exclusion of missing data). The first model was adjusted for sex, age and type of data source. In order to further investigate differences between countries, the second and third model was stratified by type of data source and adjusted for country/region of origin. We used the largest sub-groups as the comparison groups. Data from each source were included in each analysis where information was available for more than 100 people in each age group to reduce variability due to small numbers.

Comparison over time

Using data from the subset of countries that contributed data to this analysis and the same methods and data sources as the previous international comparison [8], we investigated the change in HbA_{1c} profiles by calculating the absolute and relative change in the proportion of individuals with HbA_{1c}< 58 mmol/mol (< 7.5%), 58 – 74 mmol/mol (7.5 – 8.9%) and ≥ 75 mmol/mol (≥ 9.0%). New Zealand and Ukraine contributed data to both analyses but, as different data sources or populations were used or included for the two periods, time comparisons were not performed. For consistency with the previous analysis [8], data from England and Wales were combined for individuals aged 15 – 24 and ≥ 25 years in the time comparison analysis.

Ethics statement

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Contributors obtained the appropriate approvals for contributing to this collaboration for their jurisdiction. The nature of the study using anonymised and/or aggregated data in the form of clinical audit means that individual consent and formal ethical approval is not required.

Results

Study population

Data were obtained from 520,392 children and adults with type 1 diabetes from 17 national or regional population-based registers (Austria, Australia, Belgium, Denmark, England, Finland, Germany, Hong Kong, Italy, Latvia, New Zealand, Norway, Scotland, Slovenia, Sweden, Ukraine, and Wales) and five clinic-based registers (Canada, France, Greece, Ireland, Netherlands). Details of the different data sources including their representativeness and how diagnosis of type 1 diabetes was validated are given in Supplementary Table 1. The time periods for each data source over the 2016 – 2020 period are described in Supplementary Figure 1. Sample sizes ranged from 479 (New Zealand) to 283,414 (England) prior to exclusion of people with missing data and restriction to data from countries where information was available for more than 100 people in each age group (Supplementary Table 2). Data were not available for all groups for all countries, for example when data for children and adults are not collected in the same register.

Descriptive statistics

In total, data were available for 54,158 children aged < 15 years, 83,065 young adults aged 15 – 24 years, and 382,907 adults aged ≥ 25 years (see Table 1 for further detail including type of data source as national, regional or clinic where national or regional data were estimated to cover over 80% of the relevant population). Median HbA_{1c} ranged from 55 to 79 mmol/mol (7.2 to 9.4%) across populations and age groups. The proportion of individuals using CSII varied from 2.2% to 74.8% among children aged < 15 years, 1.0% to 74.6% among young adults aged 15 – 24 years, and 8.1% to 60.8% among adults aged ≥ 25 years. The proportion of individuals who have had diabetes for at least 5 years varied from 32.0% to 75.0%, 62.8% to 83.9%, and 76.3% to 94.8% among the three age groups respectively.

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The proportion of individuals with HbA_{1c}≥ 75 mmol/mol (≥ 9.0%) varied between data sources (Figure 1). Proportions with HbA_{1c}≥ 75 mmol/mol (≥ 9.0%) were lower in clinic-based than population-based data sources among children aged <15 years (10.5% vs. 16.1%), young adults aged 15 – 24 years (28.9% vs. 37.5%), and adults aged ≥ 25 years (19.8% vs. 26.7%). Among all age groups, the proportion with HbA_{1c}≥ 75 mmol/mol (≥ 9.0 %) was slightly lower and the proportion with HbA_{1c}< 58 mmol/mol (<7.5 %) was slightly higher among men than among women (Supplementary Table 3). In the majority of countries, the proportion of individuals using CSII was lowest among those with HbA_{1c}≥ 75 mmol/mol (≥ 9.0%) (Figure 2). For populations with data available for HbA_{1c}< 48 mmol/mol (< 6.5%) the proportions of people in each of the five HbA_{1c} categories in the three age groups by countries and data sources are presented in Supplementary Figure 2.

Comparison of glycaemic outcome between centres and over time

Differences between populations persisted after adjusting for sex, age, and data source (Table 2). Adjusted odds ratios (95% CI) for HbA_{1c}< 58 mmol/mol (< 7.5%) were 1.24 (1.19 – 1.30) for clinic-based data compared to population-based data. In analyses stratified by type of data source, differences between populations persisted after adjusting for sex and age. Among population-based registers, adjusted odds ratios (95% CI) for HbA_{1c} < 58 mmol/mol (< 7.5%) were 0.91 (0.90 – 0.92) for women compared to men, 1.42 (1.39 – 1.46) and 0.77 (0.76 – 0.78) for people aged < 15 years and 15 – 24 years compared to those aged ≥ 25 years, respectively. For data from clinic-based registers, adjusted odds ratios (95% CI) for HbA_{1c} < 58 mmol/mol (< 7.5%) were 0.89 (0.81 – 0.97) for women compared to men, 0.93 (0.76 – 1.14) and 0.52 (0.46 – 0.60) for people aged < 15 years and 15 – 24 years compared to those aged ≥ 25 years, respectively.

In the majority of data sources that have contributed to both our previous and current international comparison, the proportion of people with HbA_{1c}< 58mmol/mol (<7.5 %) increased and the proportion of people with HbA_{1c}≥ 75 mmol/mol (≥9.0 %) decreased over time (Figure 3a, Figure 3b, Figure 3c). Supplementary Tables 4 – 6 describe the absolute and relative change in the proportion of people with HbA_{1c}≥ 75 mmol/mol (≥9.0 %) for the population with available data for each of the three age groups.

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Discussion

Our data, describing glycaemic control from over half a million people with type 1 diabetes across 22 different countries, clearly demonstrate the challenge of achieving lower HbA_{1c} targets to minimise the risk of developing long-term complications. Glycaemic control continues to vary substantially between age groups, countries and type of data source, with large proportions of people with HbA_{1c} ≥ 75 mmol/mol (≥ 9.0 %), particularly among people aged 15 – 24 years. A small proportion of people in each population achieve the tighter glycaemic targets recommended in recent guidelines [5]. We have also shown better glycaemic control in children compared to adults with type 1 diabetes in population-based data. As we did not have access to individual level data, we were not able to establish whether the variations in improvements in glycaemic control over time by age group in this analysis were statistically significant.

Use of new technologies such as CSII, CGM and closed loop, sensor augmented CSII devices are associated with lower HbA_{1c}[11-15] but they were not available to all the populations studied in this report. Previous Scottish studies have shown lower HbA_{1c} in people using CSII in a clinic population [16] and time trends between 2004 and 2016 in declining HbA_{1c} across the whole Scottish population of people with type 1 diabetes, with the most marked improvements in children and adolescents [17].

Data from the National Paediatric Diabetes Audit in England and Wales technologies spotlight audit have demonstrated a 6 mmol/mol lower HbA_{1c} in those using CSII in combination with CGM compared to multiple daily injections alone independent of ethnicity, duration of diabetes or social deprivation [18]. There are several possible explanations for the difference in glycaemic control, including allocation bias arising from the fact that characteristics of people that receive CSII differ from those that do not receive CSII in many settings. In addition, local resource and support for those initiating and continuing CSII is likely to vary within and across populations. The association between use of technology and proportions achieving glycaemic targets may not be consistent within or across different settings.

It is possible that some of the differences between populations and changes over time could be explained by the extent of introduction of new technologies at the time of the data extraction. However we did not observe any association between proportions of each population using CSII

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and median HbA1c (using data reported in table 1). We did not collect data on use of CSII and CGM for our previous analysis or on CGM for this analysis and have therefore not been able to explore their role in temporal changes. The fact that data included in this comparison were extracted between 2016 and 2020 (although most data were for 2018-2019, see Supplementary Figure 1) and use of technologies differs between countries limits direct comparisons. Other important contributing factors to differences between populations that we were unable to consider include socioeconomic deprivation, educational attainment, diet, eating habits, ethnicity, physical activity, diabetes education, social and psychological support and health systems including insurance coverage in some countries.

Despite noting that many people do not achieve recommended glycaemic targets, we have found an improvement in glycaemic control among people with type 1 diabetes in most countries over time, though to a greater extent in some than others, but particularly amongst those aged <15 years. This is encouraging and is likely to be due to a combination of the factors described above.

This analysis has several possible limitations, including selection bias. We have described our data sources in detail. The data from clinics are more likely to be affected by selection bias than those from population-based datasets but missing data may introduce bias in population-based datasets. It seems probable that data are more likely to be missing from people with poor engagement with services who are less likely to have good control, as illustrated by data from north-east Scotland [19]. Although we have described data sources using the name of the country of origin, it is important to recognise that some of these datasets may not be representative of the wider community of people with diabetes in that country if regional differences exist or clinic based populations are a selected sub-group of the population of interest. We did not collect data on duration of diabetes that would have been needed to sub-divide data for the oldest age-group that includes both people with type 1 diabetes since childhood and people who developed type 1 diabetes as adults.

Some variability in HbA_{1c} values might be caused by different laboratory methods in our populations, even if all national standards for good laboratory practice were met. In addition, it was not possible to compare incidence of hypoglycaemic episodes, use of different types of CSII, glucose sensors or any sensor-augmented systems.

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We have demonstrated differences in glycaemic control in different populations and age groups and shown that differences persist between populations over time. Further research is required to better understand whether apparent differences between health systems may relate to such influences as societal factors, structure and delivery of clinical care and resource allocation. Their better understanding could help inform development of cost-effective interventions to improve outcomes. Our data reinforce existing knowledge that adolescence and early adulthood is a particularly challenging time for managing type 1 diabetes and that there is considerable scope for improving glycaemic control in this age group in most populations. The consistent pattern of improvement in those <15 years is the greatest encouragement, and it will be informative to see if it continues as this group becomes older. In general, data that are available for children are more representative than for adults and subsequent analysis of better quality data would be helpful to address the limitations of this work.

It is possible that wider use of newer technologies including sensors and closed loop systems could contribute to further improvements in glycaemic control, particularly among populations where they are not yet available. However, use of technology is only one factor in glycaemic control and maximising the effectiveness of conventional approaches to management of type 1 diabetes, including education, encouraging acceptance of the condition and frequent glucose measurement, remain important. These latter aspects are obviously particularly relevant in low resource settings although all health services need to adapt to changes in the available technology.

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Conflicts of Interest: None declared.

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Figure legends

Figure 1: Proportions of individuals in each HbA_{1c} category in each of the three age groups by country and type of data source

***** Data in age group 15 – 24 years are for individuals aged 15 – 21 years.

†Data in age group 15 – 24 years are for individuals aged 18 – 24 years.

‡Data in age group 15 – 24 years are for individuals aged 15 – 18 years.

Figure 2: Proportions of individuals using CSII by HbA_{1c} category and country and type of data source in each of the three age groups

* Data in age group 15 – 24 years are for individuals aged 15 – 21 years.

†Data in age group 15 – 24 years are for individuals aged 18 – 24 years.

Figure 3: Analysis of change between 2010-2012 and 2016-2020 time periods in the proportions of individuals in each HbA_{1c} category in each of the three age groups for countries that had contributed to both the previous and current international comparison: (a) <15years old, (b) 15 – 24 years old, (c) ≥ 25 years old

* Data in age group 15 – 24 years are for individuals aged 15 – 21 years.

†Data in age group 15 – 24 years are for individuals aged 18 – 24 years.

Figure 3 (a) <15years old

Figure 3b) 15 – 24 years old

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Figure 3 c) ≥ 25 years old

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Table 1: Characteristics of populations of people with type 1 diabetes by country for each of the three age groups presented in decreasing population size for national, regional and clinic based data sources. Data included were extracted between 2016 and 2020 (see Supplementary Figure 1 for details.)

Country or region	Data source	N	Male (%)[i]	Median HbA_{1c} mmol/mol (IQR)	HbA_{1c} % (IQR)	Missing HbA_{1c} (%)i	Diabetes duration ≥ 5 years (%)i	CSII use (%)i
< 15 years								
England	national	18,514	51.4	60 (54; 68)	7.7 (7.0; 8.3)	6.1	---	38.8
Germany	national	17,463	52.1	58 (51; 67)	7.5 (6.8; 8.3)	1.3	---	59.3
Ukraine	national	6,618	51.4	67 (56; 83)	8.3 (7.3; 9.7)	13.3	32.0	2.2
Belgium	national	2,242	51.9	56 (50; 63)	7.3 (6.7; 7.9)	1.0	36.6	24.6
Scotland	national	1,960	51.7	62 (56; 69)	7.8 (7.3; 8.5)	2.2	35.6	46.4
Denmark	national	1,869	52.6	57 (50; 64)	7.4 (6.7; 8.0)	15.5	28.5	71.3
Austria	national	1,444	54.4	57 (50; 64)	7.4 (6.8; 8.1)	0.6	---	63.8
Wales	national	1,045	48.3	60 (52; 68)	7.7 (7.0; 8.4)	5.6	---	37.8
Latvia	national	396	46.5	76 (62; 95)	9.1 (7.8; 10.8)	12.1	36.4	---
Slovenia	national	382	48.4	58 (53; 65)	7.5 (7.0; 8.1)	0.0	36.6	74.8
Hong Kong	national	228	38.2	65 (56; 75)	8.1 (7.3; 9.0)	8.3	39.5	---
Australia	regional	627	51.7	60 (52; 66)	7.6 (6.9; 8.2)	3.5	38.0	48.0
New Zealand	regional	324	47.2	67 (57; 81)	8.3 (7.4; 9.6)	8.8	42.8	22.5
Italy	regional	192	55.7	55 (51; 65)	7.2 (6.8; 8.1)	0.0	36.5	37.0
Finland	regional	131	64.1	62 (56; 68)	7.8 (7.3; 8.4)	2.3	---	---
France	regional	40	55.0	64 (58; 69)	8.0 (7.5; 8.5)	0.0	75.0	2.6
Netherlands	clinic	583	50.6	57 (52; 65)	7.4 (6.9; 8.1)	2.2	43.1	66.0
Ireland	clinic	74	43.2	68 (58; 78)	8.4 (7.5; 9.2)	12.2	38.9	31.1
Greece	clinic	26	46.2	55 (51; 60)	7.2 (6.8; 7.6)	3.8	50.0	15.4
15 – 24 years								
England	national	43,115	53.5	72 (60; 88)	8.7 (7.6; 10.2)	18.7	69.1	11.2
Germany	national	10,823	54.1	62 (53; 74)	7.8 (7.0; 8.9)	1.8	---	42.4
Wales	national	5,995	53.4	73 (61; 88)	8.8 (7.7; 10.2)	20.6	69.1	11.2
Sweden[ii]	national	5,175	55.9	58 (50; 70)	7.5 (6.7; 8.6)	2.4	82.1	40.6
Belgium	national	4,692	53.3	60 (52; 69)	7.6 (6.9; 8.5)	2.2	71.5	12.8
Scotland	national	4,237	52.1	71 (60; 86)	8.6 (7.6; 10.0)	9.0	77.0	24.0
Ukraine[iii]	national	2,665	52.5	72 (61; 88)	8.7 (7.7; 10.2)	10.0	62.8	1.0
Norwayii	national	1,632	56.1	66 (55; 77)	8.2 (7.2; 9.2)	2.1	78.8	52.9
Latvia	national	529	54.6	79 (64; 99)	9.4 (8.0; 11.2)	21.9	74.5	---
Hong Kong	national	410	46.1	64 (54; 77)	8.0 (7.0; 9.2)	16.3	70.7	---
Slovenia	national	355	54.9	61 (53; 70)	7.7 (7.0; 8.6)	0.8	76.9	74.6

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Australia[iv]	regional	484	50.2	64 (55; 78)	8.0 (7.2; 9.3)	1.9	73.6	48.1
Italy	regional	324	50.6	60 (53; 69)	7.6 (7.0; 8.5)	1.2	76.5	26.5
Finland	regional	177	53.1	68 (59; 76)	8.3 (7.5; 9.1)	4.5	---	---
New Zealand	regional	155	57.4	72 (58; 88)	8.7 (7.5; 10.1)	6.6	69.0	23.2
Netherlands	clinic	1,392	46.8	63 (55; 75)	7.9 (7.2; 9.0)	2.9	83.1	60.6
Canada	clinic	419	51.1	67 (56; 79)	8.3 (7.2; 9.3)	17.7	83.9	41.3
Ireland	clinic	222	49.5	71 (62; 80)	8.6 (7.8; 9.5)	24.3	76.9	17.6
France	clinic	142	47.2	64 (53; 75)	8.0 (7.0; 9.0)	0.0	83.1	33.1
Greece	clinic	122	53.3	56 (50; 66)	7.3 (6.7; 8.2)	5.7	76.2	21.3
≥ 25 years								
England	national	221,545	56.3	66 (57; 78)	8.2 (7.4; 9.3)	10.2	85.7	8.1
Sweden	national	43,510	55.7	58 (51; 67)	7.5 (6.8; 8.3)	1.5	93.4	22.6
Belgium	national	30,398	55.0	58 (52; 67)	7.5 (6.9; 8.3)	2.3	90.5	12.1
Wales	national	27,160	53.8	68 (58; 80)	8.4 (7.5; 9.5)	13.8	84.3	10.2
Scotland	national	25,844	56.7	67 (58; 79)	8.3 (7.5; 9.4)	12.2	93.0	11.5
Norway	national	12,136	55.1	61 (52; 70)	7.7 (7.0; 8.5)	2.4	90.5	30.9
Germany	national	8,644	51.9	58 (50; 68)	7.4 (6.7; 8.4)	7.2	---	12.4
Latvia	national	1,958	53.6	67 (57; 80)	8.3 (7.4; 9.5)	31.7	94.8	---
Hong Kong	national	1,597	49.1	60 (51; 72)	7.6 (6.8; 8.7)	21.1	76.3	---
Italy	regional	2,468	55.5	61 (53; 69)	7.7 (7.0; 8.5)	1.1	90.5	18.5
Finland	regional	1,130	58.5	64 (56; 74)	8.1 (7.3; 8.9)	7.5	---	---
Canada	clinic	3,454	54.5	62 (54; 70)	7.8 (7.0; 8.6)	8.7	90.7	36.2
Ireland	clinic	1,341	53.5	66 (56; 76)	8.2 (7.3; 9.1)	45.4	91.2	11.4
Netherlands	clinic	720	49.4	56 (50; 65)	7.3 (6.7; 8.1)	5.8	93.2	60.8
France	clinic	644	51.1	64 (53; 75)	8.0 (7.0; 9.0)	0.0	91.2	59.9
Greece	clinic	358	45.0	58 (52; 68)	7.5 (6.9; 8.4)	2.0	89.5	19.3

[i] Patients with missing information were not included in the denominator.
[ii] Data are for individuals aged 18 – 24 years.
[iii] Data are for individuals aged 15 – 18 years.
[iv] Data are for individuals aged 15 – 21 years.

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Table 2: Odds ratios (95 % CI) for HbA_{1c}<58 mmol/mol for sex, age, data source, and country.

Data included were extracted between 2016 and 2020 (see Supplementary Figure 1 for details.)

	Overall		Data source			
			Population-based		Clinic-based	
Variable	**OR (95 % CI)**	**p**	**OR (95 % CI)**	**p**	**OR (95 % CI)**	**p**
Sex						
Female	0.91 (0.90; 0.92)	<0.001	0.91 (0.90; 0.92)	<0.001	0.89 (0.81; 0.97)	0.011
Male	ref.	—	ref.	—	ref.	—
Age groups						
< 15 years	1.68 (1.65; 1.71)	<0.001	1.42 (1.39; 1.46)	<0.001	0.93 (0.76; 1.14)	0.469
15 – 24 years	0.81 (0.79; 0.82)	<0.001	0.77 (0.76; 0.78)	<0.001	0.52 (0.46; 0.60)	<0.001
≥ 25 years	ref.	—	ref.	—	ref.	—
Data source						
Clinic	1.24 (1.19; 1.30)	<0.001	—	—	—	—
Population	ref.	—	—	—	—	—
Country (population based)						
Australia	—	—	1.57 (1.38; 1.77)	<0.001	—	—
Austria	—	—	2.21 (1.98; 2.46)	<0.001	—	—
Belgium	—	—	2.09 (2.05; 2.14)	<0.001	—	—
Denmark	—	—	2.29 (2.07; 2.54)	<0.001	—	—
Finland	—	—	0.94 (0.84; 1.06)	0.340	—	—
Germany	—	—	2.08 (2.03; 2.13)	<0.001	—	—
Hong Kong	—	—	1.74 (1.58; 1.91)	<0.001	—	—
Italy	—	—	1.77 (1.64; 1.90)	<0.001	—	—
Latvia	—	—	0.71 (0.64; 0.79)	<0.001	—	—
New Zealand	—	—	0.55 (0.44; 0.68)	<0.001	—	—
Norway	—	—	1.65 (1.59; 1.71)	<0.001	—	—
Scotland	—	—	0.80 (0.78; 0.83)	<0.001	—	—
Slovenia	—	—	1.91 (1.65; 2.21)	<0.001	—	—
Sweden	—	—	2.30 (2.25; 2.34)	<0.001	—	—
Wales	—	—	1.00 (0.98; 1.03)	0.768	—	—
England	—	—	ref.	—	—	—
Country (clinic based)						
France	—	—	—	—	1.01 (0.85; 1.18)	0.946

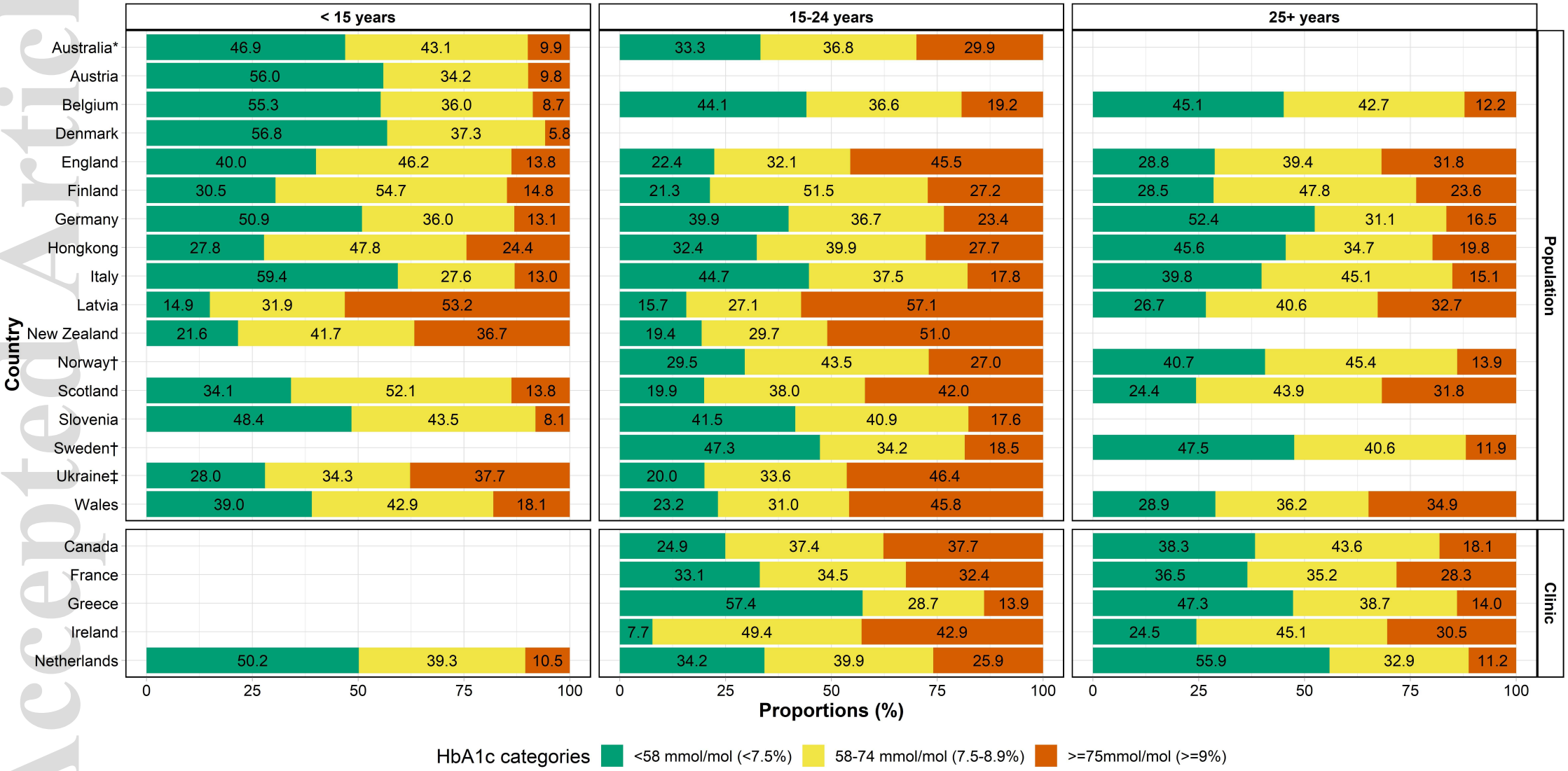
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Greece	—	—	—	—	1.88 (1.55; 2.29)	<0.001
Ireland	—	—	—	—	0.48 (0.41; 0.57)	<0.001
Netherlands	—	—	—	—	1.75 (1.53; 2.01)	<0.001
Canada	—	—	—	—	ref.	—

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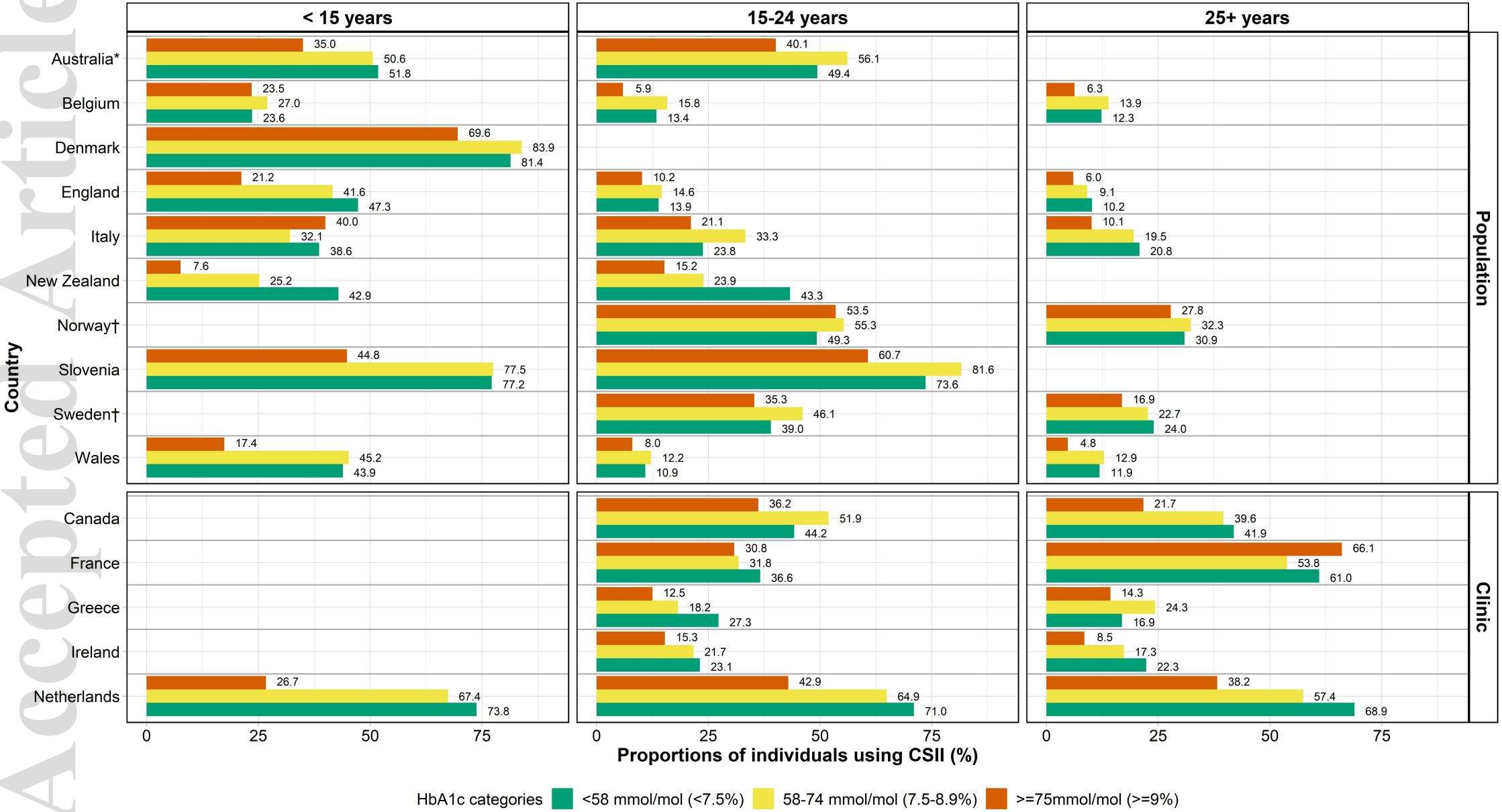
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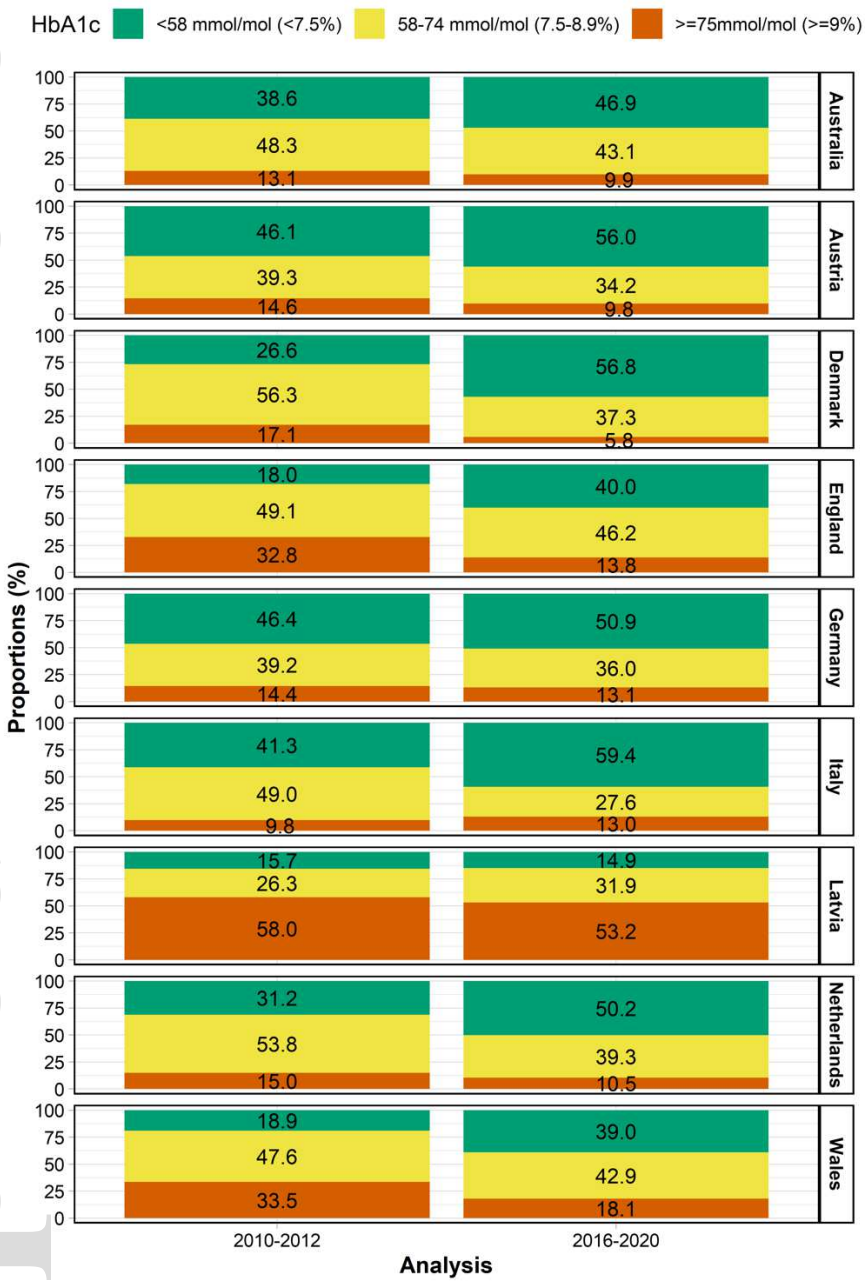
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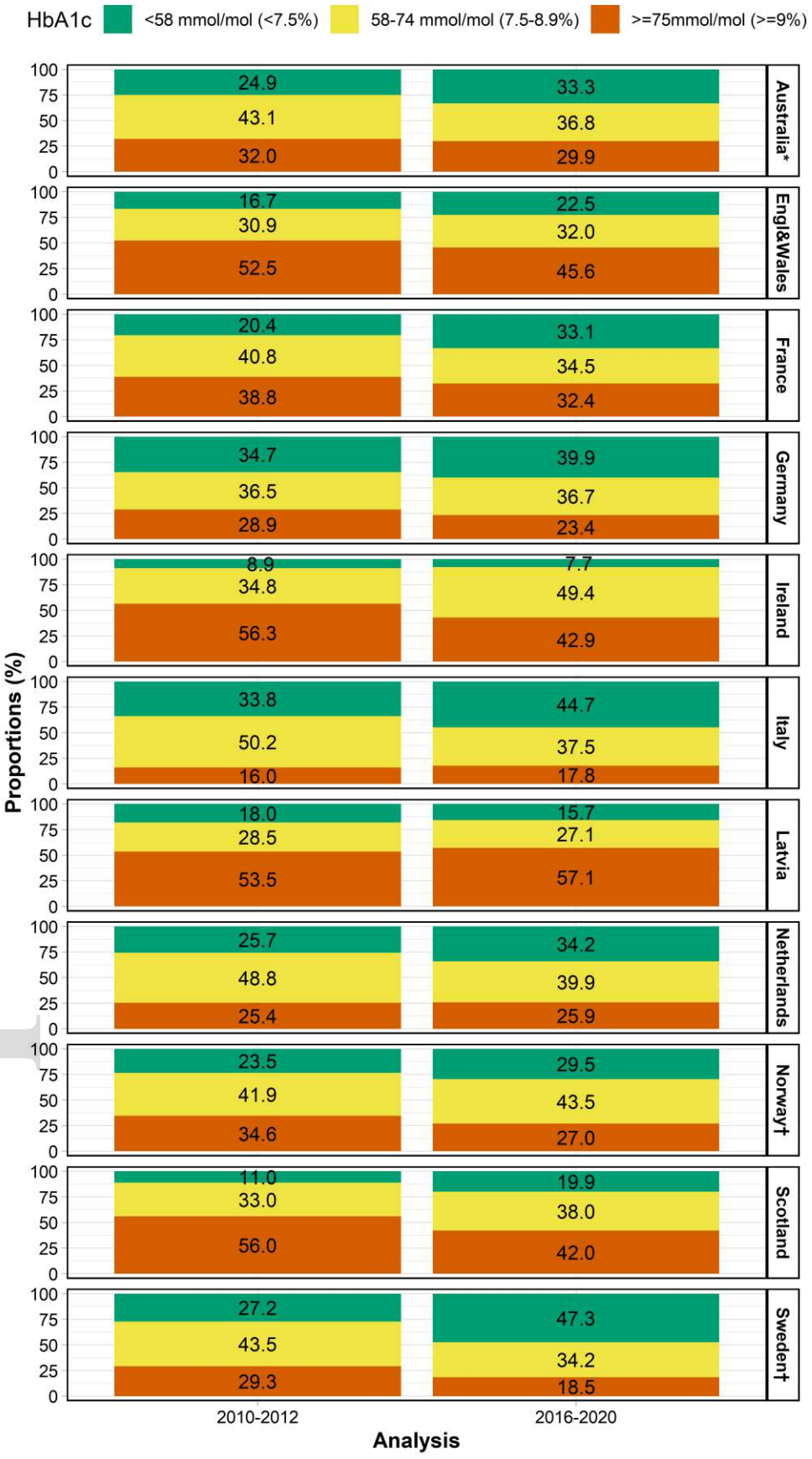
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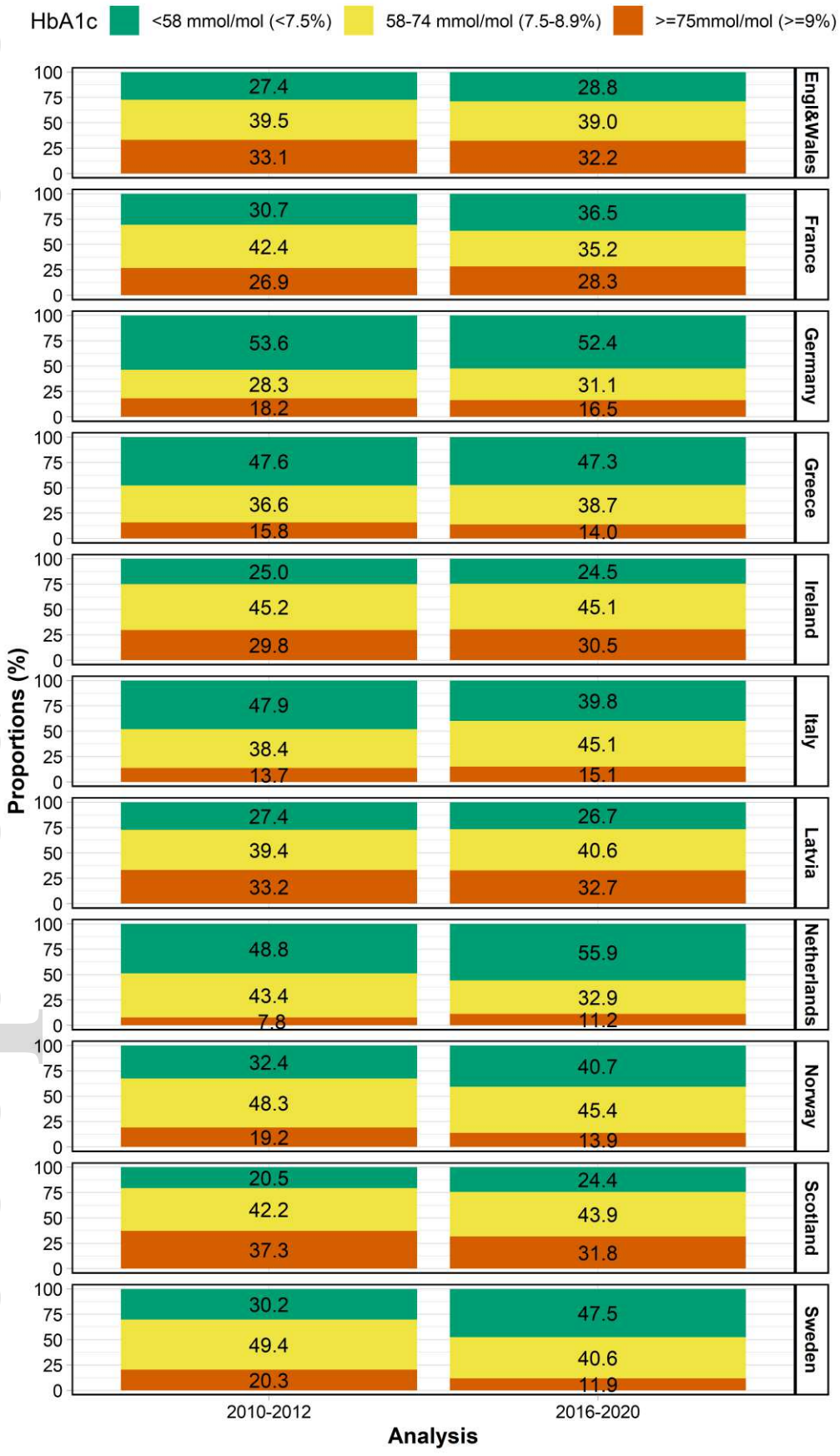
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