






## RESEARCH ARTICLE

# Type 1 diabetes incidence in Scotland between 2006 and 2019

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## Abstract

**Aims:** To describe type 1 diabetes incidence in Scotland between 2006 and 2019.

**Methods:** Repeated annual cross-sectional studies of type 1 diabetes incidence were conducted. Incident cases were identified from the Scottish Care Information—Diabetes Collaboration (SCI-DC), a population-based register of people with diagnosed diabetes derived from primary and secondary care data. Mid-year population estimates for Scotland were used as the denominator to calculate annual incidence with stratification by age and sex. Joinpoint regression was used to investigate whether incidence changed during the study period. Age and sex-specific type 1 diabetes incidence over the whole time period was estimated by quintile of the Scottish Index of Multiple Deprivation (SIMD), an area-based measure, in which Q1 and Q5 denote the most and least deprived fifths of the population, respectively, with quasi-Poisson regression used to compare incidence for Q5 compared to Q1.

**Results:** The median (IQR) age of the study population of 14,564 individuals with incident type 1 diabetes was 24.1 (12.3–42.4) years, 56% were men, 23% were in Q1 and 16% were in Q5. Incidence of T1DM was higher in men than women overall (at around 22 and 17 per 100,000, respectively) and in under 15 year olds (approximately 40 per 100,000 in both sexes) than other age groups and was similar across the study period in all strata. There was an inverse association between socio-economic status and type 1 diabetes incidence for 15–29, 30–49 and 50+ year olds [incidence rate ratio (IRR) for Q5 compared to Q1; IRR (95% CI) 0.52 (0.47–0.58), 0.68 (0.61–0.76) and 0.53(0.46–0.61), respectively] but not for under 15 year olds [1.02 (0.92–1.12)].

**Conclusion:** Incidence of type 1 diabetes varies by age, sex and socio-economic status and has remained approximately stable from 2006 to 2019 in Scotland.

## KEYWORDS

incidence, Scotland, socio-economic status, time trends, type 1 diabetes

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## 1 | INTRODUCTION

The availability of data on the incidence of type 1 diabetes varies by age and country. With a few exceptions, existing data suggest that incidence is higher in populations of northern European ancestry than among other ethnic groups. A literature review of publications after 1990 conducted for the tenth edition of the International Diabetes Federation's Diabetes Atlas found estimates for children and young people under 20 years of age for 97 countries (45% of all countries, 13% of countries in sub-Saharan Africa and 75% of countries in Europe.<sup>1</sup>) These data were used to estimate global numbers of young people with incident type 1 diabetes for 2021. The most recent published estimates of incidence of type 1 diabetes for children in Scotland include data up to 1993.<sup>2</sup> Incidence of type 1 diabetes in children increased in several countries in the world in the second half of the twentieth century.<sup>3</sup> More recent data up to 2013 have suggested less marked increases in the incidence of type 1 diabetes in children in regions with particularly high incidence such as Scandinavia although incidence has continued to increase in other settings and in pooled analyses of data from European countries.<sup>4</sup>

Data on the incidence of type 1 diabetes in adults are even more limited, with estimates available for approximately 10 countries<sup>5</sup> and from a 2022 systematic review that data from 32 countries between 1973 and 2019.<sup>6</sup> As a consequence, global estimates of numbers of incident type 1 diabetes cases for all age groups for the majority of countries have had to be based on ratios of incidence rates for adults compared to children.<sup>5</sup>

The aims of this paper were to provide more recent Scottish data on time trends in incidence of type 1 diabetes among children, to provide estimates of the incidence of type 1 diabetes in adults and to investigate the roles of sex, socio-economic status and seasonal variation on incidence of type 1 diabetes.

## 2 | METHODS

A research extract of the Scottish Care Information (SCI)-Diabetes dataset was used to identify people with a date of diagnosis of type 1 diabetes in the 14 years between 2006 and 2019. SCI-Diabetes contains data for people with a diagnosis of diabetes, downloaded daily from all general practices and diabetes clinics in hospitals across Scotland. Date of diagnosis of diabetes is derived from clinical records and is not related to date of inclusion in SCI-Diabetes. Full population coverage of the dataset was achieved by 2006, which determined our choice of start date. Historical records, including date of diagnosis

### What's new?

#### What is already known about this subject?

- Incidence of type 1 diabetes in children increased in many countries during the twentieth century although increases have been less marked more recently among high incidence countries.
- There is limited information on incidence of type 1 diabetes in adults.

#### What is the key question?

- What is the contemporary incidence of type 1 diabetes in Scotland and how does it vary by age, sex, socio-economic status and calendar month of diagnosis.

#### What are the new findings?

Incidence of type 1 diabetes in Scotland:

- has been approximately stable between 2006 and 2019.
- varies by age and sex and by socio-economic status for individuals above 14 years of age.
- among children is higher compared to previous periods in Scotland, to other regions of the United Kingdom and to most other European countries.

#### How might this have an impact on clinical practice in the foreseeable future?

- These findings can be used for health service planning and to support appropriate resource allocation.

of diabetes, were imported into SCI-diabetes so people with prevalent diabetes were included at inception of SCI-diabetes. The completeness of SCI-Diabetes is regularly validated against population-based in-patient hospital records of diabetes diagnoses and prescribing of insulin and sulfonylureas, with estimates of >99% completeness in 2015/6 and 2018/9. The end date was chosen to exclude any possible effects of the COVID-19 pandemic. Permission for use of pseudonymised data for research was obtained from the Scottish Multicentre Research Ethics Committee (reference 11/AL/0225) and the Public Benefit and Privacy Panel (reference 1617-0147).

For research purposes, clinically assigned type of diabetes is re-classified using an algorithm. The algorithm uses information on clinical record of type of diabetes, age

at diagnosis of diabetes and type of treatment. Prescription of insulin within 1 year after diagnosis of diabetes and no record of prescription of treatments for diabetes other than metformin at any time are required to meet criteria for type 1 diabetes. Possible type 1 diabetes is identified among people with a clinical record of type 2 diabetes who have a record of insulin prescription within a year of diagnosis of diabetes and who have no record of prescription of treatments for diabetes other than metformin at any time.<sup>7</sup>

Socio-economic status (SES) was measured using the Scottish Index of Multiple Deprivation (SIMD) 2016, which ranks areas of concentration of deprivation by taking into account seven domains; Income, Employment, Education, Health, Access to Services, Crime and Housing. The index is created through Scotland being split into 6976 small areas, which are then ranked across the seven domains from least to most deprived.<sup>8</sup> SIMD combines data from the domains to generate a single score for an area. The most deprived fifth of areas are represented by Q1 and the least deprived by Q5. People with missing data for SIMD (1.6%) were excluded from estimates of diabetes incidence by SES. Mid-year population estimates by age, sex and fifth of SIMD were obtained from the National Records of Scotland.

## 2.1 | Statistical analysis

Incidence of type 1 diabetes over the whole study period was initially described by individual year of age at diagnosis and sex. For analysis of time trends age at diagnosis of type 1 diabetes was categorised in four groups: under 15, 15–29, 30–49 and 50+ years, with additional estimates for 0–4, 5–9 and 10–14 year olds.

Incidence for under 15 year olds was standardised for age by the direct method<sup>9</sup> using a standard population with an equal number of children in each 5-year population category. This approach is consistent with that used in the IDF atlas and the EURODIAB study and allowed estimates of type 1 diabetes incidence for under 15 year olds to be calculated, which were comparable to estimates for other regions/countries in the EURODIAB study.<sup>2,3</sup> In addition we generated the age-standardised rate for under 15 year olds using relevant 5-year age strata from the 2013 European standard population. Joinpoint regression models, which allow segmented log-linear relationships to be fitted to incidence trends, were run to investigate possible non-linear time trends. We investigated potential cohort effects using generalised additive models to fit the smoothed effects of age, period and cohort.

Age and sex-specific type 1 diabetes incidence by SIMD quintile was estimated for under 15, 15–29, 30–49 and 50+ year olds. Exploratory data analysis revealed marked variance in the distribution of incidence counts (overdispersion) that means use of Poisson models would be inappropriate.<sup>10</sup> Incidence risk ratios (IRRs) and 95% CI for each SIMD quintile compared with quintile 1 were, therefore, estimated using quasi-Poisson regression models that can be used in the presence of overdispersion.<sup>11</sup> Potential interactions between SIMD quintile, sex and age were explored through the use of chi-squared tests.<sup>12</sup> Sensitivity analyses were conducted to investigate whether exclusion of people with possible type 1 diabetes influenced the conclusions.

Seasonal patterns in incidence were explored by comparing the mean numbers of incident cases by month of diagnosis of diabetes across the whole 14 year study period, after adjusting the numbers each month of diagnosis where appropriate as if there were 30 days in each month, taking leap years into account. Dates of diagnosis of diabetes on 1 January were excluded from the seasonal analyses, as there was a relatively high proportion on this date, particularly for the early years of the study period (821 cases in total). These Mean (SD) cases per month were estimated for under 15, 15–29, 30–49 and 50+ year olds but estimates were not stratified by sex as patterns appeared similar for both sexes. Chi-squared tests were used for each age stratum to test for difference by month.

R (version 3.6),<sup>13</sup> together with packages (tidyverse,<sup>14</sup> car,<sup>15</sup> haven,<sup>16</sup> AER,<sup>17</sup> segmented<sup>18</sup> mgcv<sup>19</sup>) and other functions in base R, were used for statistical analysis.

## 3 | RESULTS

The study cohort included 14,564 people diagnosed with type 1 diabetes or possible type 1 diabetes in Scotland between 2006 and 2019. Table 1 describes the characteristics of the Scottish population with incident type 1 diabetes (including numbers of people with possible type 1 diabetes), grouped in three calendar periods, the first two of 5 years duration and the third of 4 years. The most deprived fifth (Q1) of the Scottish population (approximately 20% for each time period) was overrepresented in people with incident T1DM (23.2% overall).

The overall incidence of type 1 diabetes, across the whole study period by individual year of age and diagnosis and sex, increased to a peak at 12 and 10 years of age for men and women, respectively, and then decreased (Figure 1). Incidence was higher in men than women among 15–49 year olds. Five-year age- and sex-specific

TABLE 1 Characteristics of the individuals with T1DM in Scotland, between 2006 and 2019.

Characteristics	2006–2010 (n = 5178)	2011–2015 (n = 5196)	2016–2019 (n = 4190)	2006–2019 (n = 14,564)
<i>Age at diagnosis (years)</i>				
Median (IQR)	24.5 (12.4, 42.4)	23.9 (12.3, 42.3)	23.8 (12.0, 42.6)	24.1 (12.3, 42.4)
<i>Sex</i>				
Men, n (%)	2948 (56.9)	2871 (55.3)	2310 (55.1)	8129 (55.8)
Women, n (%)	2230 (43.1)	2325 (44.8)	1880 (44.9)	6435 (44.2)
<i>Type of T1DM</i>				
Diagnosed T1DM, n (%)	4368 (84.4)	4412 (84.9)	3629 (86.6)	12,409 (85.2)
Possible T1DM (<35 years), n (%)	100 (1.9)	122 (2.4)	72 (1.7)	294 (2.0)
Possible T1DM (≥35 years), n (%)	710 (13.7)	662 (12.7)	489 (11.7)	1861 (12.8)
<i>Socio-economic status<sup>a</sup></i>				
Q1, n (%)	1180 (22.8)	1219 (23.5)	982 (23.4)	3381 (23.2)
Q2, n (%)	1105 (21.3)	1128 (21.7)	893 (21.3)	3126 (21.5)
Q3, n (%)	982 (19.0)	1037 (20.0)	823 (19.6)	2842 (19.5)
Q4, n (%)	894 (17.3)	955 (18.4)	790 (18.9)	2639 (18.1)
Q5, n (%)	819 (15.8)	835 (16.1)	691 (16.5)	2345 (16.1)
Missing, n (%)	198 (3.8)	22 (0.4)	11 (0.3)	231 (1.6)

<sup>a</sup>Q1 represents the most deprived quintile, while Q5 is the least deprived.

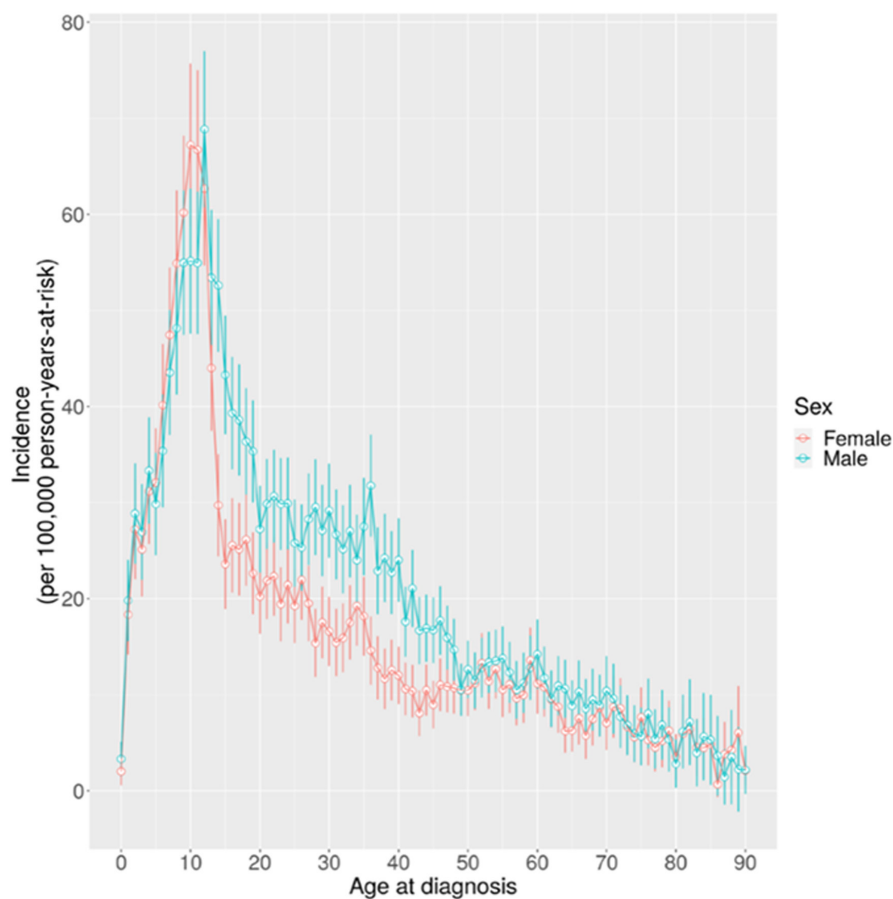


FIGURE 1 Incidence of T1DM in Scotland between 2006 and 2019 by individual year of age at diagnosis by sex.

total numbers of cases and incidence of type 1 diabetes per 100,000 people are provided in Table S1.

Incidence by age group (Figure 2) shows limited variation in type 1 diabetes incidence over time within the 15–29, 30–49 and 50+ age groups. Marked but inconsistent year to year fluctuation in 5-year age strata of under 15 year olds (Figure S1). There was no evidence for time trends, either for a pattern that was approximately equal over time ( $p = 0.44$  for linear estimates) or for a pattern that changed within the study period ( $p = 0.39$  for one breakpoint that would suggest differing time trends in two smaller periods and  $p = 0.33$  for two break points that would suggest differing time trends in three smaller periods). The age-period-cohort models showed weak evidence of a cohort effect. The  $p$  value for the likelihood ratio test for the comparison of age-period and age-period-cohort models was 0.03 and age-specific incidence stratified by birth-year cohort is illustrated in Figure S2. Summary estimates of incidence of type 1 diabetes per 100,000 person years over the whole time period for the primary analysis for under 15, 15–29, 30–49 and 50+ year olds were 39.9, 32.0, 21.3 and 10.0 for men and 39.7, 21.7, 12.7 and 8.3 for women. The age-sex standardised incidence of type 1 diabetes in under 15 year olds for 2008–2013 in Scotland was 39.9/100,000 using equal numbers of children in each age stratum in the standard population and 40.1/100,000 using the 2013 European standard population. The proportions of incident cases of type 1 diabetes for both sexes combined for under 15, 15–29, 30–49 and 50+ year olds were 33%, 26%,

23% and 17%, respectively (with approximately 6% among people of 65+ years of age).

The quasi-Poisson models did not provide evidence for an interaction between calendar year and deprivation during the study period so estimates of incidence by deprivation were based on data for all years combined. However, there was evidence of interaction between age group and deprivation and between age group and sex. Figure 3 illustrated the incidence of type 1 diabetes over the whole time period stratified by age group, sex and SIMD quintile. No consistent pattern by SES was observed for under 15 year olds [IRR for Q5 compared to Q1 adjusted for sex: IRR (95% CI) (1.02 (0.93–1.12))]. In contrast, there was an inverse association with incidence of type 1 diabetes in 15–29, 30–49 and 50+ year olds [IRR for Q5 compared to Q1 adjusted for sex: IRR (95% CI) 0.52 (0.47–0.58), 0.68 (0.61–0.76) and 0.53 (0.46–0.61), respectively].

Sensitivity analyses after excluding people with possible type 1 diabetes reduced the sample size to 12,409, the median age at diagnosis of type 1 diabetes to 20.1 years (IQR 11.1–34.9) and the proportion of people in the most deprived fifth of the population to 22.1%. Incidence of type 1 diabetes was lower in the 50+ year age group (4.4/100,000 for both men and women) than in the primary analysis (10.0/100,000 and 8.3/100,000 for men and women, respectively). The positive association between deprivation and incidence persisted among 15–49 year olds but was attenuated in the 50+ age groups (data not shown but available from authors). This raises important questions about the validity

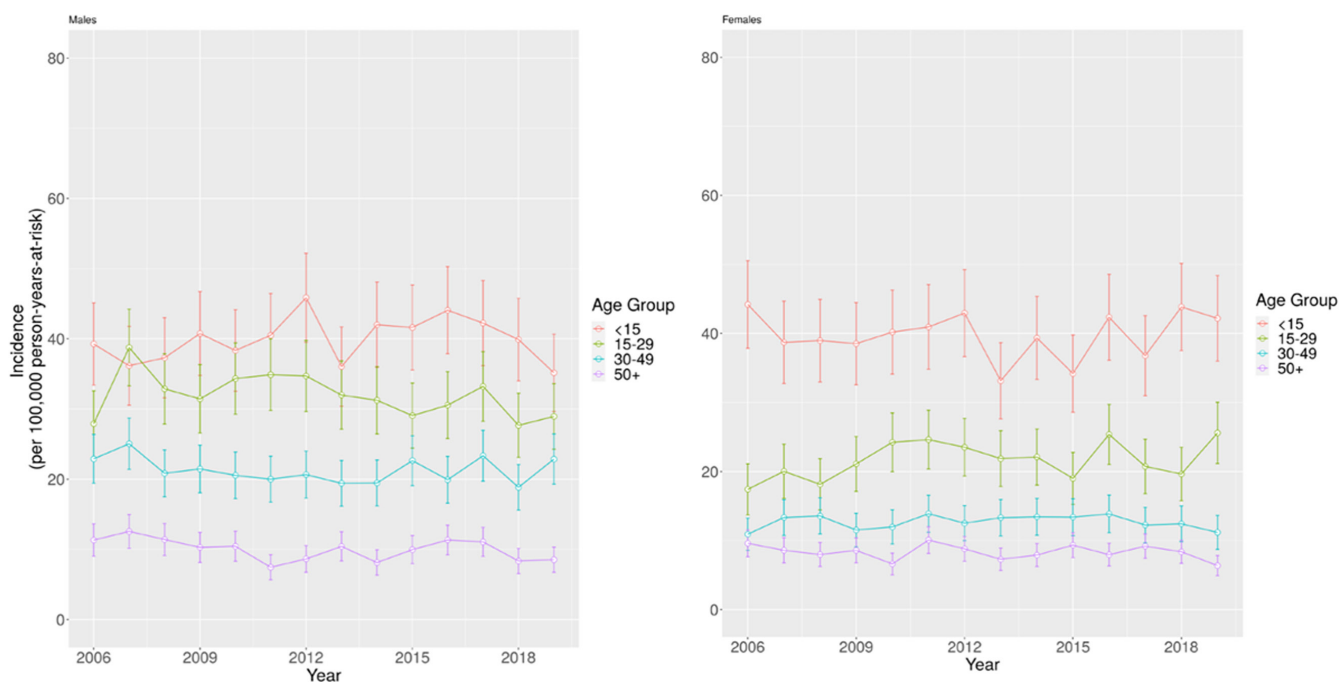
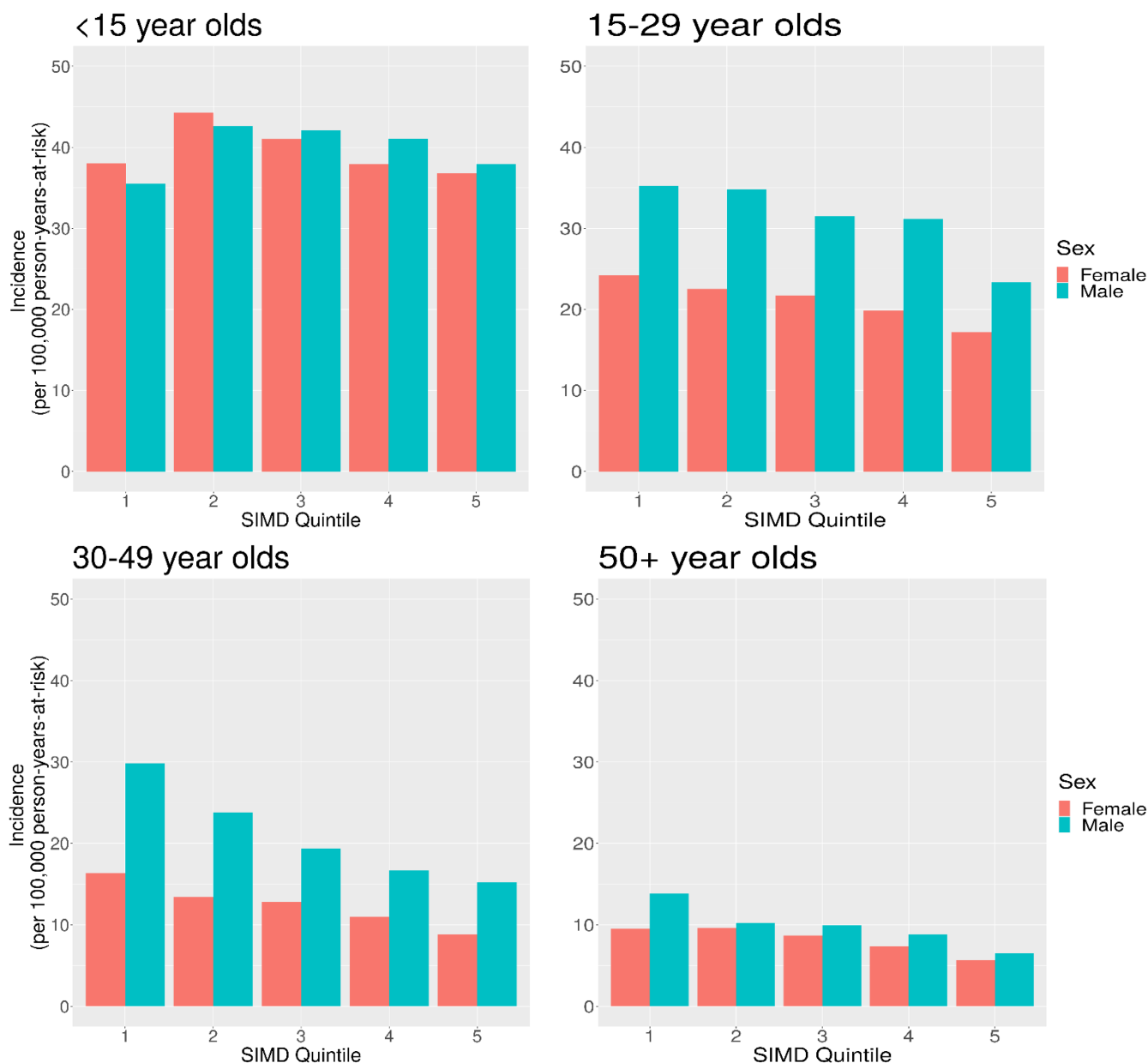


FIGURE 2 Annual incidence of T1DM in Scotland for 2006 to 2019 by sex for age groups <15, 15–29, 30–49 and 50+ years.



**FIGURE 3** Incidence of T1DM in Scotland 2006–2019 by age group, sex and fifths of the SIMD, where Q1 describes the most and Q5 the least deprived fifth (*top panel for <15 and 15–29 year olds and bottom panel for 30–49 and, 50+ year olds*).

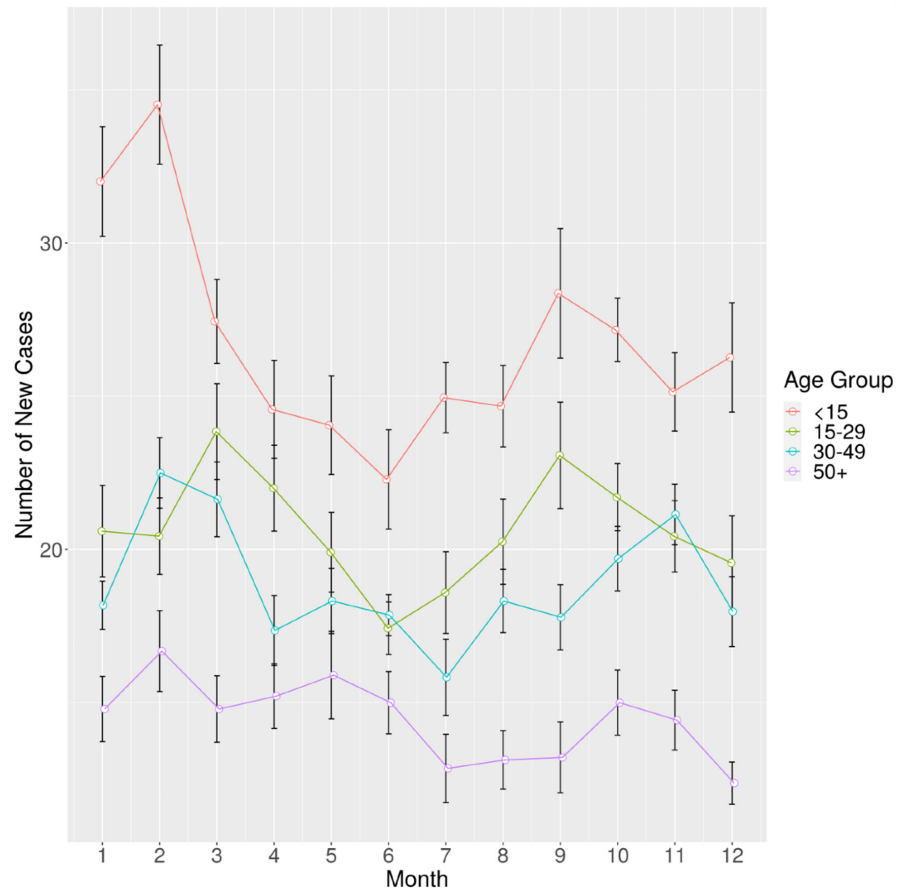
of the assignment of type of diabetes in 50+ year olds and incidence of type 1 diabetes for this age group may be overestimated by inclusion of possible type 1 diabetes.

When examining the number of incident type 1 diabetes cases between 2006 and 2019 by age group and month (Figure 4), there were fewer cases in the summer months for most age groups and a January/February peak was only observed for under 15 year olds. Chi-squared goodness of fit tests across the 12 months for each of the different age groups revealed a significant difference in new cases across months for those under 50 years old ( $p < 0.0005$ ), providing evidence of differences in incidence by month.

## 4 | DISCUSSION

We have shown that incidence of type 1 diabetes varies by age, sex and month and also, for people over 14 years of age, by SES. The incidence of type 1 diabetes has been approximately stable in Scotland between 2006 and 2019. The Scottish Diabetes Surveys<sup>20</sup> indicate that prevalence of type 1 diabetes in Scotland has increased from 0.52% in 2006 to 0.61% in 2019, which is consistent with previous reports of declining mortality over time among people with type 1 diabetes in Scotland.<sup>21</sup>

**FIGURE 4** Mean (SD) number of incident T1DM cases between 2006 and 2019 in Scotland by age group and month, where 1 is January and 12 December (adjusted to equal length months and after exclusion of diagnoses on 1 January).



Our findings contrast with previous estimates of incidence of type 1 diabetes among children in Scotland. These were based on data derived from one or both of paediatric hospital admission records (with correction for re-admission) and a register maintained by the Scottish Study Group for the Care of Diabetes in the Young (SSGCDY). Incidence of type 1 diabetes was approximately 13.8 per 100,000 in under 15 year olds for 1968–1976,<sup>1</sup> 21.0 for under 19 year olds for 1977–1983<sup>22</sup> and 23.9 per 100,000 under 15 year olds for 1984–1993.<sup>2</sup> Unpublished data collated by one of the co-authors (NW) from the SSGCDY register suggested that incidence of type 1 diabetes increased from approximately 25 to 33 per 100,000 in under 15 year olds between 1994 and 2005. A comparison of numbers of incident cases between 1985 and 2014 performed by other co-authors (SP and SW) found slightly higher numbers in SCI-diabetes than the SSGDY register suggesting minor under-ascertainment in the SSGDY register. Our estimates based on data from the SCI-diabetes dataset suggest that type 1 diabetes has been approximately stable between 2006 and 2019 at around 40 per 100,000 for under 15 year olds. This pattern of reduction in the rate of increase in type 1 diabetes incidence over time is consistent with that reported in other high-risk countries at the start of the 21st century.<sup>3</sup> In Finland between 2003 and 2018 incidence of type 1 diabetes declined in <5 year olds of both

sexes, in 5–9 year old girls with stable incidence for 10–14 year olds.<sup>23</sup> Type 1 diabetes incidence in <15 year olds in Wales declined between 2010 and 2019 for all 5-year age strata.<sup>24</sup> We found no evidence to suggest that there is a four- or six-yearly cyclical pattern of type 1 diabetes incidence as reported in some other countries.<sup>3</sup> Incidence of type 1 diabetes in children in Scotland increased in 2020 and 2021 with incidence approximately 1.2 times higher than the average for 2015–2021, marked variation by year and no evidence to suggest that this increase was caused by SARS-CoV-2 infection.<sup>25</sup>

Scotland has the second-highest age-sex standardised incidence of type 1 diabetes in under 15 year olds (39.9/100,000) after Finland (60.9/100,000) for the period 2008–2013 using equal numbers of children in each five-year stratum in the standard population. Incidence in Scotland for this period was similar to that in Stockholm county in Sweden (39.6/100,000) and higher than for Northern Ireland (34.4/100,000), Yorkshire (31.0/100,000) and Oxford (22.8/100,000) as reported in the EURODIAB study.<sup>3</sup> Estimates for type 1 diabetes incidence for under 15 year olds for Wales for 2008–2018 were 33.6/100,000.<sup>26</sup> These findings are consistent with suggestions of a positive association between T1DM incidence and latitude.<sup>27</sup> There are, however, some notable exceptions to this pattern given high incidence of type 1 diabetes among under

15 year olds reported in Sardinia (38.8 per 100,000 for 1989–1999,<sup>28</sup>) Kuwait (40.9 per 100,000 for 2011–2013<sup>29</sup>) and eastern Saudi Arabia (36.9 per 100,000 for 2007.<sup>30</sup>)

The incidence rate ratios for adults compared to under 15 year olds that were used in recent global estimates of type 1 diabetes incidence and prevalence derived from Danish data were broadly similar in Scottish data including probable type 1 diabetes: 0.50 (Danish) and 0.63 (Scottish) for 15–39 year olds; 0.30 (Danish) and 0.32 (Scottish) for 40–64 year olds; 0.25 (Danish) and 0.19 (Scottish) for 65+ year olds.<sup>5</sup> However, further data are clearly needed for populations beyond northern Europe to validate these estimates and this approach to estimating type 1 diabetes incidence and prevalence in adults. Different age categories, time periods and definitions of type 1 diabetes were used in the 2022 systematic review of type 1 incidence in adults<sup>6</sup> that limit direct comparison and may account for apparent discrepancy in findings for Scotland. The systematic review stated that type 1 diabetes incidence in Scotland increased between 2012 and 2019 in two of the three age strata. The methods of assessing time trends and their statistical significance in the review were not described. Although the joinpoint regression models in our analysis did not provide any evidence of non-linear change in incidence for >15 year olds in Scotland between 2006 and 2019, this analysis was based on assuming only either one or two break points and was fitted to a relatively short time series so had limited power. Non-linear cohort effects that varied between centres were identified in age-period-cohort models in the 25 year follow-up of the EURODIAB study<sup>31</sup> but limited evidence of a cohort effect was identified in this study. Further investigation of cohort effects on incidence of type 1 diabetes in Scotland will be valuable when data for a longer period have accumulated. Consistent with the systematic review's findings, we also found that type 1 diabetes incidence is higher in men than women and that type 1 diabetes incidence in adults declines with increasing age, which was identified as an area of uncertainty in the review.<sup>6</sup> The declining incidence of type 1 diabetes with age in this study occurred even though overestimation may have occurred due to misclassification of type of diabetes.

These estimates of incidence of type 1 diabetes in Scotland for 2006–2019 are based on data on the diagnosis of diabetes in a whole population, that validation against hospital admission and prescription data suggests is close to complete. There is scope for misclassification of diabetes type, particularly in adult populations, despite the application of an algorithm to improve the classification. Applying the algorithm to data for people with prevalent diabetes in 2010–2019 resulted in reclassification of approximately 1300 people with a clinical record of type

1 diabetes to type 2 diabetes and of approximately 3352 people with a clinical record of type 2 diabetes to type 1 diabetes.<sup>32</sup> It is possible that incidence of type 1 diabetes may be overestimated in 50+ year olds by implementing the algorithm. Increasing measurement of C-peptide and islet cell antibodies after a clinical diagnosis of type 1 diabetes is likely to improve classification of type of diabetes in the future. It is possible that date of diagnosis of diabetes is less accurate for people who move to Scotland after diagnosis of diabetes. For the seasonal analyses we excluded people with a date of diagnosis on 1 January because the unexpectedly high proportion suggested that the day and month of diagnosis of diabetes were implausible. Another option would have been to re-distribute these cases throughout the year in proportion to the distribution of cases with a plausible date of diagnosis of diabetes, but doing this would not change our conclusions about seasonal patterns.

We noted an inverse association between incidence of type 1 diabetes and SES among people over 14 years of age consistent with that observed in non-age stratified data for Wales.<sup>26</sup> However, the lack of an association for under 15 year olds contrasts with the finding of a positive association between area-based SES measured using the Carstairs score and incidence of type 1 diabetes identified from hospital admission in under 19 year olds previously reported in Scotland between 1977 and 1983.<sup>30</sup> The small proportion (1.6%) of people who were excluded from the estimates of incidence of type 1 diabetes by SES as a consequence of missing data means that the estimates are unlikely to be biased or conclusions materially affected. SIMD is an area-based measure of SES and does not provide information about individual socio-economic status or the relative contribution of different domains of deprivation. In addition SIMD may reflect health inequalities differently in urban and rural areas. However, as the urban–rural classification variable is not included in SCI-diabetes it was not possible to explore this or whether urban–rural differences in type 1 diabetes persist in Scotland.

Seasonal variation in incidence of type 1 diabetes with peak incidence in the winter months has been observed among children in both northern and southern hemispheres.<sup>24,26,33–36</sup> An inverse association between ultraviolet B exposure adjusted for cloud cover and incidence of type 1 diabetes has previously been described using data for 1990–1994 from 51 regions across the world.<sup>37</sup> Meteorological data indicating increasing sunlight in Wales in recent years add further support to the hypothesis that vitamin D may play a role in both the seasonal variation in risk of type 1 diabetes and secular trends in incidence.<sup>24</sup> We found that the seasonal variation was less marked above 14 year of age although there appeared to be a trough in the summer for all age groups. A previous



study suggested that seasonal variation is less marked in children <5 years of age than older children and in girls than boys.<sup>34</sup> Other possible explanations that have been proposed to explain seasonal variation in type 1 diabetes incidence include varying exposure to infectious diseases and dietary patterns throughout the year.

In conclusion, we report approximately stable incidence of type 1 diabetes in Scotland between 2006 and 2019, variation in incidence by age and sex and by socio-economic status for individuals above 14 years of age. Incidence of type 1 diabetes in children is higher compared to previous periods in Scotland and to other regions of the United Kingdom and most estimates from other European countries. These estimates form the basis for health service planning (e.g. planning equitable services and estimating costs for introducing new technology) and for monitoring future trends. The estimates should be validated in the future when further phenotype data are routinely available.

### AUTHOR CONTRIBUTIONS

Louise Bath, Sarah Kiff, Sam Philip and Sarah H. Wild conceived the study design, Louise Bath, Sarah Kiff, and Sam Philip contributed to data acquisition the analysis was conducted by India Thomson and supervised by Niall Anderson, India Thomson wrote the first draft. All authors have interpreted the data, revised the manuscript critically and (will) approve the final version to be published.

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### CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

### DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the National Health Service in Scotland but restrictions apply to the availability of these data, which

were used under license for the current study and so are not publicly available.

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## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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