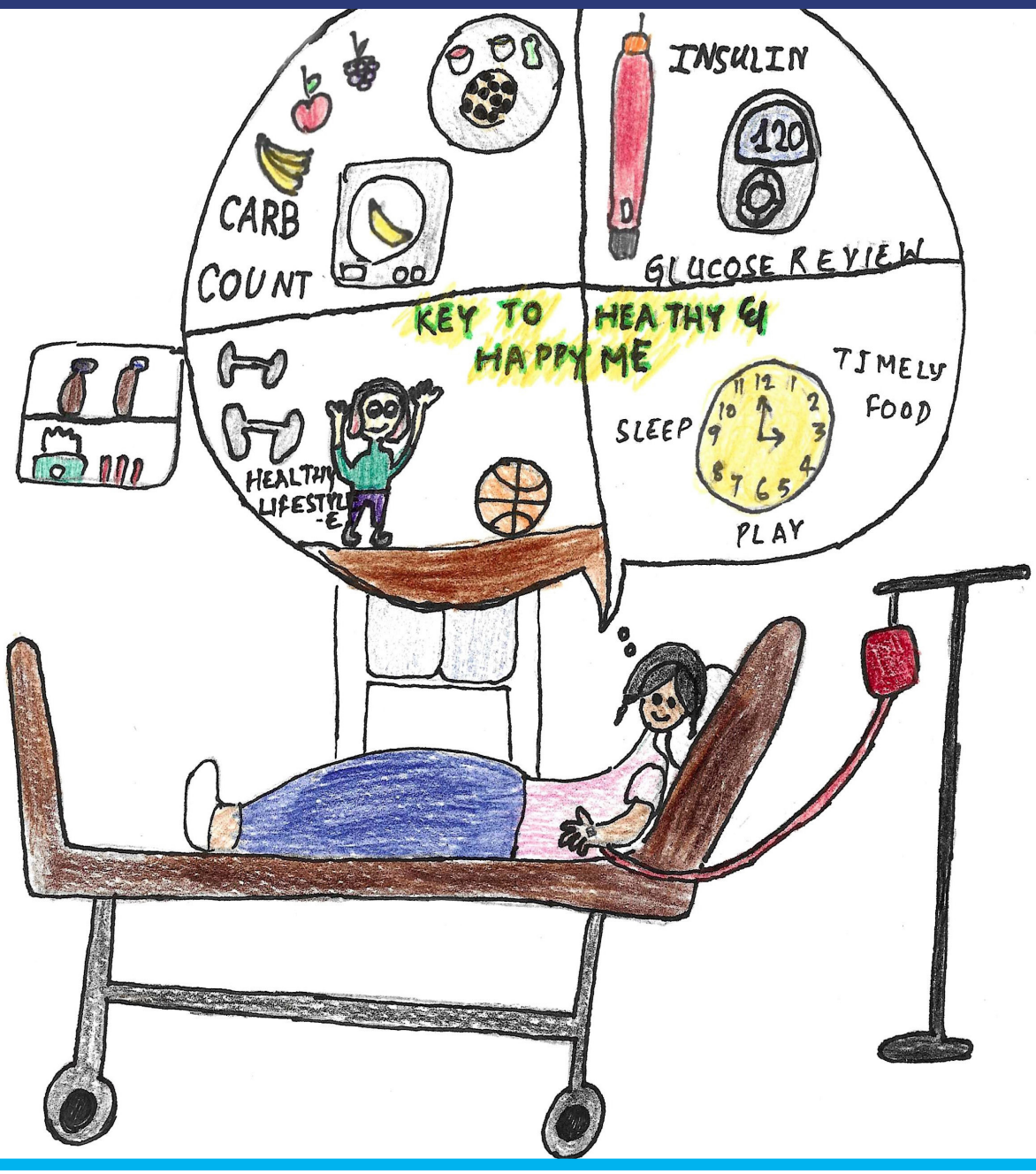
NPDA
National Paediatric Diabetes Audit

RCPCH Audits

Report on hospital admissions of children and young people with diabetes, 2015-2020



HQIP
Healthcare Quality Improvement Partnership

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Royal College of Paediatrics and Child Health
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National Paediatric Diabetes Audit

Report on hospital admissions of children and young people with diabetes, 2015-2020

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Contents

Summary of key findings, recommendations and key messages

All diabetes-related admissions

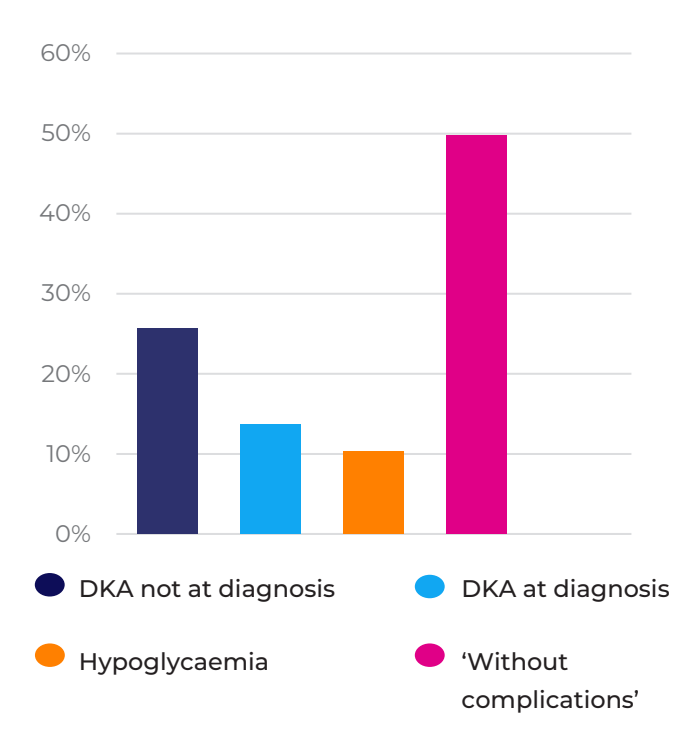
7,310-7,660
Total numbers of diabetes-related admissions recorded for children and young people receiving care from paediatric diabetes units in the 2015-16 and 2019-20 audit years, respectively, for all types of diabetes

Admission rates were stable between 2015-2020
With around 25 admissions per 100 children and young people with diabetes per year. Increases in number mirrored increases in the numbers of children and young people with diabetes over the same period

Increased admission rates were found in Wales and the North West

>95% of all admissions were of children and young people with Type 1 diabetes

Type 1 diabetes-related admissions 2015-20



Around 12% of all children and young people with Type 1 diabetes were admitted
for diabetes-related reasons subsequent to diagnosis within each audit year

Children aged 0-6 had a higher proportion of admissions than their representation in the NPDA

Girls, and children and young people living in the most deprived areas were overrepresented
in the number of admissions related to Type 1 diabetes

Around half of all admissions were coded 'Without complications'
within the HES/PEDW datasets, with ~60% of these coded as 'stabilisation of diabetes' in the NPDA dataset

DKA at diagnosis of Type 1 diabetes

There was a steady increase in DKA at diagnosis across the audit years
With the rate increasing from 29.3% in 2015/16 to 38.5% in 2019/20

A third of all DKA admissions were at diagnosis of Type 1 diabetes

Children aged 0-4, those living in the most deprived areas and those of minority ethnicity had higher rates of DKA at diagnosis

There was a variation of admission rates for DKA at diagnosis between regions
and between the same regions in different years

DKA admissions of children and young people with Type 1 diabetes not related to diagnosis

Between 4.6% and 5.2% of all children with Type 1 diabetes were admitted with DKA, not at diagnosis, within each audit year
This rate was stable between 2015-2020

~15% of all children and young people with an HbA1c >80mmol/mol had a DKA admission within each audit year
and less than 2% of those with an HbA1c ≤48mmol/mol were admitted with DKA

Adolescents with a longer duration of diabetes, those living in the most deprived areas and black children and young people had higher rates of DKA not at diagnosis

Mannitol or hyper tonic saline was used in ~5% of all DKA admissions
to treat or prevent cerebral oedema

Risk factors for DKA not related to diagnosis

A generalised structure equation model revealed that the following patient characteristics were associated with an increased risk of admission (after controlling for other factors in the model)

Age <5 years old

With those aged 5-9 years having a 43.5% lower risk of admission compared to those aged 0-4 years.

Duration of diabetes >1 year

With those having longer duration being more than twice as likely to require admission compared to those in their first year of diabetes.

Female sex

With girls having a 33.3% higher risk of admission than boys.

Higher HbA1c

With an eightfold increased risk of admission amongst children and young people with HbA1c ≥80 mmol/mol compared to those with HbA1c <58 mmol/mol.

Deprivation and ethnicity

With children and young people living in the least deprived areas having a 41% lower risk of admission compared to those in the most deprived areas, and children of minority ethnicities having lower risk than White children and young people of admission of between 17.6 and 39.2%*.

Treatment regimen

With a 21.3 % lower risk of admission associated with insulin pump therapy combined with rtCGM compared to use of insulin injections alone.

* Higher rates of admissions observed for non-White children and young people are possibly explicable based on typically higher HbA1c and higher deprivation amongst these cohorts. Please see page 26 for further details.

Admissions of children and young people with Type 1 diabetes for hypoglycaemia

Hypoglycaemia was present in ~10% of diabetes-related admissions
This rate was stable between 2015-16 and 2019-20.

~ 2.5% of all children and young people with Type 1 diabetes had an admission with hypoglycaemia in each audit year

Children aged 0-4, girls, those living in a deprived areas and those with higher HbA1c
had higher rates of hypoglycaemia admission

Risk factors for admission with hypoglycaemia

A generalised structural equation model revealed that the following patient characteristics were associated with increased risk of admission (after controlling for other factors included in the model):

Younger age
With those aged 5-9 having a 53.0% reduced risk compared to those aged 0-4.

Duration of diabetes >1 year
With 16.7% increased risk if diagnosed 10+ years before compared to those diagnosed less than 1 year before each audit period.

Female sex
With 12.5% higher risk of admission compared to boys.

Higher HbA1c
With 33.3% increased risk for those with HbA1c ≥80 mmol/mol compared to those HbA1c <58 mmol/mol.

Deprivation
With 38.7% lower risk for children and young people living in the least deprived areas compared those in the most deprived areas.

Treatment regimen
With 65.4% increased risk of admission with use of insulin injections plus rtCGM compared to injections alone*, and 15.4% reduction in risk if using insulin pump compared to injections alone.

*This finding should be interpreted with caution, as it could be explained by children and young people having an admission for hypoglycaemia earlier in the audit year, and subsequently being offered a rtCGM to support future avoidance of admission.

Recommendations

1. Every emergency hospital admission for children and young people with diabetes is potentially avoidable. Integrated Care Boards (ICBs) in England and Local Health Boards (LHBs) in Wales should undertake reviews of services within their respective areas and benchmark them against others. ICBs and LHBs should also ensure that training is provided to families and healthcare professionals to avoid further events using nationally approved guidelines (e.g. those developed by the **British Society for Paediatric Endocrinology and Diabetes (BSPED)**, and the **Association for Children's Diabetes Clinicians ACDC)**), structured education programmes (e.g. **SEREN**, **DEAPP**), and **Digibete** (an NHS England/Wales funded digital education resource). This should include 24-hour expert advice to families and health professionals providing care in the acute setting.

2. Campaigns to aid early diagnosis of Type 1 diabetes by raising awareness of signs and symptoms of diabetes should be reinvigorated and strongly supported by all stakeholders e.g. Diabetes UK's 4 'T's campaign.

3. Integrated Care Boards (ICBs) across England, in line with the aims for diabetes care set out within Core20PLUS5 (the NHS England approach to reducing health inequalities for children and young people), and Local Health Boards (LHBs) and Public Health Wales, should be aware of the different case mix managed by their paediatric diabetes teams across their respective areas and recognise where higher proportions of children and young people with certain demographics (adolescence, non-white ethnicity, female sex, and living in a deprived area) are associated with higher rates of admission. ICBs and LHBs and Public Health Wales should ensure that training and adequate resourcing should be provided to meet these extra needs.

4. All children and young people with Type 1 diabetes should be able to access a choice of diabetes- related technologies appropriate to their individual needs, with families being made aware of the potential differences in risk of admission with different modalities of insulin delivery and blood glucose monitoring.

5. Integrated Care Boards (ICBs) in England and Local Health Boards (LHBs) in Wales should provide appropriate funding to support the use of diabetes-related technologies within paediatric diabetes services in their areas of responsibility to help reduce the risk of acute hospital admissions. This should not only include the cost of the technology, but also the cost of training staff and families to use such technologies successfully.

Key Messages

1. All cause admission rates remained constant in England and Wales despite a downward trend in national HbA1c from 2015/16 to 2019/20. However, there was considerable regional variability.

2. Rates of DKA at diagnosis of Type 1 diabetes increased over five years.

3. Lower rates of admission with DKA, not at diagnosis, were associated with lower HbA1c and use of real time continuous glucose monitoring (rtCGM) in children and young people with Type 1 diabetes.

4. Children and young people with Type 1 diabetes were more likely to be admitted for diabetes-related reasons if they were female, of Black ethnicity, or were living in more deprived areas, with longer duration of diabetes associated with higher risk of hypoglycaemia and DKA admission not at diagnosis.

5. Statistical modelling of admissions for DKA post diagnosis and HbA1c > 80 mmol/mol suggests that admission rates could be improved amongst children and young people with Type 1 diabetes in this HbA1c category by using an insulin pump and rtCGM.

Introduction

The National Paediatric Diabetes Audit (NPDA) is managed by the Royal College of Paediatrics and Child Health (RCPCH) and commissioned by the Healthcare Quality Improvement Partnership (HQIP) as part of the National Clinical Audit and Patient Outcomes Programme (NCAPOP). HQIP is led by a consortium of the Academy of Medical Royal Colleges, the Royal College of Nursing, and National Voices. It aims to promote quality improvement in patient outcomes, and in particular, to increase the impact that clinical audit, outcome review programmes and registries have on healthcare quality in England and Wales. HQIP holds the contract to commission, manage, and develop the National Clinical Audit and Patient Outcomes Programme (NCAPOP), comprising around 40 projects covering care provided to people with a wide range of medical, surgical and mental health conditions. The programme is funded by NHS England, the Welsh Government and, with some individual projects, other devolved administrations and crown dependencies **www.hqip.org.uk/national-programmes**.

The NPDA has been reporting for 19 years. Data is submitted by healthcare professionals in Paediatric Diabetes Units (PDUs) in England and Wales about the care received by the children and young people with diabetes using their service. The effectiveness of diabetes care is measured in a core annual audit against NICE guidelines (**NG18**, **NICE 2015**) and includes treatment targets, health checks, patient education, psychological wellbeing, and assessment of diabetes-related complications including acute hospital admissions, all of which are vital for monitoring and improving the long-term health and wellbeing of children and young people with diabetes.

This report provides additional analysis of admissions of children and young people with diabetes over five annual audit cycles between the 1st April 2015 and the 31st March 2020.

Admissions to hospital among children and young people with diabetes place a large burden on NHS resources and patient and family wellbeing and can be considered as a quality of care or performance indicator. This report investigates acute emergency hospital admissions where the primary diagnosis is related to diabetes in children and young people cared for in Paediatric Diabetes Units (PDUs) in England and Wales.

Key audit questions:

- How many children and young people with diabetes are being admitted to hospital each year for diabetes-related causes?
- Have there been changes to admission rates over time?
- Is there regional variation in hospital admission rates?
- What patient characteristics are associated with risk of hospital admission?
- What associations are there between use of diabetes-related technologies and admission rates?

Methodology

Between 1st April 2015 and 31st March 2020 there were 38,095 all cause diabetes-related admissions to hospital of children and young people receiving care from PDUs. Admission numbers were obtained by triangulating data submitted by PDUs with data from the Hospital Episode Statistics for England (HES) database and Patient Episode Database for Wales (PEDW), which were obtained by linking NHS numbers of children and young people with diabetes submitted to the NPDA .

The NPDA dataset was limited to hospital admissions where the diagnosis was recorded as:

- Diabetic ketoacidosis
- Hypoglycaemia
- Stabilisation of diabetes
- Ketosis without acidosis

The HES/PEDW datasets were limited to admissions with specific ICD-10 codes related to diabetes as the primary cause of admission and included:

- Diabetic ketoacidosis (ICD-10 code E10.1)
- Hypoglycaemia (ICD-10 codes E160, E161 and E16.2)
- Admissions 'without complications' (ICD- 10 code E10.9)
- Other diabetic complications (ICD-10 codes E100, E102-10.8)

Datasets were cleaned and merged, matching on admission date and NHS number.

Figure 1 shows that 39.9% of these admissions were found in both datasets, 52.4% were only found in the HES/PEDW dataset, and a further 7.7% were found in the NPDA dataset alone.

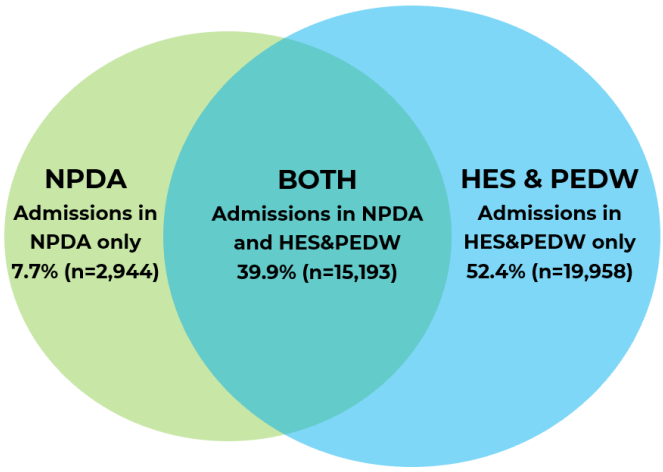


Figure 1: Number and percentage of all cause diabetes related admissions recorded as the primary diagnostic code in the HES/PEDW and NPDA datasets April 2015-March 2020.

The methodology for identifying admissions for analysis differed from that used for the previous NPDA admissions report (RCPCH, 2017) so results should be compared with caution.

The full methodology is shown in Appendix I.

Diabetes-related hospital admissions: All diabetes types

Rates of hospital admissions amongst children and young people with diabetes

There were a total of **38,095 all cause** diabetes-related hospital admissions of children and young people with all types of diabetes between 2015-2020. See Appendix II for a breakdown of all cause admissions by region and nation. Figure 2 presents the rate of admissions per every 100 children and young people of all types of diabetes, by nation, regional network and NHSE region, broken down by audit year. Overall there was little change in the rate over five years, but regional variability is observed with the North West and Wales showing the highest rates, with about 30 admissions per every 100 children with diabetes. A complete table of numerators and denominators is available in the Appendix of this report.

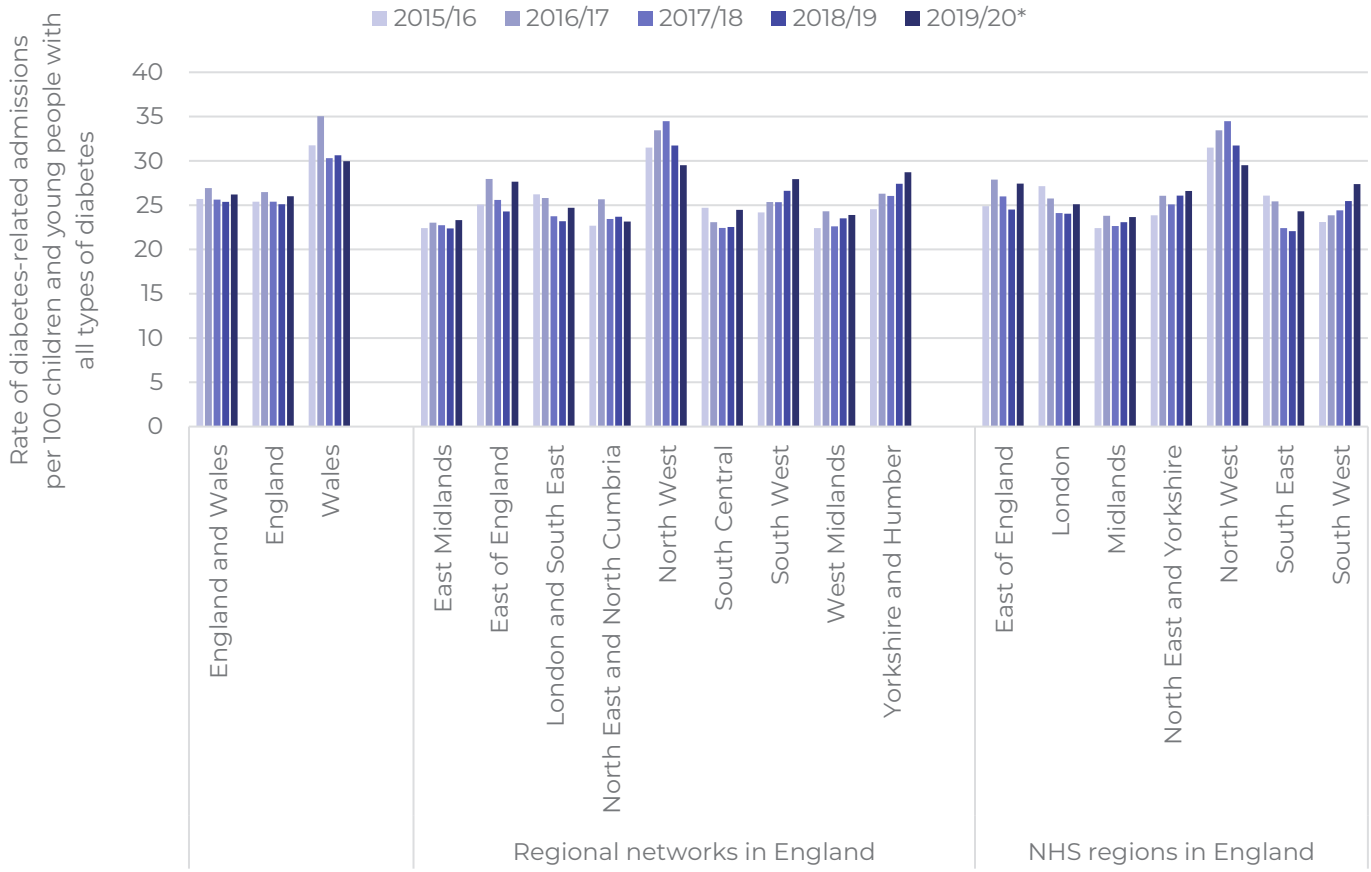


Figure 2: Rate of all cause diabetes-related admissions per 100 children and young people with all types of diabetes, by country, regional network, NHSE regions (2015-2020)
(denominators = number of children and young people with all types of diabetes)

Diabetes-related admissions by diabetes type

Table 1 shows the breakdown of all diabetes-related admissions by diabetes type over the five audit years. Most hospital admissions were of children and young people with Type 1 diabetes (>96% for all five years), which is consistent with the proportion of children with Type 1 diabetes recorded in the NPDA.

Table 1: Numbers and percentage of all diabetes-related admissions by diabetes type (2015/16-2019/20), and percentage of children and young people with all types of diabetes in the NPDA (2019/20) (denominator= all diabetes-related admissions with known diabetes type)

Diabetes type	2015/16 n (%)	2016/17 n (%)	2017/18 n (%)	2018/19 n (%)	2019/20 n (%)	%CYP with diabetes 2019/20
Type 1 diabetes	7121 (97.5%)	7636 (97.4%)	7405 (97.2%)	7413 (97%)	7378 (96.7%)	95.1%
Type 2 diabetes	144 (2%)	142 (1.8%)	144 (1.9%)	148 (1.9%)	166 (2.2%)	3.0%
Cystic fibrosis	11 (0.2%)	11 (0.1%)	8 (0.1%)	8 (0.1%)	15 (0.2%)	0.7%
Maturity onset diabetes of the young (MODY)	14 (0.2%)	17 (0.2%)	20 (0.3%)	18 (0.2%)	28 (0.4%)	0.4%
Other types	15 (0.2%)	33 (0.4%)	38 (0.5%)	54 (0.7%)	42 (0.6%)	0.8%

* Excludes unspecified types of diabetes, which was close to 0% each year.

Further breakdown of admission cause is presented for children and young people with Type 1 diabetes only, as small numbers in the other diabetes groups do not permit meaningful analysis.

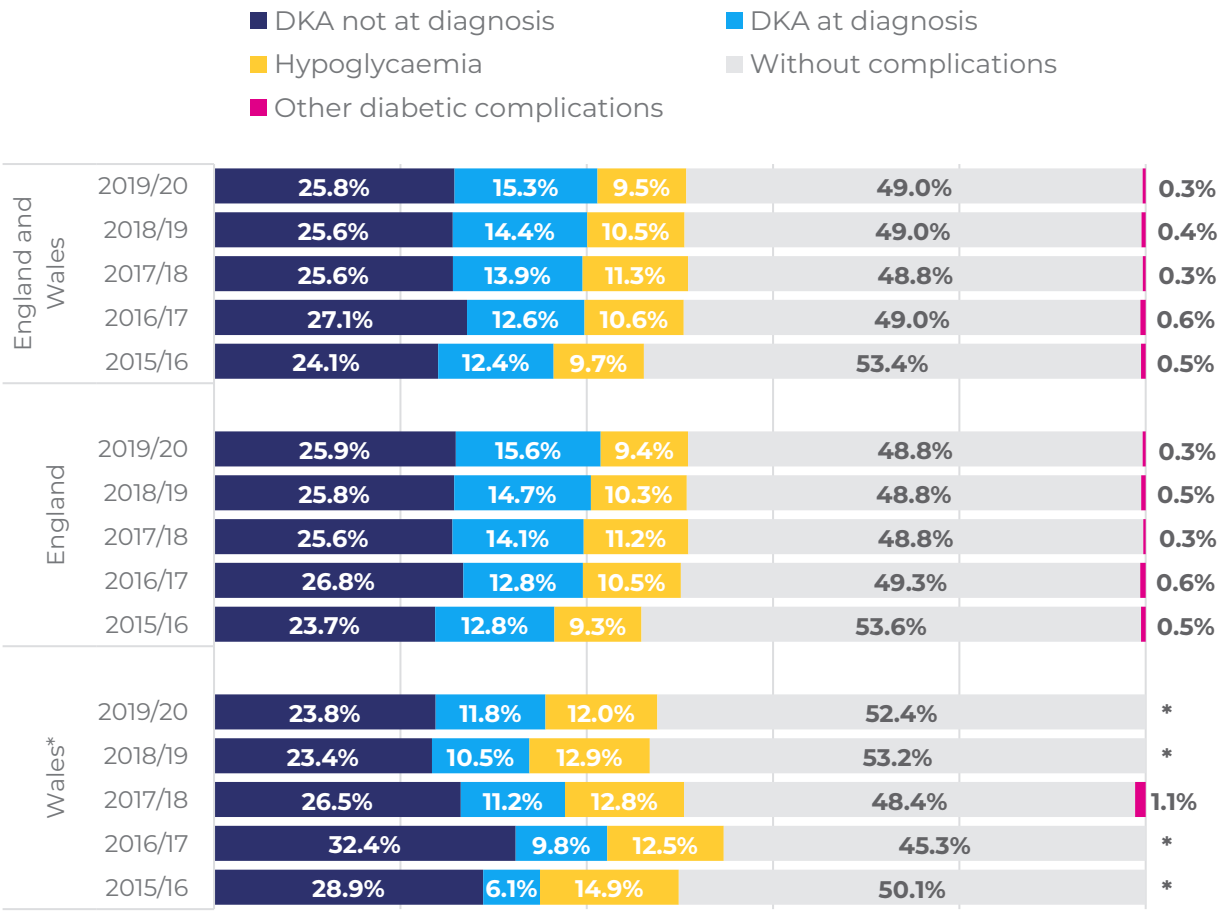
Type 1 diabetes-related admissions

Type 1 diabetes-related admissions, by admission reason

Figure 3 shows the percentage of admissions in children and young people with Type 1 diabetes by cause and audit year for England, Wales and overall. Approximately 40% of all admissions in children and young people with Type 1 diabetes related to DKA (either at diagnosis or post diagnosis), 10% related to hypoglycaemia, and about 50% related to other causes with little variation over the five years.

The category 'without complications' aggregates the categories of ketosis without acidosis and stabilisation of diabetes within the NPDA dataset, and the code E109 "admissions without complications" within the HES/PEDW dataset. A breakdown of the reasons for admission recorded in the NPDA for those admissions that were matched within the HES/PEDW and coded E109 shows that 64.8% corresponded to 'stabilisation of diabetes' and 23.6% to 'ketosis without acidosis'.

The category 'other diabetic complications' aggregates admissions coded E100, E102-108, referring to diabetes with coma, renal complications, ophthalmic complications, neurological complications, peripheral circulatory complications and multiple complications, within the HES/PEDW dataset.



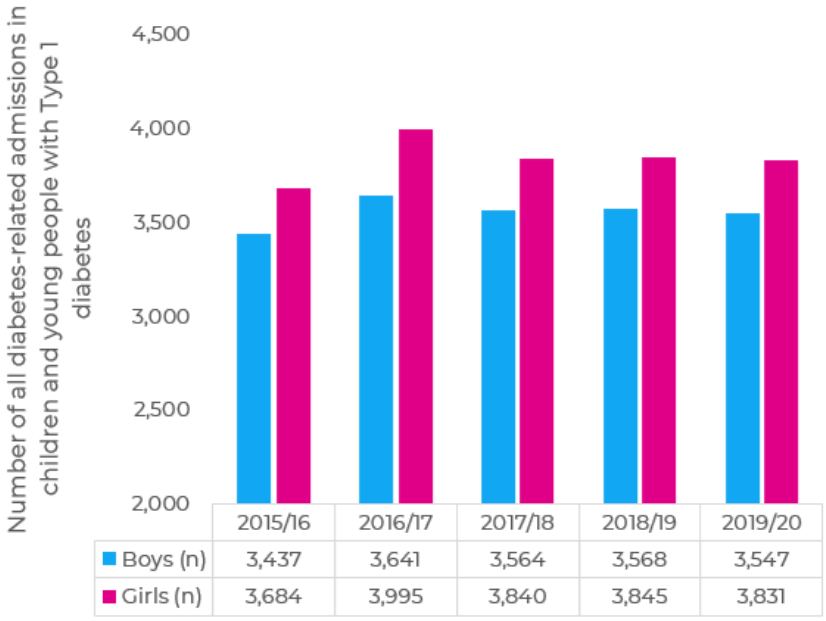
* Numbers <4 masked for "other diabetic complications."

Figure 3: Breakdown of admission reasons for Type 1 diabetes-related admissions in England and Wales (2015/16-2019/20)
(denominator= all diabetes-related admissions in children and young people with Type 1 diabetes)

Characteristics of children and young people with Type 1 diabetes admitted for diabetes related reasons

Sex

There was a higher number of diabetes-related hospital admissions for girls with Type 1 diabetes compared to boys (Figure 4), with consistency in this trend over the five years.



	2015/16	2016/17	2017/18	2018/19	2019/20
Boys (n)	3,437	3,641	3,564	3,568	3,547
Girls (n)	3,684	3,995	3,840	3,845	3,831

	% of admissions where the patient was female	% of CYP included in the core NPDA who were female
2019/20	51.9%	47.7%
2018/19	51.9%	47.8%
2017/18	51.9%	47.6%
2016/17	52.3%	47.6%
2015/16	51.7%	47.4%

Figure 4: Number of diabetes-related admissions in children and young people with Type 1 diabetes, by gender (2015/16-2019/20) and percentage of admissions in girls with Type 1 diabetes (2015/16 - 2019/20)

Age

The numbers and proportions of all diabetes-related admissions by age-group for those with Type 1 diabetes remained stable across the five audit years.

Figure 5 shows the proportion of diabetes-related admissions in children and young people with Type 1 diabetes, and the overall proportion of children and young people with Type 1 diabetes, by each year of age. There was a greater proportion of admissions in younger children. Around 60% of admissions in children 0-4 years old correspond to admissions at diagnosis. Caution should be taken in the interpretation of the admission rates in the 15-24 age group as the case ascertainment of the NPDA starts to decrease from age 15 as young people begin to transition to adult services.

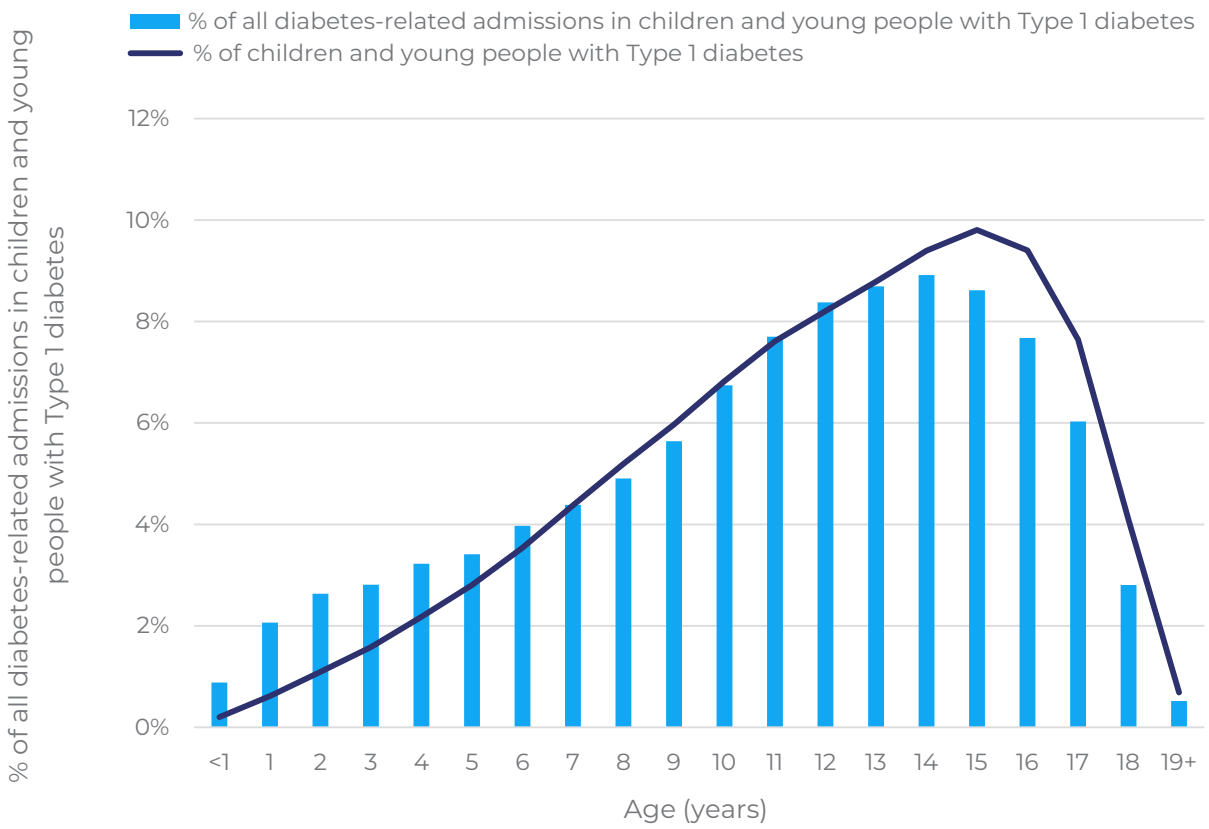


Figure 5: Percentage of all diabetes-related admissions and of children and young people with Type 1 diabetes by single year of age (2015-2020)
(denominator= all diabetes-related admissions in children and young people with Type 1 diabetes)

Duration of diabetes

Figure 6 shows that the proportion of admissions by single year of duration of diabetes decreased at a similar rate as the proportion of children within each group.

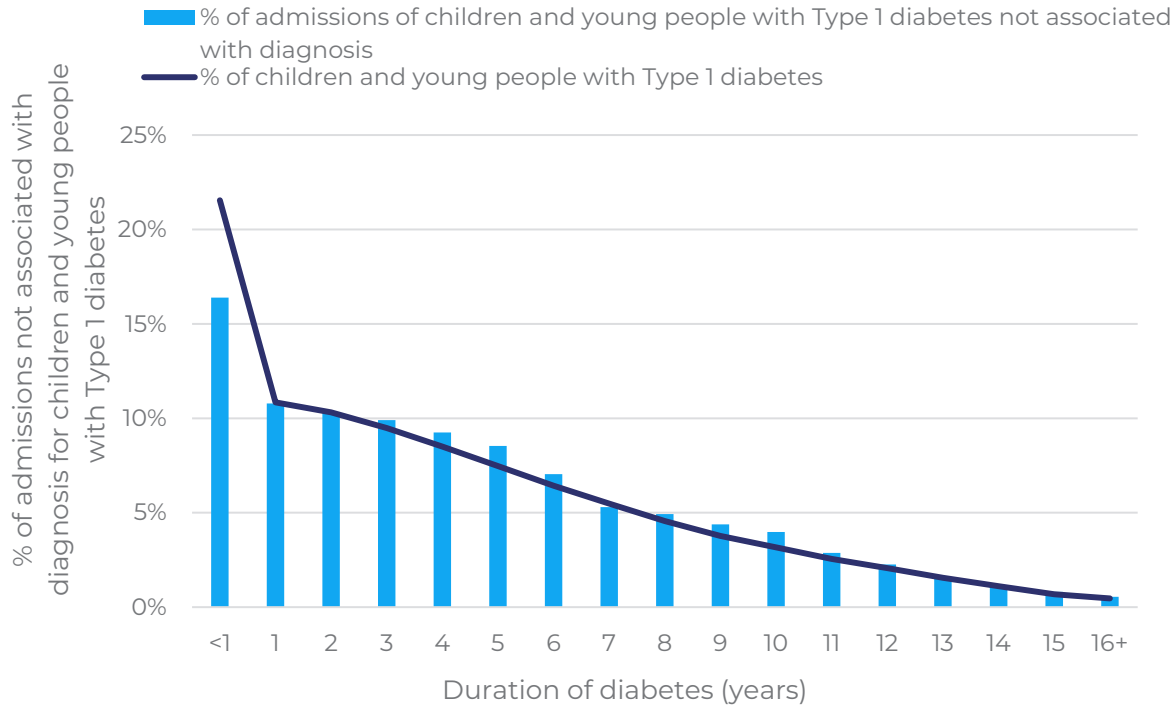


Figure 6: Percentage of admissions not-at-diagnosis and of children and young people with Type 1 diabetes by single year of duration of diabetes (2015-2020)
(denominator= all diabetes-related admissions not associated with diagnosis in children and young people with Type 1 diabetes and a known date of diabetes diagnosis)

Ethnicity

Table 2 shows the breakdown of admission rates for children and young people with Type 1 diabetes within each ethnic category across the five years compared to the background percentage within each ethnic category in 2019/20. It shows similar percentages of admissions of children and young people with Type 1 diabetes compared with the representation of each ethnic category in the NPDA.

Table 2: Percentage and number of diabetes-related admissions for children and young people with Type 1 diabetes, by ethnic group (2015/16-2019/20)
(denominator= all diabetes-related admissions in children and young people with Type 1 diabetes and a known ethnicity)

Ethnicity	2015/16 n (%)	2016/17 n (%)	2017/18 n (%)	2018/19 n (%)	2019/20 n (%)	% CYP with T1D, 2019/20*
White	5858 (83.7%)	6296 (83.9%)	5990 (82.3%)	5953 (82%)	5934 (82.6%)	84.1%
Asian	435 (6.2%)	469 (6.2%)	497 (6.8%)	499 (6.9%)	466 (6.5%)	6.6%
Black	353 (5%)	372 (5%)	387 (5.3%)	363 (5%)	389 (5.4%)	4.0%
Mixed	227 (3.2%)	227 (3%)	254 (3.5%)	279 (3.8%)	248 (3.5%)	3.2%
Other	128 (1.8%)	144 (1.9%)	148 (2%)	167 (2.3%)	148 (2.1%)	2.1%

* The proportions presented exclude missing and unknown ethnicity, ~ 2% each year, as recorded in the 2019/20 core NPDA audit.

Deprivation

Table 3 shows the number and proportion of diabetes-related admissions for children and young people with Type 1 diabetes by deprivation quintile over the five years compared to the percentage within each quintile in 2019/20. Children living in more deprived areas were over-represented in the number of admissions.

Table 3: Number and percentage of all diabetes-related admissions for children and young people with Type 1 diabetes, by deprivation quintile (2015/16-2019/20). Percentage of children and young people with Type 1 diabetes (2019/20)*

(denominator= all diabetes-related admissions in children and young people with Type 1 diabetes and known deprivation quintile)

Deprivation quintile	2015/16 n (%)	2016/17 n (%)	2017/18 n (%)	2018/19 n (%)	2019/20 n (%)	% CYP with T1D, 2019/20
Most deprived	1980 (27.8%)	2135 (28%)	2127 (28.7%)	2125 (28.7%)	2121 (28.8%)	23.1%
Second most deprived	1639 (23%)	1698 (22.3%)	1635 (22.1%)	1618 (21.8%)	1621 (22%)	20.3%
Third least deprived	1270 (17.8%)	1417 (18.6%)	1322 (17.9%)	1423 (19.2%)	1426 (19.3%)	19.1%
Second least deprived	1114 (15.6%)	1277 (16.7%)	1227 (16.6%)	1193 (16.1%)	1179 (16%)	18.6%
Least deprived	1117 (15.7%)	1101 (14.4%)	1093 (14.8%)	1052 (14.2%)	1025 (13.9%)	19.0%

* The proportions presented exclude those with a missing deprivation quintile, ~ 0% each year.

Diabetes-related admissions per patient

Table 4 shows that ~12% of children and young people receiving care from PDUs were admitted at least once per audit year with a diabetes-related admission, not associated with diagnosis, although much smaller percentages were admitted more than once.

Table 4: Number and percentage of the total number of children and young people with Type 1 diabetes having one or more diabetes-related admissions not associated with diagnosis per audit year (2015/16-2019/20)

(denominator= all children and young people with Type 1 diabetes submitted to the NPDA)

	2015/16	2016/17	2017/18	2018/19	2019/20*
Total number of CYP with T1D	27,229	27,860	28,403	28,697	27,733
1 admission n (%)	2531 (9.3)	2609 (9.4)	2586 (9.1)	2656 (9.3)	2516 (9.1)
2 admissions n (%)	502 (1.8)	529 (1.9)	489 (1.7)	472 (1.6)	448 (1.6)
3 admissions n (%)	151 (0.6)	153 (0.5)	154 (0.5)	138 (0.5)	140 (0.5)
4 or more admissions n (%)	91 (0.3)	151 (0.5)	131 (0.5)	132 (0.5)	122 (0.4)
1 or more admissions n (%)	3275 (12)	3442 (12.4)	3360 (11.8)	3398 (11.8)	3226 (11.6)

* Seven out of 173 PDUs did not submit data to the NPDA for the audit year due to the impact of the COVID-19 pandemic, and total numbers of children and young people with Type 1 diabetes reported to the audit and presented above are smaller than previous years as a consequence. The number of admissions corresponding to children and young people within those non-submitting PDUs have been excluded from the percentages in 2019/20.

DKA admissions of children and young people with Type 1 diabetes

All DKA admissions amongst children and young people with Type 1 diabetes

Approximately 35% of DKA admissions were at the initial diagnosis of diabetes across the five audit years. See Appendix III for a breakdown of the numbers and percentages admitted for DKA at diagnosis, or after diagnosis, across the five years broken down by patient characteristics.

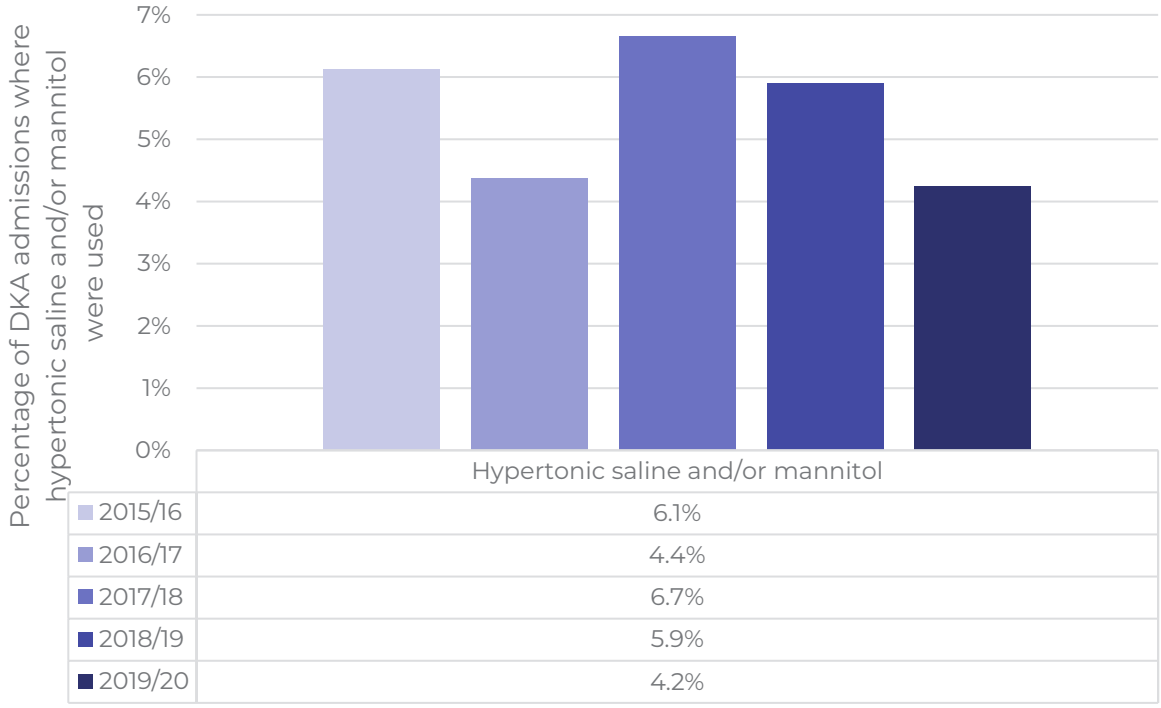
Deaths caused by DKA amongst children and young people with Type 1 diabetes

Mortality statistics produced by the **Office for National Statistics** (accessed March 2023) show that there were four deaths recorded with DKA as the underlying cause between 2015-2020 across England and Wales amongst those aged 0-14 years.

Use of agents during DKA admissions to treat/prevent cerebral oedema

DKA admissions can be associated with acute life-threatening complications such as cerebral oedema. The NPDA has collected data on the use of mannitol/hypertonic saline and bicarbonate during a DKA admission as a proxy for a clinical decision that a child may have or could be developing cerebral oedema and/or DKA severity.

The proportions of those admissions involving the use of hypertonic saline or mannitol are shown in Figure 7.



	Hypertonic saline and/or mannitol
2015/16	6.1%
2016/17	4.4%
2017/18	6.7%
2018/19	5.9%
2019/20	4.2%

Figure 7: Percentages of DKA admissions of children and young people with Type 1 diabetes where hypertonic saline and/or mannitol for DKA in patients with Type 1 diabetes was used, as reported in NPDA admissions data, 2015/16-2019/20

[1] DKA admissions found only in HES/PEDW are not included in this analysis because HES/PEDW do not measure the use of these agents.

[2] Data for patients receiving bicarbonate are not shown due to small numbers.

DKA admissions at diagnosis of Type 1 diabetes

DKA at diagnosis of diabetes can be a quality indicator in its own right, as it may reflect the speed with which diabetes is diagnosed by healthcare professionals prior to being referred to a PDU. For the purpose of this report, the NPDA has defined DKA at diagnosis as any DKA episode recorded within 10 days of the date of diagnosis. The tolerance of 10 days was selected to allow for discrepancies between the date of diagnosis provided by PDUs and the date of admission provided by HES/PEDW. The likelihood of a repeat admission with DKA within 10 days of the diagnosis of diabetes is extremely low unless it is related to the diagnosis.

Trends in DKA at diagnosis admissions amongst newly diagnosed patients

Figure 8 presents percentages of newly diagnosed children and young people with diabetes where DKA was present at diagnosis between the audit years of 2015/16 and 2019/20. Overall there was a steady year on year increase in the DKA at diagnosis rates, from 29.3% in 2015/16 to 38.5% in 2019/20. Variability in rates of DKA at diagnosis of Type 1 diabetes can be seen between, and within, network regions (Figure 8) and NHSE network regions (Figure 9). See Appendix II for the numerators and denominators.

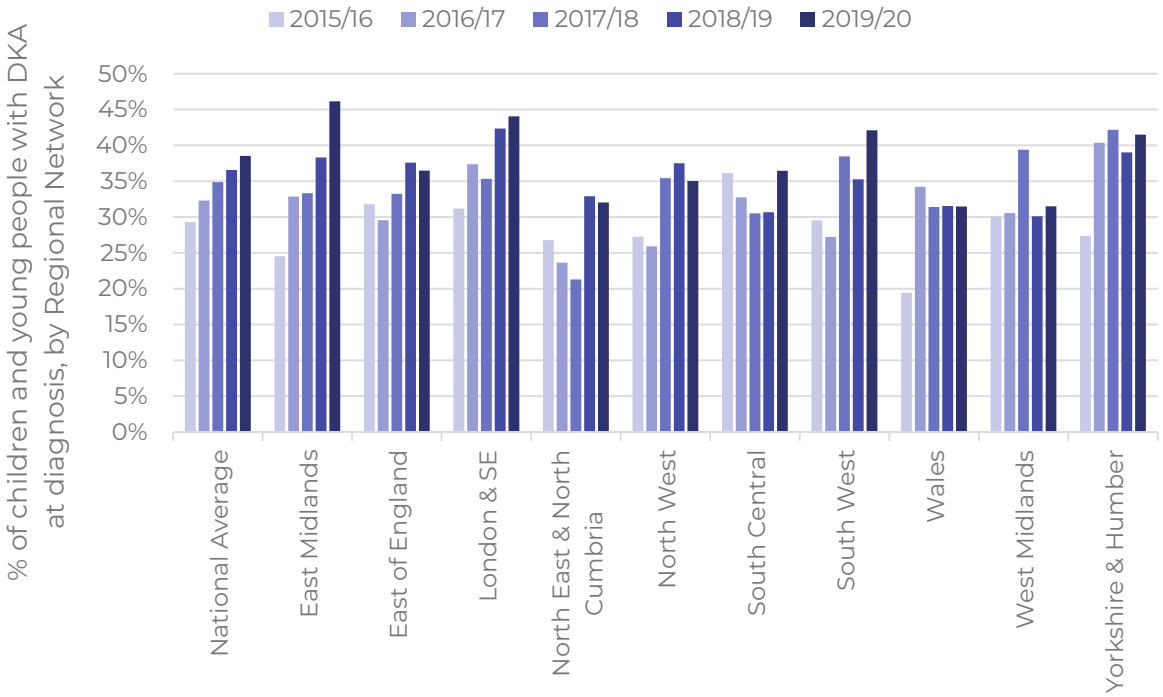


Figure 8: Percentage of children and young people diagnosed with Type 1 diabetes within each audit year with DKA at diagnosis by region, 2015/16-2019/20

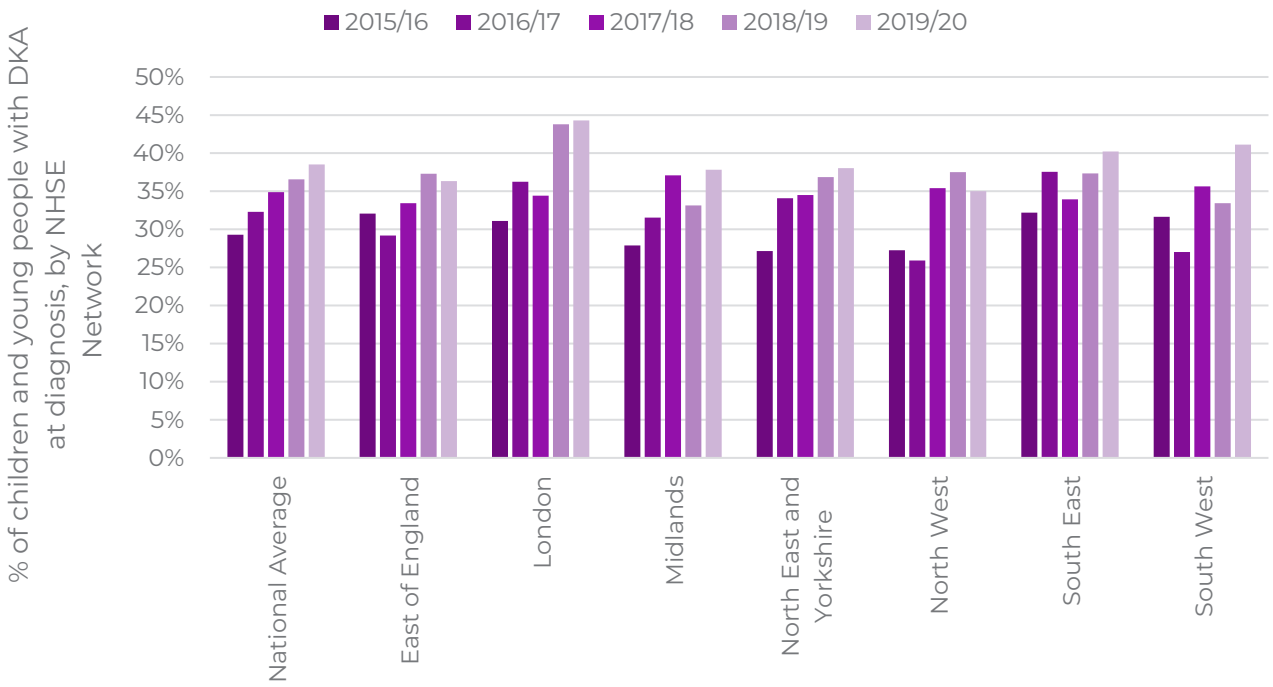


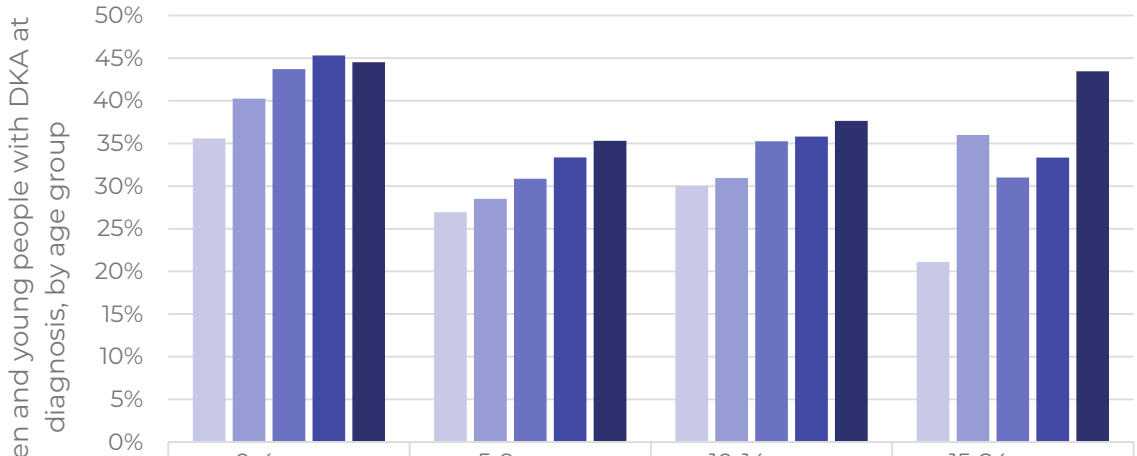
Figure 9: Percentage of children and young people diagnosed with Type 1 diabetes within each audit year with DKA at diagnosis by NHSE region, 2015/16-2019/20

DKA at diagnosis, broken down by patient characteristics

Presented in this section are graphs showing where inequalities were marked. A table with numbers and percentages of children and young people with Type 1 diabetes admitted with DKA at diagnosis within different demographic categories is presented in Appendix II.

DKA at diagnosis by age

Figure 10 shows that those aged 0-4 years were at the greatest risk of DKA at diagnosis within each audit year compared to those in any other age group. The rate of DKA at diagnosis increases across all age groups over the five years.

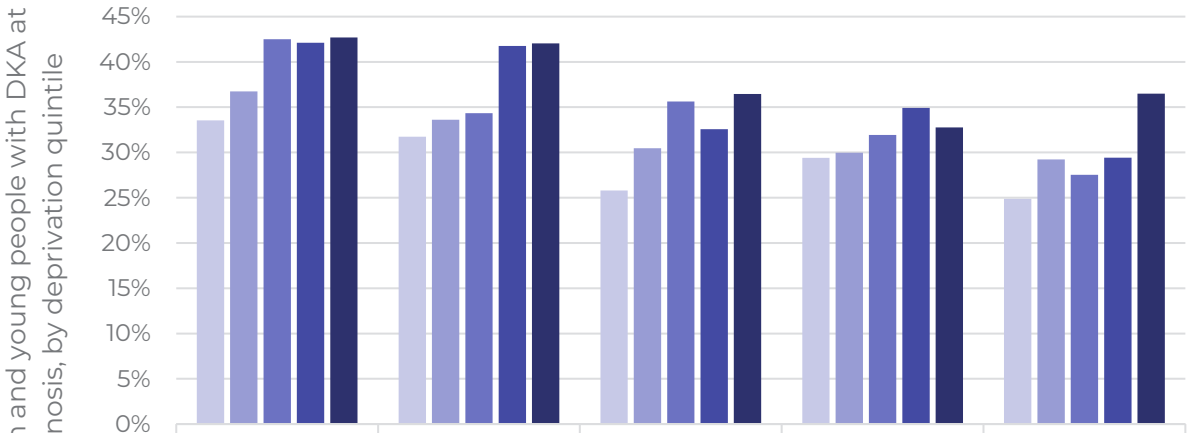


	0-4 years	5-9 years	10-14 years	15-24 years
2015/16	35.6%	26.9%	30.0%	21.1%
2016/17	40.3%	28.5%	31.0%	36.0%
2017/18	43.7%	30.9%	35.3%	31.0%
2018/19	45.3%	33.4%	35.8%	33.3%
2019/20	44.5%	35.3%	37.7%	43.5%

Figure 10: Percentage of admissions due to DKA at diagnosis as a proportion of total numbers of newly diagnosed children and young people with Type 1 diabetes in each age group per audit year

DKA at diagnosis by deprivation

Figure 11 shows that risk of DKA at diagnosis is highest in those living in the most deprived areas, and that the increased rates of DKA at diagnosis were observed across all levels of deprivation over time.

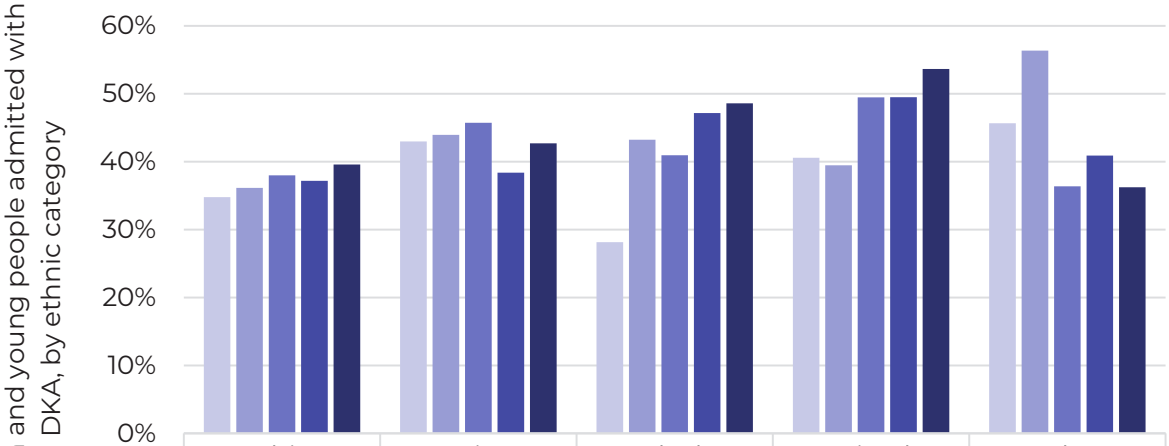


	Most deprived	Second most deprived	Third least deprived	Second least deprived	Least deprived
2015/16	33.5%	31.7%	25.8%	29.4%	24.9%
2016/17	36.7%	33.6%	30.5%	30.0%	29.2%
2017/18	42.5%	34.3%	35.6%	31.9%	27.5%
2018/19	42.1%	41.8%	32.6%	34.9%	29.4%
2019/20	42.7%	42.0%	36.5%	32.8%	36.5%

Figure 11: Percentage of admissions due to DKA at diagnosis as a proportion of total numbers of newly diagnosed children and young people with Type 1 diabetes in each deprivation quintile per audit year

DKA at diagnosis by ethnic category

Figure 12 shows that risk of DKA at diagnosis differed by ethnicity throughout the five-year audit period, with a trend for White children and young people with Type 1 diabetes having lower rates of DKA at diagnosis compared to other ethnic categories.



	White	Asian	Black	Mixed	Other
2015/16	34.8%	43.0%	28.2%	40.6%	45.7%
2016/17	36.2%	43.9%	43.2%	39.5%	56.4%
2017/18	38.0%	45.7%	41.0%	49.5%	36.4%
2018/19	37.2%	38.4%	47.2%	49.5%	40.9%
2019/20	39.6%	42.7%	48.6%	53.7%	36.2%

Figure 12: Percentage of admissions due to DKA at diagnosis as a proportion of total numbers of newly diagnosed children and young people with Type 1 diabetes by ethnicity per audit year

DKA admissions not related to diagnosis in children and young people with Type 1 diabetes

DKA admissions following diagnosis of diabetes can be considered as a performance indicator for PDUs, as some of these admissions could represent an inability to self-manage diabetes at home.

DKA admissions not at diagnosis amongst those with Type 1 diabetes, broken down by nation

Table 5 shows the percentage and number of children and young people with Type 1 diabetes who were admitted at least once with DKA, not at diagnosis, within each audit year. Overall there is little change over the five years although the rate in Wales appears to be steadily reducing.

Table 5: Percentages and numbers of children and young people with Type 1 diabetes admitted to hospital with DKA at least once, not at diagnosis (denominator = number of children and young people with Type 1 diabetes in each audit year)

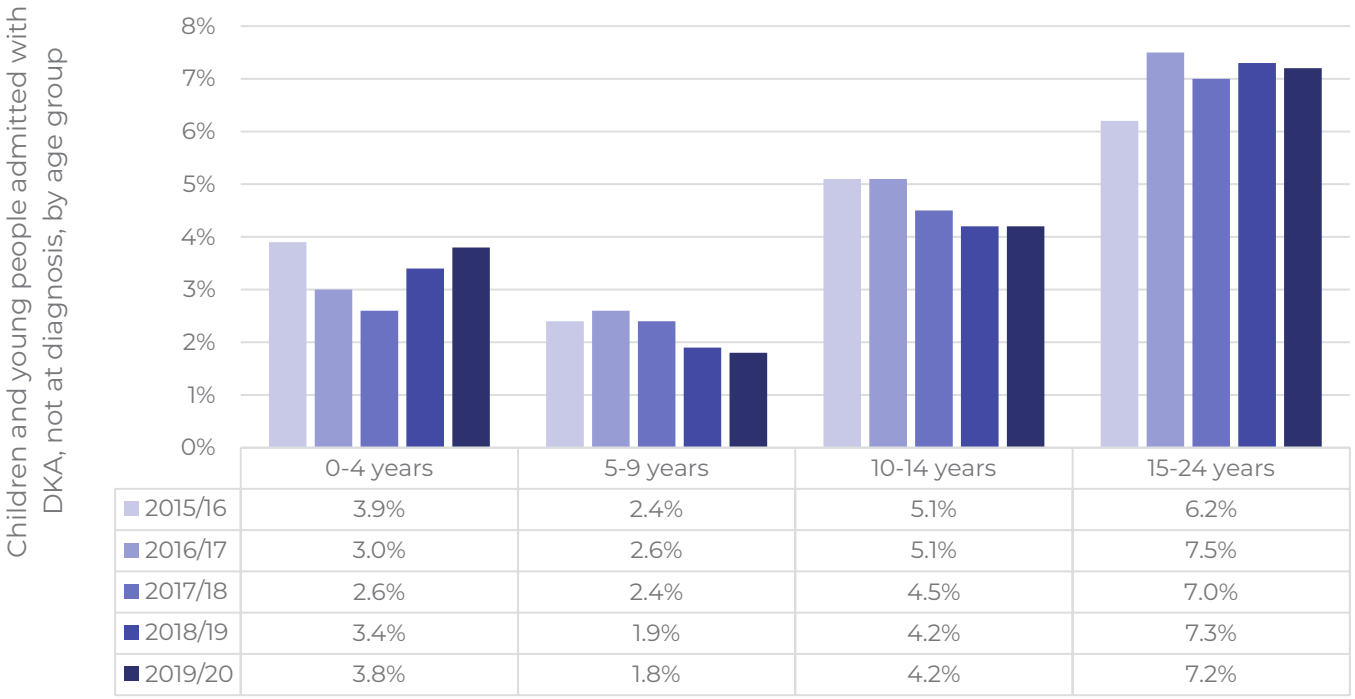
	2015-16	2016-17	2017-18	2018-19	2019-20
Country					
England and Wales	4.8% (1301/27229)	5.2% (1445/27860)	4.7% (1342/28403)	4.6% (1328/28697)	4.6% (1279/27733)
England	4.6% (1201/25855)	5.1% (1340/26409)	4.6% (1253/26957)	4.6% (1248/27259)	4.6% (1202/26321)
Wales	7.3% (100/1374)	7.2% (105/1451)	6.2% (89/1446)	5.6% (80/1438)	5.5% (77/1412)

DKA admissions not at diagnosis broken down by patient characteristics

See Appendix II for a breakdown of numerators and denominators for the graphs presented in this section.

DKA admissions by age

Figure 13 shows that there was a higher admission rate for DKA (not at diagnosis) amongst those age 10-24 years old compared to younger children.

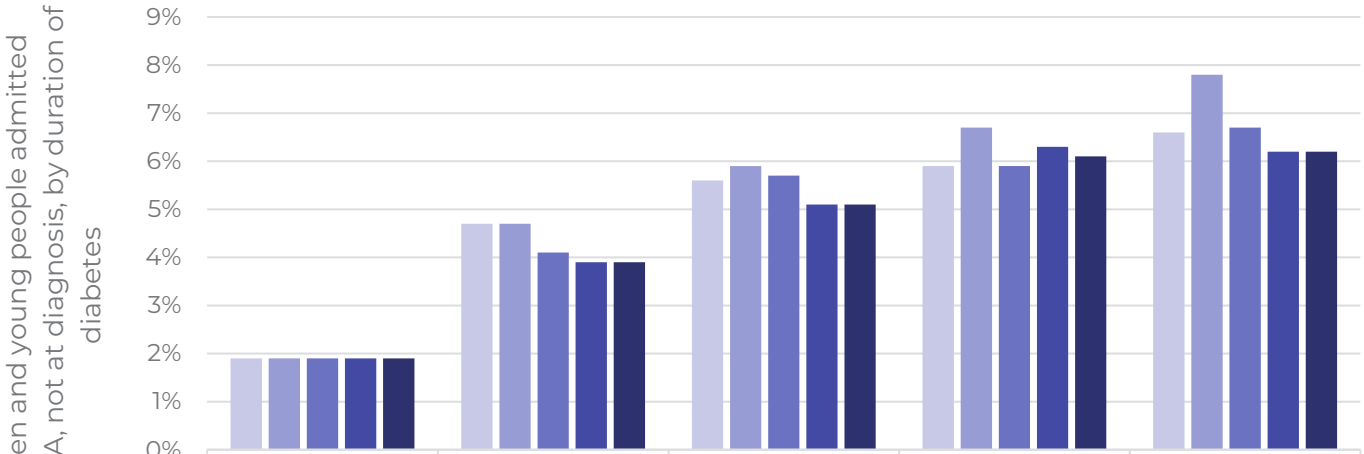


	0-4 years	5-9 years	10-14 years	15-24 years
2015/16	3.9%	2.4%	5.1%	6.2%
2016/17	3.0%	2.6%	5.1%	7.5%
2017/18	2.6%	2.4%	4.5%	7.0%
2018/19	3.4%	1.9%	4.2%	7.3%
2019/20	3.8%	1.8%	4.2%	7.2%

Figure 13: Proportion of children and young people with Type 1 diabetes admitted at least once for DKA (not at diagnosis), by age group, 2015/16-2019/20

DKA admissions by duration of diabetes

Figure 14 shows that the rate of admission with DKA (not at diagnosis) increased with duration of diabetes.

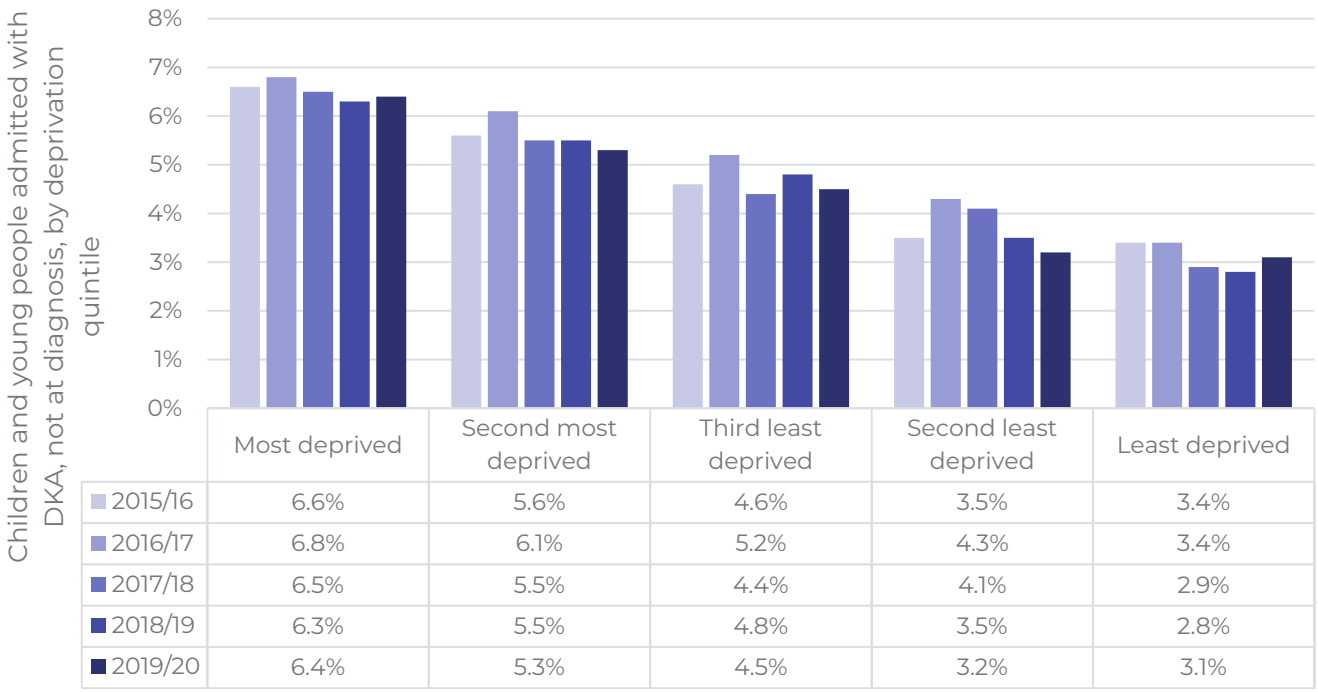


	Less than 1 year	1-2 years	3-4 years	5-9 years	10+ years
2015/16	1.9%	4.7%	5.6%	5.9%	6.6%
2016/17	1.9%	4.7%	5.9%	6.7%	7.8%
2017/18	1.9%	4.1%	5.7%	5.9%	6.7%
2018/19	1.9%	3.9%	5.1%	6.3%	6.2%
2019/20	1.9%	3.9%	5.1%	6.1%	6.2%

Figure 14: Proportion of children and young people with Type 1 diabetes admitted for DKA at least once (not at diagnosis), by duration of diagnosis, 2015/16-2019/20

DKA admissions by deprivation quintile

Figure 15 shows that there was a lower rate of DKA admission not at diagnosis for those living in the least deprived areas compared to those in the most deprived areas, and that this was consistent across the five audit years.

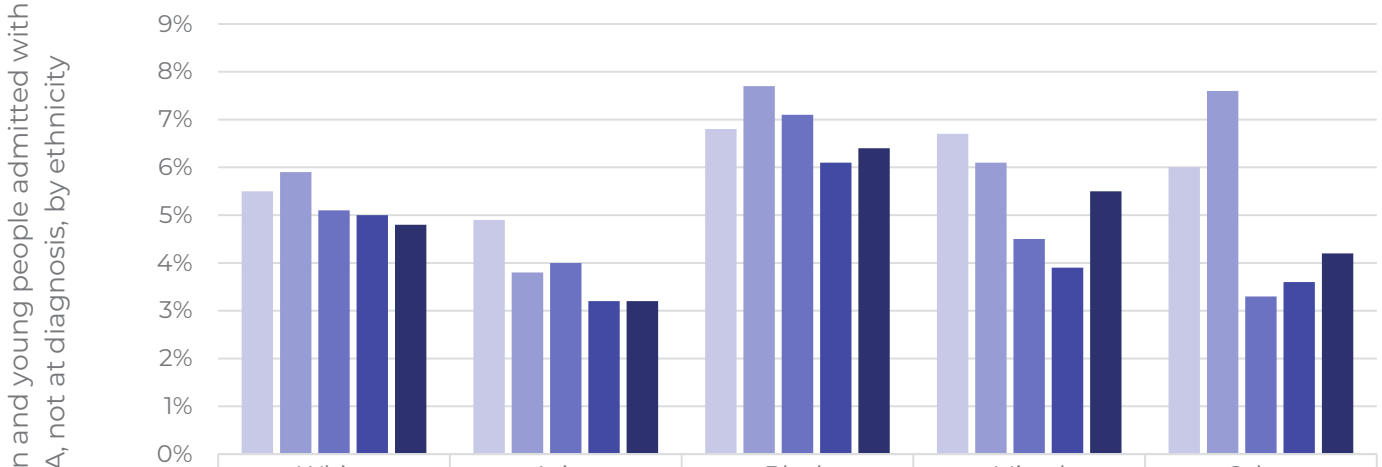


	Most deprived	Second most deprived	Third least deprived	Second least deprived	Least deprived
2015/16	6.6%	5.6%	4.6%	3.5%	3.4%
2016/17	6.8%	6.1%	5.2%	4.3%	3.4%
2017/18	6.5%	5.5%	4.4%	4.1%	2.9%
2018/19	6.3%	5.5%	4.8%	3.5%	2.8%
2019/20	6.4%	5.3%	4.5%	3.2%	3.1%

Figure 15: Proportion of children and young people with Type 1 diabetes admitted at least once for DKA (not at diagnosis), by deprivation quintile, 2015/16-2019/20

DKA admissions by ethnic category

Figure 16 shows the admission rates for DKA (not at diagnosis) by ethnicity throughout the five-year audit period. Children and young people with Type 1 diabetes of Black or Mixed ethnicity had a higher rate of admission.



	White	Asian	Black	Mixed	Other
2015/16	5.5%	4.9%	6.8%	6.7%	6.0%
2016/17	5.9%	3.8%	7.7%	6.1%	7.6%
2017/18	5.1%	4.0%	7.1%	4.5%	3.3%
2018/19	5.0%	3.2%	6.1%	3.9%	3.6%
2019/20	4.8%	3.2%	6.4%	5.5%	4.2%

Figure 16: Proportion of children and young people with Type 1 diabetes admitted at least once for DKA (not at diagnosis), by ethnicity, 2015/16-2019/20

DKA admissions by HbA1c outcomes

Table 6 shows that those admitted with DKA not at diagnosis had higher HbA1c levels compared to those that were not admitted during the audit period with a median difference of approximately 20mmol/mol in each audit year.

Table 6: Median HbA1c of children and young people who were admitted with DKA (not at diagnosis) compared to those who had no admission, 2015/16-2019/20

	2015-16 Mmol/mol (n)	2016-17 Mmol/mol (n)	2017-18 Mmol/mol (n)	2018-19 Mmol/mol (n)	2019-20 Mmol/mol (n)
Admitted in audit period	81.0 (1121)	80.0 (1241)	84.0 (1116)	81.0 (1130)	80.0 (1080)
Not admitted in audit period	64.5 (21029)	64 (21460)	64 (22122)	61.5 (22368)	61.5 (21661)

Figure 17 shows DKA admission rates (not at diagnosis) for children and young people with Type 1 diabetes by HbA1c target category (based on their median HbA1c in the audit year). There was an upward trend for those with higher HbA1c over the five-year audit period, with 17.1% of children and young people with a median HbA1c greater than 80mmol/mol being admitted with DKA (not at diagnosis) in 2019/20, while just over 14% of the same group were admitted in 2015/16. Similar increases were seen for those with HbA1c greater than 69mmol/mol and greater than 75mmol/mol. Admission rates for DKA (not at diagnosis) for children and young people with lower median HbA1cs (less than 58mmol/mol) remained stable over the five-year audit period.

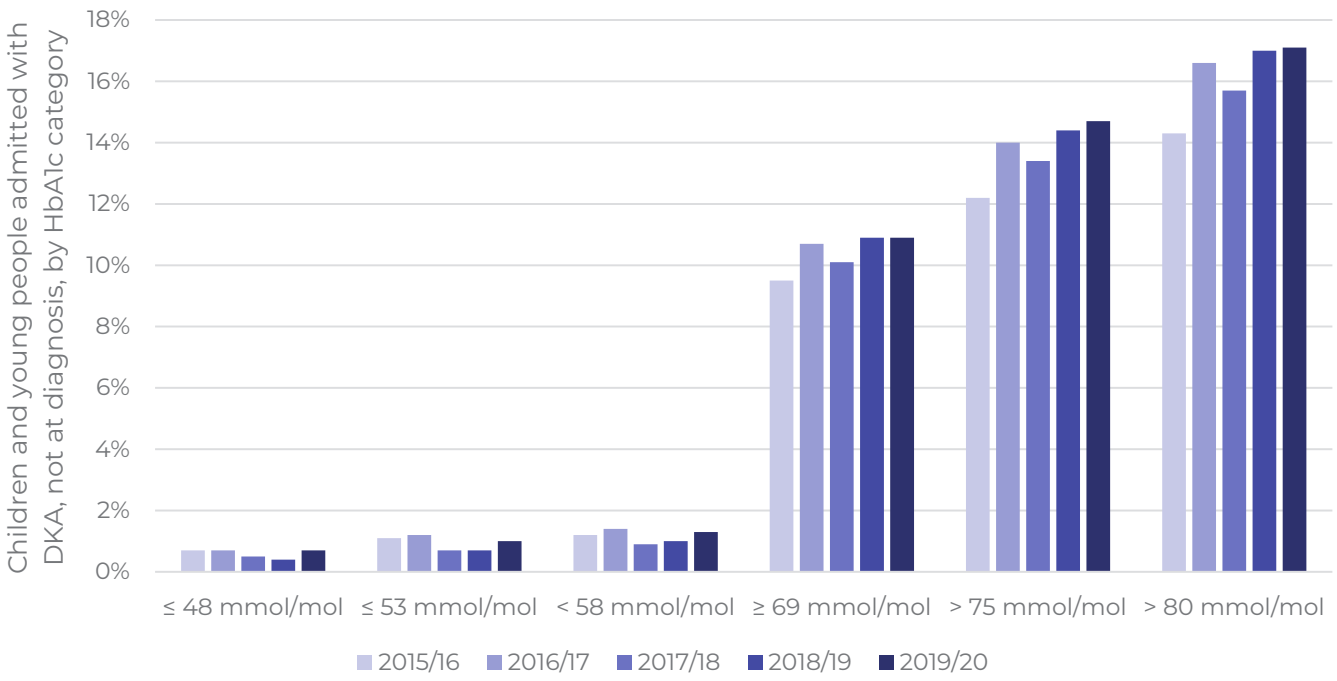


Figure 17: Proportion of children and young people with Type 1 diabetes admitted at least once for DKA (not at diagnosis) by HbA1c category, 2015/16-2019/20

Socio-demographic and diabetes-related risk factors for DKA admission (not at diagnosis) for children and young people with Type 1 diabetes

A patient level regression analysis was performed using socio-economic factors, diabetes characteristics and use of diabetes-related technologies to explore the relative influences on the risk of an admission with DKA (not at diagnosis). Table 7 shows the significant factors and their effect and magnitude on risk, after adjusting for the influence of all the other characteristics in the table. Full details of the model can be found in Appendix V.

Table 7 shows that higher risk of admission for DKA (not at diagnosis) was associated with having an HbA1c

≥80mmol/mol, living in a deprived area, being age 0-4 years, and having a longer duration of diabetes.

Despite being overrepresented in numbers admitted with DKA (not at diagnosis), no additional *risk* of admission was associated with Black ethnicity, statistically. This means that the higher rates of admissions of Black children and young people with Type 1 diabetes were due to other factors included in the model. The core NPDA audit shows higher average HbA1c amongst this cohort, and the DKA risk model shows that the risk with the highest magnitude for DKA admission was high HbA1c. It can be extrapolated that higher rates of admission with DKA amongst Black children and young people with Type 1 diabetes are attributable to higher HbA1c and deprivation amongst this cohort, rather than there being additional risk of admission due to having Black ethnicity, all other things being equal.

Table 7: Summary of socio-demographic and diabetes-related risk factors associated with DKA admission (not at diagnosis) using a generalised structural equation model, 2015/16 - 2019/20

Characteristic	Risk effects*	Magnitude of risk (compared to reference group in left column)
Age group	Lower risk of admission for older children and young people compared to those aged 0-4 years, who had a 6.2% probability of admission.	• 43.5% reduction in risk amongst those aged 5-9 years old • 22.6% reduction in risk amongst those age 10-14 years old • 14.5% reduction in risk amongst those age 15-24 years old
Sex	Higher risk of admission for girls compared to boys, who had a 4.2% probability of admission.	• 33.3% increase in risk for girls
Ethnicity	Lower risk of admission for non-White children and young people compared to White children and young people, who had a 5.1% probability of admission.	• 39.2% reduction in risk for those of Asian ethnicity • 23.5% reduction in risk for those of 'Other' ethnicities • 19.6% reduction in risk for those of Mixed ethnicity • 17.6% reduction in risk for those of Black ethnicity
Deprivation quintile	Lower risk for those living in less deprived areas compared to those living in the most deprived areas, who had a 6.1% probability of admission.	• 11.5% reduction in risk for those living in the second most deprived areas • 21.3% reduction in risk for those living in the third least deprived areas • 34.4% reduction in risk for those living in the second least deprived areas • 41.0% reduction in risk for those living in the least deprived areas
Duration of diabetes	Higher risk associated with longer duration of diabetes compared to those with a duration of diabetes <1 year, who had a 2.3% probability of admission.	• 121.7% increase in risk if 1-2 years duration of diabetes • 152.2% increase in risk if 3-4 years duration of diabetes • 143.5% increase in risk if 5-9 years duration of diabetes • 121.7% increase in risk if 10+ years duration of diabetes
Insulin regimen in combination with rtCGM	Reduced risk associated with the use of insulin pump plus rtCGM compared to use of insulin injections alone, users of which having a 4.7% probability of admission.	• 21.3% reduction in risk with use of insulin pump plus rtCGM • No significant reduction in risk for injections plus CGM, and pump use alone, compared to injections alone.
HbA1c	Increasing risk with increasing HbA1c compared to those with HbA1c <58 mmol/mol, who had a 1.3% probability of admission.	• 176.9% increase in risk if HbA1c is 58-79 mmol/mol • 807.7% increase in risk if HbA1c is ≥80 mmol/mol compared to <58 mmol/mol

*Risk of admission at least once within each audit year with DKA, not at diagnosis, controlling for all other factors within the table.

Table 8 is based on the model described above and considers the impact of use of diabetes-related technologies and treatment regimens for children and young people with HbA1c in the different target categories. It shows that for patients in the highest HbA1c category (≥80mmol/mol) the risk of admission for DKA (not at diagnosis) when using an insulin pump plus rtCGM, was reduced to almost half compared to those on insulin injections alone.

Table 8: Predicted probability of being admitted with DKA (not at diagnosis) for children and young people with Type 1 diabetes, by HbA1c category and insulin regimen (all other characteristics evaluated at means)

	HbA1c <58 mmol/mol	HbA1c 58-79 mmol/mol	HbA1c ≥80 mmol/mol
Injections alone	1.1%	3.4%	13.1%
Injections+rtCGM	1.2%	3.9%	11.4%
Pump alone	1.8%	4.1%	10.2%
Pump+rtCGM	1.1%	3.6%	7.6%

The potential impact on DKA admissions not at diagnosis of those with HbA1c ≥ 80 mmol/mol if they were all using rtCGM and an insulin pump is simulated in Table 9. Based on the model above, Table 9 shows that if all children and young people with HbA1c ≥ 80 mmol/mol were using these technologies, the percentage of them being admitted with DKA at least once (not at diagnosis) could fall from 12.9% (observed rate of admission) to 7.6%, which equates to 282 fewer children being admitted. Using the average number of bed nights per child being admitted, this equates to a reduction of 964 bed nights per annum for DKA admissions. This is a conservative estimate since some children and young people were admitted more than once in each audit year, and because the model does not assume any reduction in HbA1c. Based on 2019/20 **NHS reference costs** of £755 for a non-elective short stay for DKA, this represents a potential saving of £ 727,507 in avoided admission costs. This does not take into account the reduction in burden on children and young people with Type 1 diabetes and their families.

Table 9: Potential implications of a reduction in the risk of being admitted for DKA not at diagnosis, in children and young people with Type 1 diabetes and HbA1c ≥80mmol/mol, if all were using an insulin pump and rtCGM

	Observed values 2019/20*	Estimated values 2019/20 if all were using an insulin pump and a rtCGM*	Difference
Total number of children and young people with Type 1 diabetes and HbA1c ≥80mmol/mol	5,347	5,347	Assumption: remains constant
% of children and young people with Type 1 diabetes and HbA1c ≥80mmol/mol having admissions for DKA not at diagnosis	12.9%	7.6%	Risk reduction associated to the use of Pump+rtCGM
Number of children and young people with Type 1 diabetes and HbA1c ≥80mmol/mol having admissions for DKA not at diagnosis	688	406	282 fewer CYP with admissions for DKA not at diagnosis in the year
Number of nights in hospital for DKA not at diagnosis	2,354	1,390**	964 fewer nights in hospital
Estimated cost of admissions (unit cost: £755 of a non-elective short stay for DKA based on NHS reference costs)	£ 1,777,256	£ 1,049,749	£ 727,507 less in cost of admissions

* Excluding admissions from children within 7 PDUs not submitting information to the NPDA in 2019/20.
** Applying the average number of nights observed in children with Type 1 diabetes and HbA1c ≥80mmol/mol having admissions for DKA not at diagnosis in 2019/20 (3.4 nights per child)

Hypoglycaemia admissions of children and young people with Type 1 diabetes

Hypoglycaemia admissions amongst those with Type 1 diabetes, broken down by nation

Table 10 shows that overall, the admission rate for hypoglycaemia has remained stable over the five audit years with Wales having a higher but improving rate.

Table 10: Percentage and number of children and young people with Type 1 diabetes admitted to hospital with hypoglycaemia at least once in each audit year as a proportion of the total number of those with Type 1 diabetes, by nation, 2015/16-2019/20

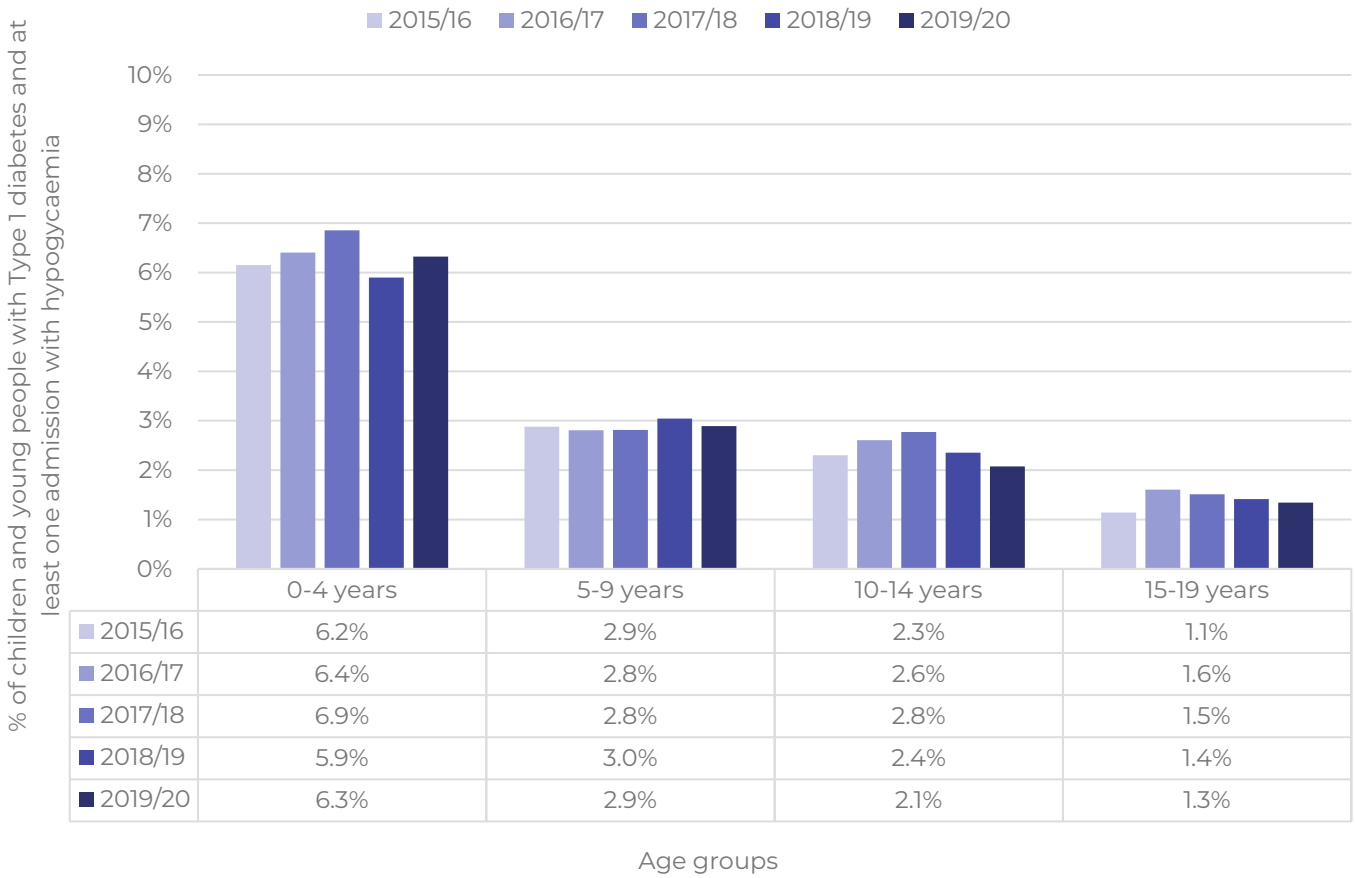
	2015/16 %(n)	2016/17 %(n)	2017/18 %(n)	2018/19 %(n)	2019/20 %(n)
Country					
England and Wales	2.3 (625/27229)	2.6 (713/27860)	2.6 (741/28403)	2.4 (688/28697)	2.2 (622/27733)
England	2.2 (570/25855)	2.5 (654/26409)	2.6 (691/26957)	2.3 (640/27259)	2.2 (577/26321)
Wales	4.0 (55/1374)	4.1 (59/1451)	3.5 (50/1446)	3.3 (48/1438)	3.2 (45/1412)

Hypoglycaemia admissions amongst those with Type 1 diabetes, broken down by patient characteristics

See Appendix III for a breakdown of numerators and denominators for the graphs presented in this section.

Hypoglycaemia admissions by age

Figure 18 shows that the risk of admission with hypoglycaemia decreased with age across all five audit years, with those aged 0-4 years at greatest risk.



	0-4 years	5-9 years	10-14 years	15-19 years
2015/16	6.2%	2.9%	2.3%	1.1%
2016/17	6.4%	2.8%	2.6%	1.6%
2017/18	6.9%	2.8%	2.8%	1.5%
2018/19	5.9%	3.0%	2.4%	1.4%
2019/20	6.3%	2.9%	2.1%	1.3%

Figure 18: Percentage of children and young people with Type 1 diabetes admitted for hypoglycaemia within each age group, 2015/16-2019/20

Hypoglycaemia admissions by duration of diabetes

Figure 19 shows that the rate of admission for hypoglycaemia was similar for children and young people with Type 1 diabetes in their first two years after diagnosis and decreased thereafter.

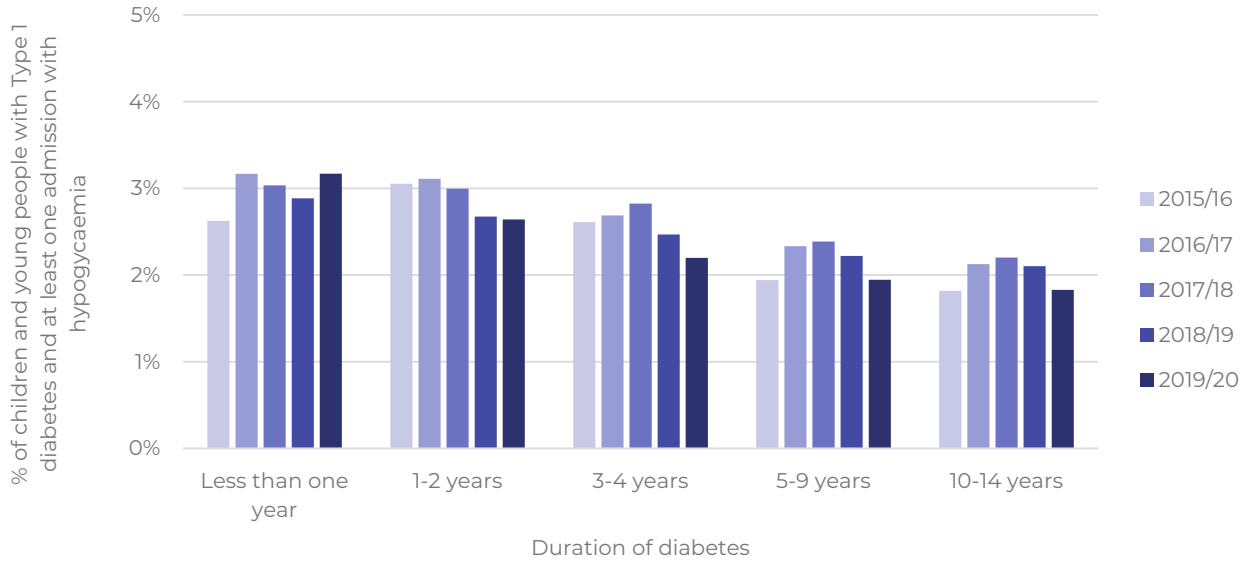


Figure 19: Percentage of children and young people with Type 1 diabetes admitted for hypoglycaemia by time since diabetes diagnosis, 2015/16-2019/20

Hypoglycaemia admissions by deprivation

Figure 20 shows that children and young people with Type 1 diabetes living in more deprived areas were more likely to be admitted with hypoglycaemia than those in the least deprived areas.

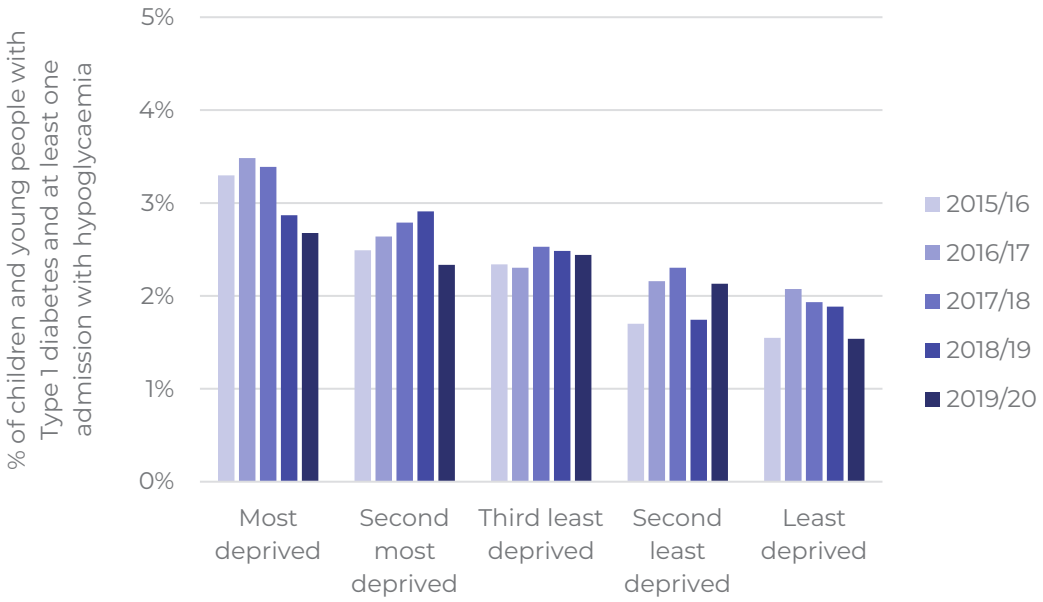
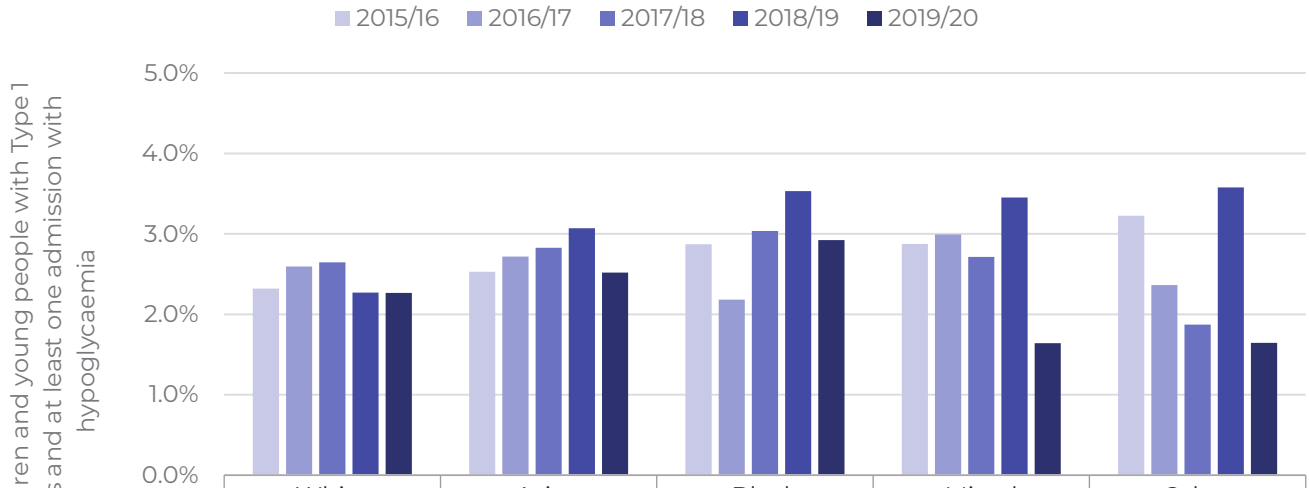


Figure 20: Percentage of children and young people with Type 1 diabetes admitted for hypoglycaemia within each deprivation quintile, 2015/16-2019/20

Hypoglycaemia admissions by ethnic category

Figure 21 shows similar rates of hypoglycaemia admissions amongst children and young people with Type 1 diabetes within different ethnic groups. There was no clear trend over the five audit years.

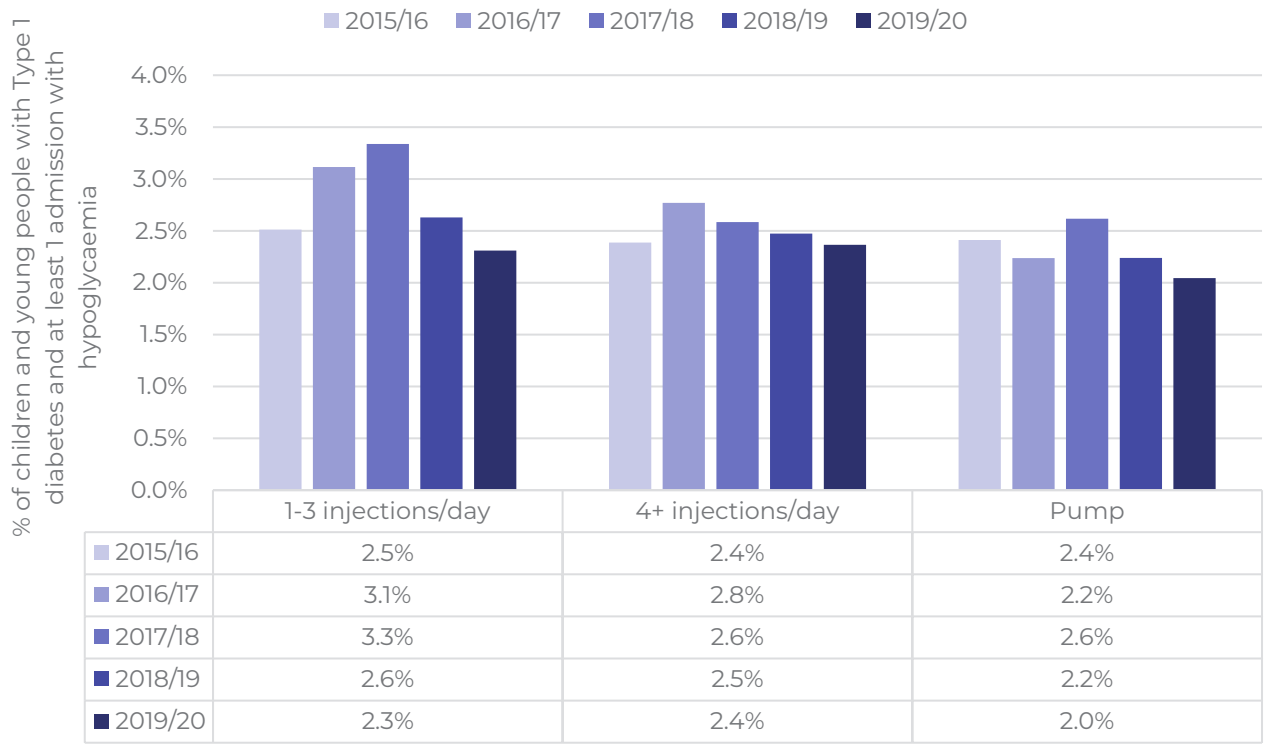


	White	Asian	Black	Mixed	Other
2015/16	2.3%	2.5%	2.9%	2.9%	3.2%
2016/17	2.6%	2.7%	2.2%	3.0%	2.4%
2017/18	2.6%	2.8%	3.0%	2.7%	1.9%
2018/19	2.3%	3.1%	3.5%	3.5%	3.6%
2019/20	2.3%	2.5%	2.9%	1.6%	1.6%

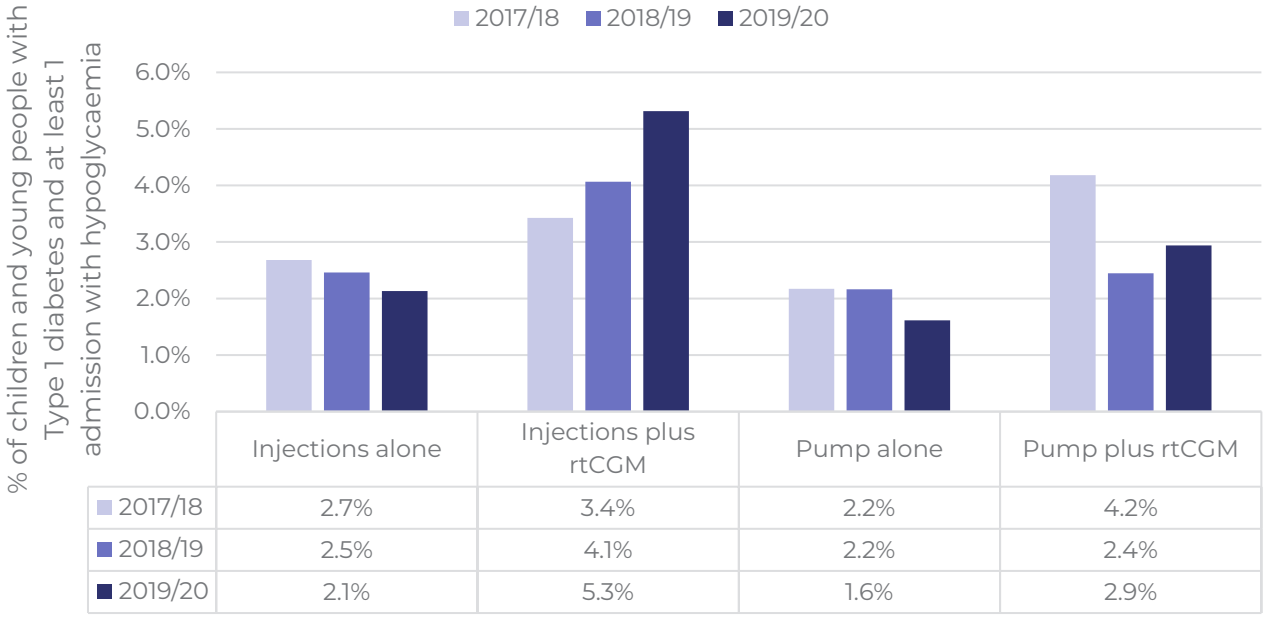
Figure 21: Percentage of children and young people with Type 1 diabetes admitted for hypoglycaemia within each ethnic group, 2015/16-2019/20

Hypoglycaemia admissions by treatment regimens and use of CGM

Figure 22 presents a breakdown of the percentage of children admitted to hospital with hypoglycaemia by insulin regimen and insulin regimen in combination with rtCGM. There was little difference in admission rates for hypoglycaemia when using insulin injections or a pump (Figure 22) but with the addition of rtCGM there was a higher percentage of admissions with hypoglycaemia both amongst insulin injection regimens or pump users (Figure 23).



	1-3 injections/day	4+ injections/day	Pump
2015/16	2.5%	2.4%	2.4%
2016/17	3.1%	2.8%	2.2%
2017/18	3.3%	2.6%	2.6%
2018/19	2.6%	2.5%	2.2%
2019/20	2.3%	2.4%	2.0%



	Injections alone	Injections plus rtCGM	Pump alone	Pump plus rtCGM
2017/18	2.7%	3.4%	2.2%	4.2%
2018/19	2.5%	4.1%	2.2%	2.4%
2019/20	2.1%	5.3%	1.6%	2.9%

Figure 22: Percentage of children and young people with Type 1 diabetes admitted to hospital with hypoglycaemia at least once in each audit year as a proportion of the total number of those with Type 1 diabetes. By insulin regimen and by insulin regimen in combination with rtCGM, 2017/18-2019/20

Hypoglycaemia admissions by HbA1c target

Table 11 shows the percentage of hypoglycaemia admissions within children and young people with Type 1 diabetes by HbA1c category. There was no real change in the frequency of admission with hypoglycaemia over the five-year audit period with a small trend towards higher risk with higher HbA1c target. However, children admitted with hypoglycaemia on average appeared to have slightly lower median HbA1c compared to those who were admitted for other reasons, and higher median HbA1c than those who had no diabetes-related admissions in the audit year (Table 11).

Table 11: Percentage and number of children and young people with Type 1 diabetes admitted to hospital with hypoglycaemia at least once in each audit year as a proportion of the total number of those with Type 1 diabetes, by HbA1c target group, 2015/16-2019/20

(denominator = number of children and young people with Type 1 diabetes within each HbA1c category)

HbA1c target group	2015/16 %(n)	2016/17 %(n)	2017/18 %(n)	2018/19 %(n)	2019/20 %(n)
≤48 mmol/mol	1.4 (23/1675)	2.6 (52/1990)	1.4 (28/1946)	1.5 (41/2811)	1.6 (46/2810)
≤53 mmol/mol	1.8 (66/3764)	2.4 (105/4302)	2.0 (85/4341)	1.7 (103/5889)	1.9 (109/5797)
<58 mmol/ mol	1.9 (131/6810)	2.5 (188/7642)	2.0 (155/7682)	2.1 (205/9753)	1.9 (176/9496)
≥69 mmol/mol	2.5 (252/9898)	2.8 (270/9682)	3.0 (292/9825)	2.7 (229/8330)	2.8 (222/8052)
> 75 mmol/mol	2.4 (148/6267)	2.6 (161/6083)	2.7 (168/6152)	2.8 (148/5215)	2.8 (141/5053)
≥ 80 mmol/ mol	2.2 (103/4582)	2.4 (103/4310)	2.6 (116/4413)	2.5 (94/3816)	2.8 (102/3661)
Median HbA1c (n)					
Admitted for hypoglycaemia	68.9mmol/mol (602)	67.1mmol/mol (688)	68.3mmol/mol (710)	66.1mmol/mol (653)	67.4mmol/mol (593)
Admitted for other reasons (except DKA at diagnosis)	73.0mmol/mol (3517)	72.9mmol/mol (3609)	74.0mmol/mol (3384)	72.0mmol/mol (3448)	72.2mmol/mol (3365)
Not admitted in audit period	67.7mmol/mol (21029)	66.6mmol/mol (21460)	66.7mmol/mol (22122)	64.2mmol/mol (22368)	64.1mmol/mol (21661)

Socio-demographic and diabetes-related risk factors for hypoglycaemia admission for children and young people with Type 1 diabetes

A patient level regression analysis was performed using socio-economic factors, diabetes characteristics and use of diabetes-related technologies to explore the relative influences on the risk of an admission with hypoglycaemia. Table 12 shows the significant factors and their effect and magnitude on risk, after adjusting for the influence of all the other characteristics in the table. Full details of the model can be found in Appendix III.

Table 12 shows that higher risk of admission for hypoglycaemia was associated with being age 0-4, female sex, living in a more deprived area, higher HbA1c, and use of rtCGM. The risk factors with the highest magnitude were being age 0-4, living in an area of highest deprivation, and use of rtCGM with injections compared to use of injections alone. This last finding should be interpreted with caution, since children and young people admitted with hypoglycaemia may have subsequently been offered a rtCGM within the same audit year.

Table 12: Summary of socio-demographic and diabetes-related risk factors associated with hypoglycaemia admission of children and young people with Type 1 diabetes using a generalised structural equation model, 2015/16 - 2019/20

Characteristic	Risk effects*	Magnitude of risk
Age group	Lower risk of admission for older children and young people compared to those age 0-4, who had a 6.6% probability for admission with hypoglycaemia.	• 53.0% reduction in risk for those age 5-9 years old. • 62.1% reduction in risk for those age 10-14 years old. • 78.8% reduction in risk for those age 15 -24 years old.
Sex	Higher risk of admission for females compared to males, who had a 2.4% probability for admission.	• 12.5% increase in risk for girls compared to boys.
Ethnicity	No significant difference in risk of admission between White children and young people, who had a 2.5% probability of admission, and those in other ethnic categories.	
Deprivation	Lower risk of admission for those living in the less deprived quintiles compared to those in the most deprived quintile, who had a probability of admission with hypoglycaemia of 3.1%.	• 12.9% reduction in risk for those living in the second most deprived areas • 19.4% reduction in risk for those living in the third least deprived areas • 32.3% reduction in risk for those living in the second least deprived compared to most deprived. • 38.7% reduction in risk for those living in the least deprived areas.
Duration of diabetes	No significant difference between those with longer duration of diabetes compared to those with a duration of diabetes <1 year, who had a probability of being admitted of 2.4%.	
Median HbA1c	Higher risk of admission for children with higher HbA1c compared to those with HbA1c <58 mmol/mol, who had a probability of admission of 2.1%.	• 28.6% increase in risk if HbA1c is 58-79 mmol/mol • 33.3% increase if HbA1c is ≥80 mmol/mol
Regimen	Higher risk of admission with use of rtCGM and insulin pump therapy compared to those using insulin injections alone, who had a 2.6% probability of admission.	• 65.4% percentage point increase in risk for children using injections plus rtCGM compared to use of injections alone • 15.4% decrease in risk in children using insulin pump alone compared to injections alone • No significant difference in risk between children using pump plus rtCGM compared to injections alone

*Risk of admission at least once within each audit year with hypoglycaemia controlling for all other factors within the table.

The same model was used to calculate the probabilities of being admitted for hypoglycaemia considering both HbA1c categories and use of diabetes-related technologies.

Table 13 shows that when all other patient characteristics are controlled for, there was highest probability of admission with hypoglycaemia amongst children and young people with Type 1 diabetes with HbA1c >80mmol/mol using injections in combination with rtCGM. As above, this finding should be interpreted with caution.

Table 13: Predicted probability of being admitted with hypoglycaemia for children and young people with Type 1 diabetes, by HbA1c category and insulin regimen (all other characteristics being controlled for)

	HbA1c <58 mmol/mol	HbA1c 58-79 mmol/mol	HbA1c >80 mmol/mol
Injections alone	2.2%	2.8%	2.8%
Injections+rtCGM	2.6%	4.7%	6.0%
Pump alone	1.9%	2.3%	2.4%
Pump+rtCGM	1.9%	3.2%	2.5%

Admissions 'without complications'

This analysis provides breakdown of the admissions identified as 'without complications' in the HES/PEDW dataset by linking it to NPDA PDU submitted admission data. Admission 'without complications' was the most cited reason for admission of children and young people in the HES/PEDW dataset, with ~ 50% of all admissions uniquely identified within this dataset having this as a primary diagnostic code between 2015/16-2019/20.

There were 6,121 admissions across the audit years where:

1. Admissions of patients with Type 1 diabetes were present in both NPDA and HES/PEDW data files (i.e. they had an exact match or up to seven days apart on admission date) and

2. HES/PEDW had recorded reason for admission as 'without complications'.

Figure 23 shows the reasons given in the NPDA dataset for the admissions 'without complications' cited in HES/PEDW.

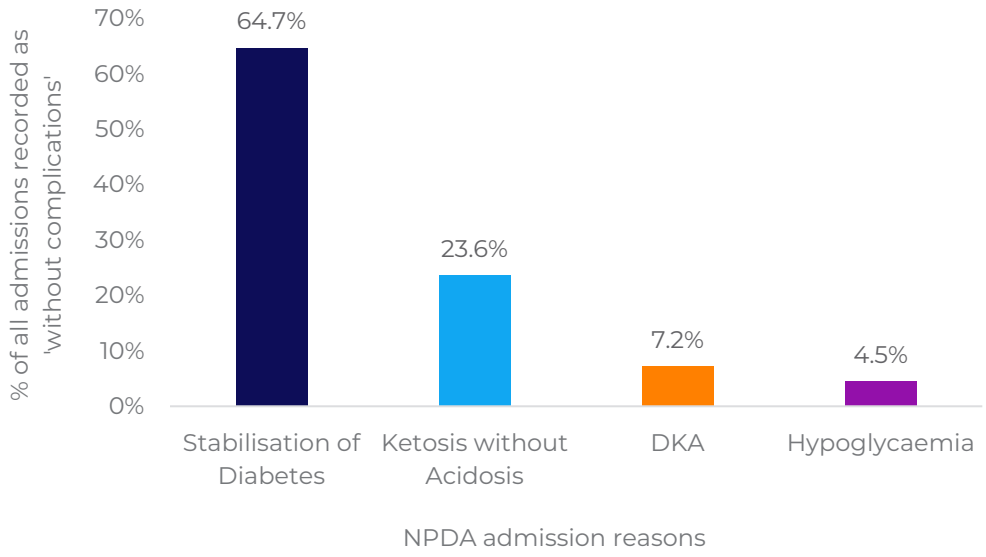


Figure 23: Percentage of different NPDA admission reasons for patients with Type 1 diabetes recorded as 'without complications' in HES/PEDW, 2015/16-2019/20

(denominator = admissions of children and young people with Type 1 diabetes, coded as 'without complications' within the HES/PEDW datasets, with a matching admission within the NPDA dataset)

Nearly two thirds of all admissions recorded as 'without complications' in the HES/PEDW dataset were related to admissions for stabilisation of diabetes according to information submitted by PDU with a further quarter related to ketosis without acidosis.

Limitations to this exploratory subgroup analysis include the variation in quality of reporting by PDUs and that the data only represents admissions with an exact match or up to seven days apart on admission date across both datasets.

Admissions with 'other diabetic complications'

There were a total of 159 diabetes-related admissions of children and young people with Type 1 diabetes referring to 'other diabetic complications' across the five audit years. This category aggregates admissions coded E100, E102-108 within the HES/PEDW datasets only, excluding any matching admissions within the NPDA dataset allocated a more specific cause.

Figure 24 shows a breakdown of the main causes having five admissions or more across the five audit years. The category 'with other complications' aggregates the codes:

- E106 'with other specified complications'
- E108 'with unspecified complications'
- E104 'neurological complications'
- E107 'multiple complications'

Neurological complications and multiple complications were included among 'other complications' in order to mask small numbers.

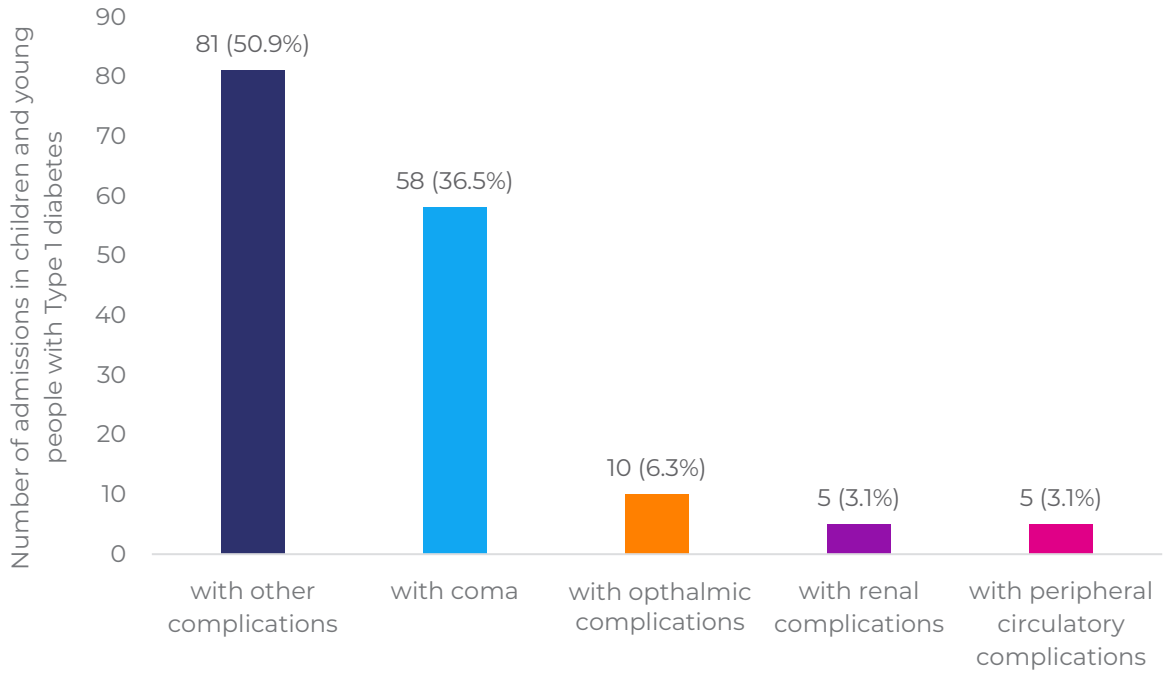


Figure 24: Number and percentage of diabetes-related admissions with 'other complications' for patients with Type 1 diabetes, 2015/16-2019/20

(n=159; denominator = admissions with other complications of children and young people with Type 1 diabetes)

Conclusion

This diabetes-related admissions report covers admissions data from 2015 to 2020. Overall there was little change in the rates of hospital admissions with the exception of admissions for DKA at diagnosis, which increased year on year. The use of pumps and rtCGM reduced the risk of DKA admission post diagnosis especially for those with high HbA1c. Higher rates of diabetes-related admissions were associated with higher HbA1c, so supporting children and young people to achieve optimal HbA1c management should entail a reduction in admissions. There has been a significant increase in the use of diabetes-related technologies amongst children and young people with diabetes since the data presented in this report were collected, and continuing reduction in national average HbA1c and in the proportion of children and young people with very high HbA1c (>80 mmol/mol). Future analysis will show whether these factors have reduced admissions subsequent to diagnosis.

This report provides new impetus to reinvigorate local and national efforts to tackle delayed diagnosis of children and young people with Type 1 diabetes leading to DKA, and to support those with very high HbA1c with self-management to reduce their risk of admission subsequent to diagnosis.

Quality improvement resources

The RCPCH Diabetes Quality Improvement Website provides multidisciplinary teams with the tools to identify, design and analyse their own interventions specific to the needs of the children and young people and their families that they care for.

Noah's Ark Children's Hospital for Wales present the results of a Quality in Care award winning intervention to improve early diagnosis of Type 1 diabetes in children and young people.

Diabetes UK's 4Ts campaign aims to educate the public about the signs and symptoms of onset of Type 1 diabetes in order to support timely diagnosis and reduce rates of DKA at diagnosis.

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Glossary

Cerebral oedema - a swelling of the brain due to an accumulation of water that can happen as a complication of Diabetic Ketoacidosis (DKA). The brain compresses because of the swelling against the skull, which can lead to brain damage and death if not treated.

Diabetes mellitus (DM) is commonly referred to as diabetes. It is a condition where the blood glucose levels remain high because the body cannot use the glucose properly without treatment. If left untreated diabetes complications will occur, the common ones include eye and kidney damage, cardiovascular disease, strokes and foot damage.

Diabetic Ketoacidosis (DKA) - This happens when a severe lack of insulin means the body cannot use glucose for energy, and the body starts to break down other body tissue for energy instead. This produces ketones: poisonous chemicals which build up and will cause the body to become acidic if left untreated, which can be fatal.

Glucose - a simple sugar with a specific chemical formula and is classed as a monosaccharide. Glucose is the sugar that is found in blood and blood glucose acts as a major source of energy for the body.

HbA1c (Glycated haemoglobin) – a blood test that measures how much glucose binds to the red blood cells. It gives a measure of the average blood glucose level approximately 6 – 8 weeks before the test, and provides an indication of overall diabetes control.

Hypoglycaemia – Hypoglycaemia (or a "hypo") occurs when blood glucose levels fall below 4 mmol/L. Mild hypoglycaemia is relatively common and can be corrected by the child or young person or their parent/carer themselves, but severe hypoglycaemia must be treated with urgency in hospital to avoid potential coma and death.

Ketones – Poisonous chemicals produced when the body breaks down fat for energy instead of glucose due to a lack of insulin.

Maturity onset diabetes of the young (MODY) – a rare form of diabetes caused by a single gene mutation, usually diagnosed in individuals under the age of 25.

Structural equation model - A structural equation model is a statistical tool that helps researchers understand how different variables are related to each other.

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Healthcare Quality Improvement partnership (HQIP)

Royal College of Paediatrics and Child Health
5-11 Theobalds Road
London WC1X 8SH