Why is the prevalence of DKA at diagnosis of type 1 diabetes increasing in children and young people?

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In England and Wales from 2015/16 to 2019/2020, the National Paediatric Diabetes Audit (NPDA) reported that approximately 40% of all hospital admissions in children and young people (CYP) with type 1 diabetes were related to diabetic ketoacidosis (DKA; NPDA, 2023). One third of these admissions were at diagnosis of type 1 diabetes. The audit showed a steady yearly increase in rates of DKA at diagnosis across the five-year audit, from 29.3% to 38.5% (*Table 1*). While it is not clear why DKA rates in CYP are increasing at diagnosis of type 1 diabetes, it has been hypothesised that it can be partly explained by the shift in demographic characteristics (Jensen et al, 2021).

The prevalence of DKA at diagnosis

Age

The NPDA (2023) reported that children aged 0–4 years were more likely to present with DKA at diagnosis than those in any other age group (*Figure 1*). Younger children rely on caregivers to recognise symptoms of illness. However, being able to recognise the signs and symptoms of hyperglycaemia in a timely manner can be challenging. This puts younger children at increased risk of developing DKA (Cherubini et al, 2020; Segerer et al, 2021; Passanisi et al, 2023).

Biology may provide an explanation. Compared to those aged over 15 years, younger children have a greater number of inflamed pancreatic islets and fewer islets with remaining beta-cells (Atkinson et al, 2015). Moreover, metabolic compensation mechanisms are not completely mature in younger children (Usher-Smith et al, 2011). Younger children, therefore, have a more aggressive autoimmune response, leading to faster beta-cell destruction and onset of symptoms (Passanisi et al, 2020). Caregivers of younger children have a shorter window to recognise symptoms of hyperglycaemia before their child presents in DKA and is diagnosed with type 1 diabetes.

Ethnicity

Across the 5-year NPDA period, there was a trend in England and Wales for White CYP with type 1 diabetes to have lower rates of DKA at diagnosis compared to other ethnic categories. In the 2019/20 period, 39.6% of children of White ethnicity newly diagnosed with type 1 diabetes were admitted with DKA, compared to 53.7% of Mixed ethnicity, 48.6% of Black ethnicity and 42.7% of Asian ethnicity.

The social determinants of health can help to explain the higher prevalence in ethnic minorities (Peters et al, 2021). People from ethnic minorities face social and cultural barriers that can negatively affect awareness and early recognition of the condition, and access to healthcare (Hayanga et al, 2023). Language is a large factor contributing to the health inequities that ethnic minorities experience (Ajayi, 2021). Parents and caregivers who speak limited English may struggle to communicate with healthcare professionals (HCPs). This may lead to delayed presentation to primary care and, with the potential for miscommunication, can result in an increased the risk of DKA at diagnosis of type 1 diabetes among children from ethnic minorities (Whitaker et al, 2022). People from ethnic

Table 1. Children and young people diagnosed with type 1 diabetes within each audit year with DKA at diagnosis.

Audit year	Children and young people with DKA at diagnosis
2015/16	29.3%
2016/17	32.3%
2017/18	34.9%
2018/19	36.6%
2019/20	38.5%

> ***"People from ethnic minorities are more likely to experience poorer determinants of health, such as deprivation, leading to poorer health outcomes."***

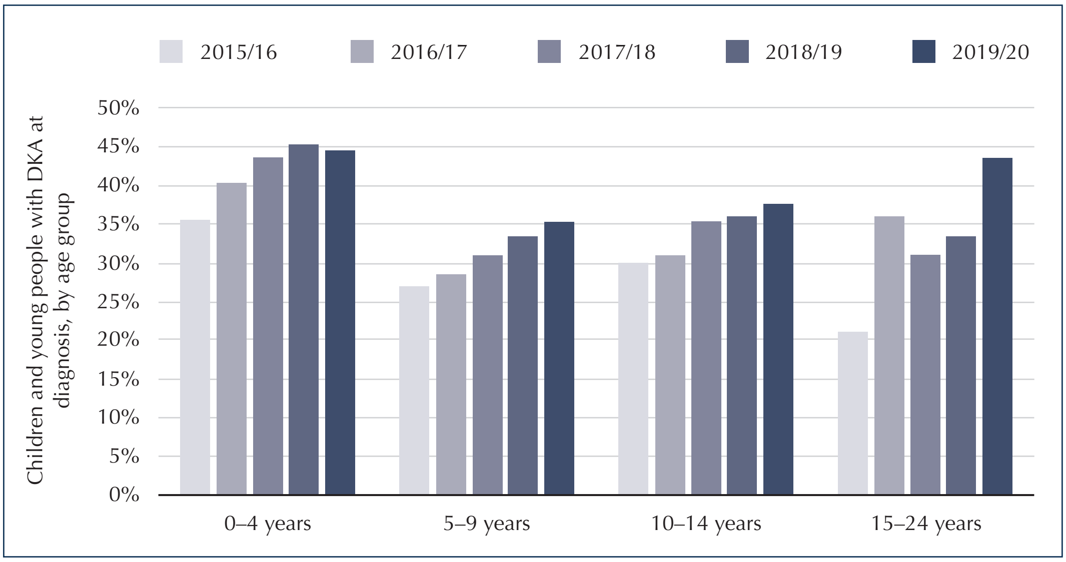

Figure 1. Percentage of admissions due to DKA at diagnosis as a proportion of total numbers of newly diagnosed children and young people with type 1 diabetes in each age group per audit year (NPDA, 2023)

minorities are also more likely to experience poorer determinants of health, such as deprivation, leading to poorer health outcomes (Raleigh, 2023).

Misdiagnosis of type 1 diabetes

Diagnosing a child with type 1 diabetes is a two-stage process. First, the caregiver must identify their child's symptoms and seek healthcare advice.

Then, the HCP must make the correct diagnosis. Studies show that a high proportion of children who have been admitted to hospital in DKA have presented to a primary care provider before being diagnosed with type 1 diabetes (Lokulo-Sodipe, 2014; Souza et al, 2020; Nagl et al, 2022). Some symptoms of type 1 diabetes, such as irritability, poor feeding and lethargy, are non-specific, so caregivers present their child at GP surgeries with the suspicion of a bacterial or viral infection (Bui et al, 2010). These symptoms can mask the early symptoms of type 1 diabetes, increasing the likelihood of misdiagnosis (Muñoz et al, 2019).

Deprivation

The NPDA (2023) highlighted that DKA at diagnosis of type 1 diabetes was more prevalent among those living in the most deprived areas (*Figure 2*). Deprivation is associated with family income, with lower income being related to lower levels of parental education (Gesuita et al, 2020). This, in turn, is associated with poorer health literacy, which increases the risk of adverse outcomes (Raleigh, 2023). Caregivers with poor health literacy struggle to obtain, process and understand the basic health information and services needed to make appropriate health decisions (Coughlin et al, 2021). This may put caregivers from more deprived areas at an increased risk of overlooking their child's symptoms of type 1 diabetes and waiting longer before seeking medical advice, and thereby increasing the risk of DKA at diagnosis (Limenis et al, 2012).

COVID-19 infection

Research has indicated that the rates of DKA at diagnosis of type 1 diabetes increased during the COVID-19 pandemic compared to pre-pandemic years. A study conducted in the UK and Ireland found a 43% increase in emergency department attendances for DKA from 2019/20 to 2020/21 in children with newly diagnosed type 1 diabetes (Ponmani et al, 2023).

Delayed presentation to healthcare providers because of the fear of contracting a COVID-19 infection is a possible contributory factor (Cherubini et al, 2022). COVID-19 information, perception of risks, and guidance and rules all influenced the decision-

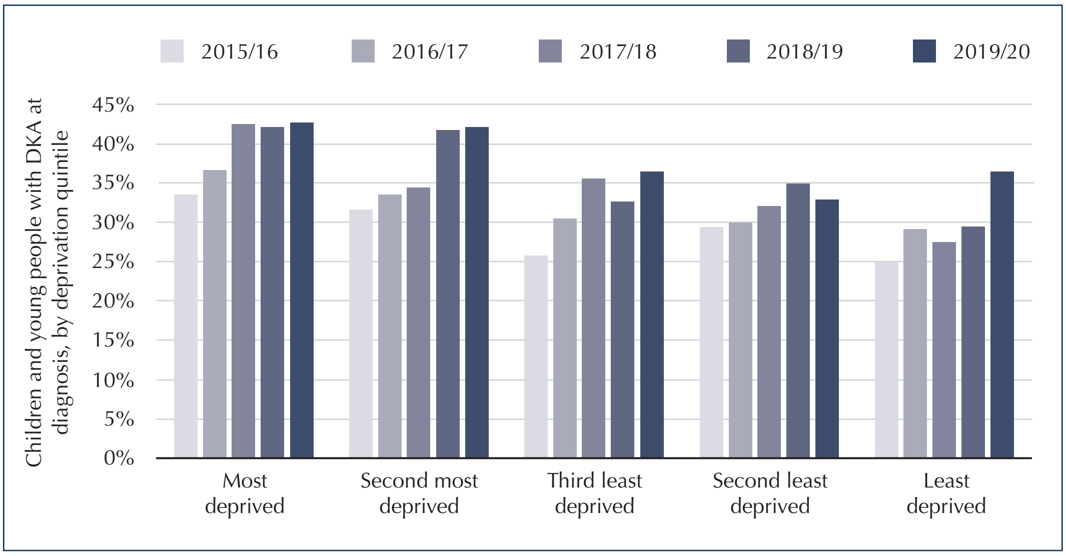

Figure 2. Percentage of admissions due to DKA at diagnosis as a proportion of total numbers of newly diagnosed children and young people with type 1 diabetes in each deprivation quintile per audit year (NPDA, 2023).

> ***"An indirect effect of COVID-19 was that the shift in medical focus towards the response to the pandemic had detrimental impacts on essential healthcare services."***

making processes of caregivers regarding taking their child to hospital (Breckons et al, 2023). Another indirect effect of COVID-19 was that the shift in medical focus towards the response to the pandemic had detrimental impacts on essential healthcare services, such as staff shortages and lack of provision of primary healthcare (Goldman et al, 2022).

One large analysis of data from around the world found that the incidence of type 1 diabetes in children and adolescents was 16% higher in the first 12 months of the pandemic and 28% higher in the subsequent 12 months compared with the year before the pandemic (Kamrath et al, 2023). The pre-pandemic annual increase in annual incidence was 2%–3%.

The reasons behind this are complicated, with suggestions that hygiene measures compromised immune systems and that lockdowns early in the pandemic delayed diagnoses. COVID-19 infection may also initiate autoimmunity or accelerate disease progression (Weiss et al, 2023). A higher incidence of DKA corresponding to the increased incidence of type 1 diabetes in children and adolescents has been reported (D'Souza et al, 2023).

Clinical implications

Education can combat increasing rates of DKA at diagnosis of type 1 diabetes. Currently, awareness campaigns, which have successfully reduced rates of DKA, especially in the UK, are currently lacking. Launched by Diabetes UK in 2013, the 4Ts campaign is a national education awareness programme to raise awareness among families and HCPs of the key symptoms of type 1 diabetes: Toilet, Thirsty, Tired and Thinner. The number of children presenting in DKA has been found to reduce after local promotion of the campaign (Gann and Modgil, 2014). However, rates have continued to rise nationally.

Future awareness campaigns should target those groups that would benefit most from them. This includes families with younger children, so that caregivers are educated on the specific signs and symptoms of hyperglycaemia. Campaigns in areas with high numbers of people belonging to an ethnic minority need to overcome language barriers and be accessible for everyone. In areas with high levels of deprivation, there needs to be a focus on health literacy, to ensure equal access to healthcare.

To reduce the number of misdiagnoses, education for HCPs in primary care should aim to improve skills in differentiating between conditions that present with similar symptoms as type 1 diabetes.

Together, these efforts could start to bring a halt to the increase in CYP presenting with DKA at hospital emergency departments. ■

> ***"Future awareness campaigns should target those groups that would benefit most from them."***

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