

# Ketone knowledge among people with type 1 diabetes

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## Article points

1. Diabetic ketoacidosis (DKA) is a potentially life-threatening complication of diabetes.
2. Self-testing of either urine or blood for ketones can predict developing DKA.
3. The authors investigated the level of knowledge on ketones and ketone testing in 120 people with type 1 diabetes at a large general hospital diabetes clinic.
4. Knowledge about ketones and ketone testing was found to be poor, and did not improve with duration of diabetes.
5. Education for people with type 1 diabetes about ketones, ketone testing and test interpretation should be ongoing, not limited to the period immediately following diagnosis.

## Key words

- Diabetic ketoacidosis
- Education
- Ketone testing
- Self-management

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At diagnosis, people with type 1 diabetes receive education regarding the risks and causes of diabetic ketoacidosis. This includes practical instruction on how to test for ketones and the provision of literature on sick-day management. The authors developed a questionnaire to assess knowledge about ketones and ketone testing in a population with type 1 diabetes attending a large general hospital. Ketone knowledge was found to be poor in this population, and the implications for clinical practice are discussed in this article.

**D**iabetic ketoacidosis (DKA) is a potentially life-threatening metabolic complication of diabetes (Higgins, 1994). DKA is a state of relative or absolute insulin deficiency and results in derangements in intermediary metabolism (Lewis, 2000). Despite improvements in diabetes care, DKA remains a significant factor in morbidity and mortality among people with diabetes (Fishbein and Palumbo, 1995; Umpierrez et al, 1997; Wallace and Matthews, 2004).

The presence of ketonuria or ketonaemia are a key factor in the prediction and diagnosis of DKA. An understanding of how and why to test for ketones, and their relationship to DKA, are important elements of type 1 diabetes education and self-management. Diabetes centres commonly advise people with type 1 diabetes to test for ketones if their blood glucose level is elevated, if they feel unwell or if they have symptoms of polyuria and polydipsia (SIGN, 2010). There are currently two methods for

people to test for ketones: blood testing and urine testing (*Box 1*).

## Study rationale

Following assessment of people with type 1 diabetes considering continuous subcutaneous insulin infusion (CSII) therapy at the Western General Hospital (WGH) diabetes clinic, the authors noted a general lack of understanding in this group regarding ketones and ketone testing. Anecdotally, people being assessed for CSII therapy are highly motivated in their diabetes self-care, yet ketones and their place in diabetes self-management appeared to be a gap in this group's knowledge. The authors developed a questionnaire to more formally assess people with type 1 diabetes' knowledge regarding ketones and ketone testing.

## Method

A questionnaire (*Box 2*) was developed and distributed to people with type 1 diabetes attending the WGH diabetes clinic between

**Box 1. Current methods for ketone testing.**

Optium Xceed (Abbott, Maidenhead)	<ul style="list-style-type: none"> <li>– Blood-testing device.</li> <li>– Tests capillary levels of beta-hydroxybutyrate (beta-HBA; the most important ketone body) quantitatively.</li> <li>– Requires 1.5 µL of blood from finger-prick.</li> <li>– Takes 10 seconds for result to be displayed on the meter screen.</li> <li>– Ten sticks cost approximately £17.50.</li> <li>– Evidence suggests that blood testing is more accurate than urine testing (Guerci et al, 2003; Turan et al, 2008).</li> </ul>
Ketostix (Bayer, Newbury)	<ul style="list-style-type: none"> <li>– Urine testing device.</li> <li>– Does not measure beta-HBA.</li> <li>– Air exposure may give false negative results.</li> <li>– Information refers to the 2–4 hour period prior to testing.</li> <li>– Urine sample required.</li> <li>– 50 strips cost approximately £4.10.</li> </ul>

**Box 2. The ketones questionnaire.**

- How long have you had diabetes?
- How old are you?
- How do you take your insulin?
  - Pen devices.
  - Insulin syringes.
  - Insulin pump.
- Do you know what ketones are?
- Do you test for ketones when your blood glucose level is high?
- If yes, what level would your blood glucose be?
  - During illness.
  - If you are vomiting.
  - If you are stressed.
  - Other reasons (please state).
- Do you test your urine for ketones?
- Do you test your blood for ketones?

1 May 2009 and 1 September 2009. People were asked to complete the questionnaire while waiting to be seen by the clinic doctor.

**Results**

One-hundred and twenty people (17% of the WGH diabetes clinic’s total population with type 1 diabetes) completed the questionnaire. Participant characteristics are shown in *Table 1*.

The majority (83%, 99/120) of participants confirmed that they knew what ketones were. One-third (33%, 40/120) of participants reported that they would check for ketones if their blood glucose level was high. The blood glucose levels at which they would check for ketones are shown in *Figure 1*.

Thirty-seven percent (44/120) of participants said they would check for ketones if they were unwell, 19% (23/120) would check if they were vomiting and 9% (11/120) would check if they were feeling stressed. Other reasons given for ketone testing were:

- Ketotic smell on breath.
- Headache.
- Sore back.
- Symptoms of hyperglycaemia.

The number of participants testing using the blood ketone meter (17%, 20/120) or the urine

test strips (16%, 19/120) was about equal. Eleven participants (9%) used both methods. The majority (58%, 70/120) of participants reported using neither method (*Table 2*).

The duration of diabetes in the 17% of participants who did not know what ketones were is shown in *Table 3*. The number of participants in each diabetes-duration bracket who did not know what ketones were was approximately equal.

**Discussion**

This study suggests a lack of knowledge among people with type 1 diabetes regarding ketones and ketone testing.

Approximately one in five people questioned did not know what a ketone was. Interestingly, the duration of diabetes did not appear to influence knowledge regarding ketones. Among the minority who reported that they would test for ketones if their blood glucose level was high, only 10% (4/39) correctly identified that ketone testing should be undertaken if blood glucose levels reach 14 mmol/L (Wallace and Matthews, 2004).

Although the present cohort may not be representative of the wider population with type 1 diabetes, participants’ attendance at the diabetes clinic at which the questionnaire was completed suggests that they are more aware of their diabetes management than clinic non-attendees. Thus, knowledge regarding ketones among people with type 1 diabetes in general may be considered to be lower than suggested by the data presented here.

It is acknowledged that the present questionnaire did not assess participant knowledge on how to interpret ketone test results. Ketone test interpretation by people with diabetes should be considered in future investigations.

**Implications for clinical practice**

Information and education regarding ketones, ketone testing and test interpretation should be provided beyond diagnosis. The importance of ketones in relation to diabetes management should be highlighted during clinical reviews at least annually, and documented appropriately.

In addition to reminders about ketones and their significance in clinical reviews, ketone testing equipment should be updated and tuition provided when appropriate. Good-quality educational materials regarding ketone testing and sick-day management should be readily available in diabetes clinic waiting rooms. People requiring additional ketone-related education should be referred to a DSN.

**Conclusion**

DKA is a preventable complication of diabetes. The data presented here suggest that the majority of clinic-attending people with type 1 diabetes do not have sufficient knowledge regarding ketones and the importance of ketone testing. Healthcare professionals providing care for people with diabetes should ensure that ketone-related education is not only given at diagnosis but is part of ongoing diabetes self-management education. Better understanding of the importance of ketones, and more frequent and appropriate testing, among people with type 1 diabetes has the potential to reduce the number of episodes of DKA. ■

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**Table 1. Participant characteristics.**

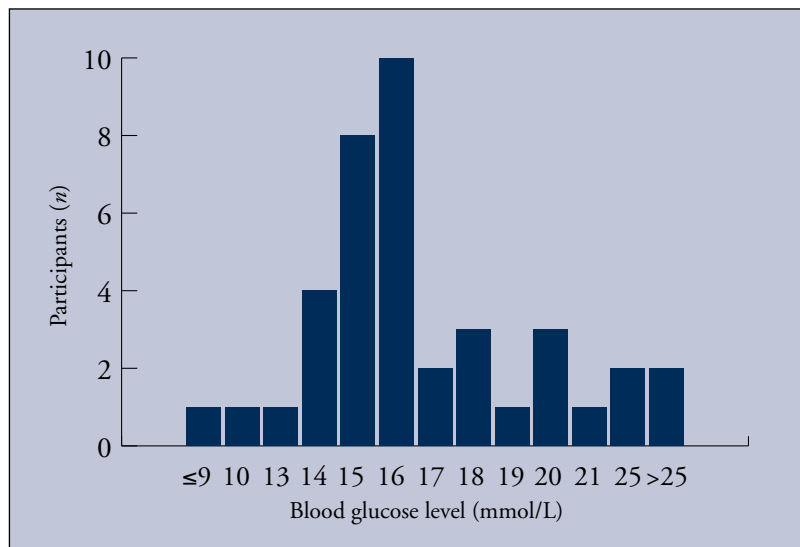
Characteristics	Data
Completed questionnaires	120 people with type 1 diabetes
Mean age (±standard deviation [SD], years)	42±16 years
Mean duration of diabetes (±SD, years)	16±12 years
Using an insulin pen device (n)	109 (91%)
Using an insulin pump (n)	6 (5%)
Using an insulin syringe (n)	5 (4%)

**Table 2. Method of ketone testing.**

Method of testing	Participants (n)
None	70 (58%)
Blood ketone meter	20 (17%)
Urine ketone test strips	19 (16%)
Both	11 (9%)

**Table 3. Duration of diabetes among participants who reported that they did not know what ketones were.**

Duration of diabetes (years)	Participants (n)
<5	5/25 (20%)
5-10	5/26 (19%)
10-15	4/17 (24%)
15-20	2/15 (13%)
20-57	5/37 (14%)



**Figure 1. The blood glucose level at which participants suggested that they would test for ketones.**