

Title Page

Understanding Type 2 Diabetes and Its Management

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1. Introduction

Diabetes mellitus is a long-term metabolic condition characterised by consistently high blood glucose due to impaired insulin production, action or both (American Diabetes Association, 2023). It is a major public health challenge of the 21st century, with prevalence rising globally. In the United Kingdom, about 4.9 million people have diabetes, with around 90% diagnosed with Type 2 diabetes (Diabetes UK, 2022).

Type 2 diabetes develops through a mix of genetic and lifestyle or environmental factors. Risk factors are non-modifiable such as age, family history and ethnic background, with higher risk among South Asian, African-Caribbean and Black African populations and modifiable, including excess weight, sedentary lifestyle, poor diet and tobacco use (Pharmacy Research UK, 2021; NICE, 2022).

The condition usually arises when insulin resistance reduces tissue responsiveness and the pancreas gradually produces insufficient insulin. As a result, glucose uptake by cells is impaired and the liver releases extra glucose into the blood, raising blood sugar levels (Galicia-Garcia et al., 2020). Understanding these mechanisms helps patients appreciate the impact of lifestyle and treatment choices on their health outcomes and long-term risk of complications.

This report provides practical guidance for practice nurses to help patients manage blood glucose and follow care plans effectively.

2. Maintenance of Blood Sugar Levels in the Body

The body maintains blood glucose within a narrow range, typically 4.0–6.0 mmol/L during fasting, through tightly regulated systems (Röder et al., 2016). Maintaining this balance is crucial as glucose is the primary energy source for all cells, with the brain alone requiring around 120 grams daily (Mergenthaler et al., 2013). Multiple organs including the pancreas, liver, fat tissue and muscles work together under hormonal control to stabilise blood sugar levels.

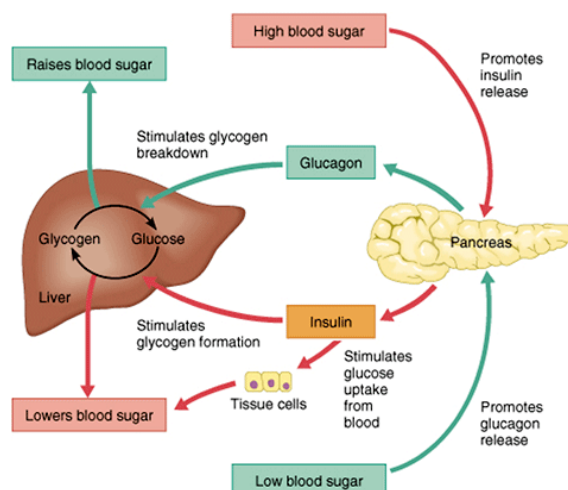


Figure 1: Regulation of blood glucose levels by insulin and glucagon
(Adapted from American Diabetes Association, 2023.)

Figure 1 shows, insulin lowers blood glucose by promoting its uptake into tissues, while glucagon raises glucose by acting on the liver (Adapted from American Diabetes Association, 2023). The pancreas contains clusters of cells called the islets of Langerhans: beta cells release insulin and alpha cells release glucagon. Together, these hormones regulate blood glucose, ensuring sufficient energy for daily activities (Campbell and Newgard, 2021).

After eating, carbohydrates are broken down into glucose, which enters the bloodstream. This rise is detected by pancreatic beta cells, triggering insulin release. Insulin facilitates glucose uptake into insulin-sensitive tissues, mainly skeletal muscle and adipose tissue via GLUT4 transporters (Leto and Saltiel, 2012). Simultaneously, insulin reduces glucose production in the liver by suppressing gluconeogenesis and glycogen breakdown while promoting glycogen storage in the liver and muscles (Petersen and Shulman, 2018).

When blood glucose levels fall such as during fasting or periods of increased energy demand, pancreatic alpha cells release glucagon. This hormone mainly acts on the liver, promoting glycogen breakdown and production of new glucose (gluconeogenesis) to restore blood glucose levels (Ramnanan et al., 2011). This counter-regulatory system keeps blood glucose stable even when dietary intake or energy use changes.

In Type 2 diabetes, this balanced system is disrupted. Body tissues become less responsive to insulin, so the pancreas produces more to maintain normal blood glucose. Over time, beta cells may struggle to meet this demand, causing a relative insulin deficiency and elevated blood glucose (Halban et al., 2014). This disruption highlights the need for lifestyle and pharmacological interventions to restore glucose homeostasis and maintain normal cellular energy metabolism.

3. Cellular Metabolism: The Role of Oxygen and Glucose in Energy Production

Inside cells, glucose and oxygen undergo chemical reactions to produce adenosine triphosphate (ATP), the energy needed for cellular activities.

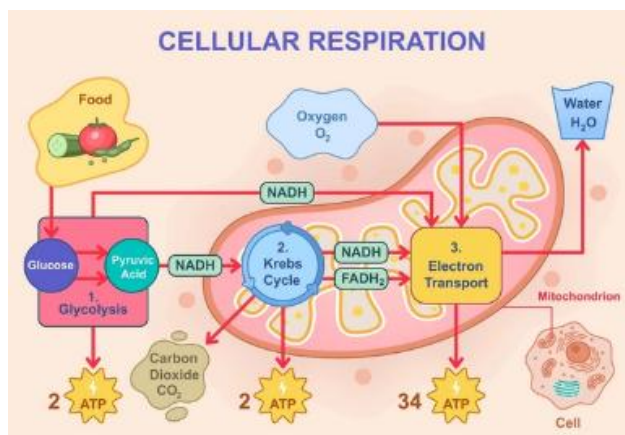


Figure 2: Overview of cellular respiration showing glycolysis, Krebs cycle, and oxidative phosphorylation (Adapted from Rich, 2017).

Figure 2 shows, glucose is broken down through glycolysis, the Krebs cycle and oxidative phosphorylation to produce ATP, with oxygen serving as the final electron acceptor in mitochondria (Adapted from Rich, 2017). This process called cellular respiration, mainly occurs in mitochondria and is vital for normal body function (Rich, 2017).

During glycolysis in the cytoplasm, one glucose molecule is split into two pyruvate molecules, generating a small amount of energy: two ATP and two NADH molecules (Lunt and Vander Heiden, 2011). Glycolysis does not need oxygen, so it provides rapid energy but in limited amounts.

When oxygen is present, pyruvate enters the mitochondria and is converted into acetyl coenzyme A (acetyl-CoA), which enters the citric acid cycle. This cycle produces additional ATP, NADH and FADH₂, while carbon dioxide is released as a waste product (Martínez-Reyes and Chandel, 2020). The NADH and FADH₂ generated during glycolysis and the citric acid cycle carry electrons to the electron transport chain, a series of protein complexes in the inner mitochondrial membrane.

The electron transport chain carries out oxidative phosphorylation, the most efficient stage of ATP production. As electrons move along the chain, energy is released and used to pump protons across the inner mitochondrial membrane, creating an electrochemical gradient. This gradient powers ATP synthase, which adds a phosphate to ADP to generate approximately 32-34 ATP from one glucose molecule (Nath, 2019). Oxygen plays a key role at the end of the chain, combining with electrons and protons to form water. Simply put, without enough oxygen, this energy-producing process slows and cells can only produce a small amount of ATP through glycolysis.

This complex energy system illustrates why both glucose and oxygen are essential for proper cellular function. Tissues with high energy demands such as the heart and brain are especially sensitive to shortages of glucose or oxygen. In people with Type 2 diabetes, insulin resistance limits cellular glucose uptake despite adequate oxygen availability, reducing the efficiency of mitochondrial ATP production and contributing to fatigue and impaired tissue function. (Szendroedi, Phielix and Roden, 2011). Understanding this helps patients see why keeping blood glucose within the recommended range is important for supporting healthy cell function and overall wellbeing.

4. The Importance of Recording and Tracking Blood Sugar Levels

Self-monitoring of blood glucose (SMBG) is vital, providing immediate feedback. For example, a patient could check their blood sugar in the morning and two hours after lunch, recording the values in a diary or using a smartphone app to share with their nurse during appointments.

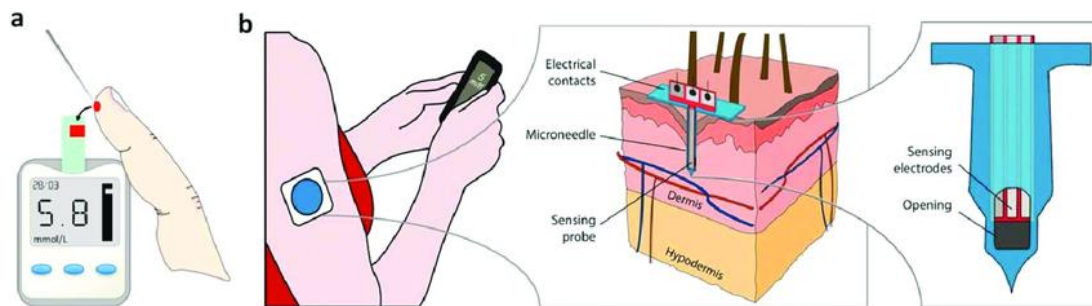


*Figure 3: A finger-prick blood glucose monitoring device using a lancet and test strip.
(Adapted from Das et al., 2022)*

Figure 3 shows a finger-prick blood glucose monitoring device using a lancet and test strip. (Adapted from Das et al., 2022)

With this information, patients can make informed choices about meals, exercise and medication (American Diabetes Association, 2023). Recording daily readings produces data that healthcare professionals can analyse to spot trends, adjust medications and personalise care plans. Regular blood glucose monitoring is essential for people with Type 2 diabetes to manage their condition safely and guide daily decisions.

Firstly, SMBG helps patients see how their blood glucose responds to different foods, making it easier to identify meals causing high post-meal spikes (Franc et al., 2021). This personalised feedback lets patients adjust what and how much they eat, improving blood glucose control while maintaining dietary satisfaction. Miller et al. (2020) found that structured SMBG with guidance on interpreting results significantly improved HbA1c compared to standard care.

Secondly, regular blood glucose monitoring helps detect hypoglycaemia early, a potentially dangerous complication, especially for patients on insulin or sulphonylureas. Hypoglycaemia, defined as blood glucose below 3.9 mmol/L can cause symptoms from sweating, palpitations and tremor to confusion, seizures or unconsciousness (International Hypoglycaemia Study Group, 2017). Early detection via SMBG lets patients take corrective action before severe hypoglycaemia occurs, reducing accident risk and helping maintain safety during daily activities like driving (Graveling and Frier, 2017).

Thirdly, keeping regular blood glucose records helps patients and healthcare professionals spot patterns over time, guiding treatment adjustments. Consistently high fasting glucose may indicate insufficient basal insulin or excess hepatic glucose production, while elevated post-meal readings may suggest adjusting meal-time insulin or oral medications (Klonoff et al., 2021). Sharing these records during clinic visits allows patients and clinicians to make personalised treatment decisions together.

Finally, regularly checking blood glucose helps patients engage in their care and boosts confidence in managing diabetes, which is linked to better outcomes. When patients understand their readings and can take action, they are more likely to follow lifestyle advice and adhere to medications (Gonzalez et al., 2016). By actively monitoring their glucose, patients shift from passive recipients to taking control of their health.

5. Evidence-Based Lifestyle Recommendations for Diabetes Management

Lifestyle modification is the cornerstone of managing Type 2 diabetes. Evidence shows that adjusting diet, engaging in regular physical activity and quitting smoking can help control blood glucose and reduce the risk of cardiovascular complications (NICE, 2022).

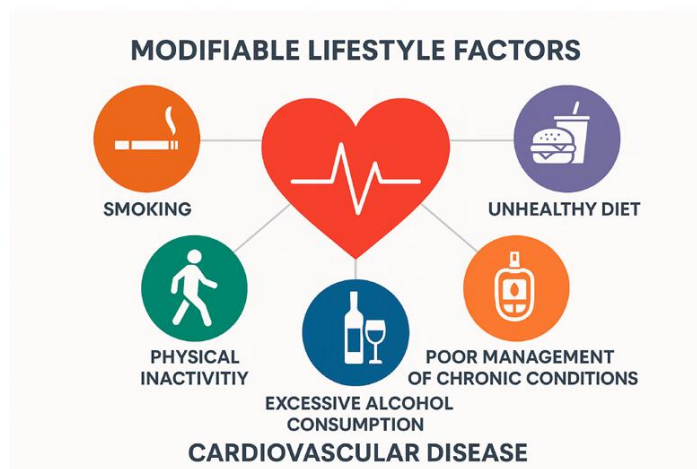


Figure 4: Lifestyle factors impacting diabetes management (Adapted from NICE, 2022).

Figure 4 illustrates how diet, physical activity and smoking cessation interact to improve blood glucose control and reduce complications in Type 2 diabetes (Adapted from NICE, 2022). The following evidence-based recommendations can support patients in improving their overall health and managing their condition effectively.

5.1 Dietary Modifications

Dietary interventions for Type 2 diabetes should help patients maintain a healthy weight, control blood glucose and reduce cardiovascular risk. Diabetes UK guidelines recommend personalised advice considering individual food preferences, cultural background and social or financial factors (Dyson et al., 2018).

Managing carbohydrate intake is key, as carbs have the largest effect on post-meal blood glucose. For example, patients could swap white bread for wholegrain toast at breakfast or add beans or lentils to lunch to increase fibre and slow glucose absorption. They should choose high-fibre, low-glycaemic index carbs such as whole grains, legumes, vegetables and fruits while limiting refined carbs and added sugars (Reynolds et al., 2020). A review by Livesey et al. (2019) found that high glycaemic index and load diets are linked to higher risk of Type 2 diabetes and poorer glycaemic control.

The type of dietary fat is also important. Patients should prioritise unsaturated fats from olive oil, nuts, seeds and oily fish, while limiting saturated and trans fats. The PREDIMED trial showed that a Mediterranean diet with extra-virgin olive oil or nuts reduced cardiovascular events in high-risk individuals, including those with Type 2 diabetes (Estruch et al., 2018). Reducing salt intake to below 5.8 g per day (about 2.3 g sodium) helps manage blood pressure, which is often elevated in people with diabetes (Whelton et al., 2018).

5.2 Physical Activity

Regular physical activity benefits people with Type 2 diabetes by improving insulin sensitivity, increasing glucose uptake by muscles, supporting weight management and reducing cardiovascular risk (Colberg et al., 2016). Adults should aim for at least 150 minutes of moderate-intensity aerobic

exercise per week, over at least three days, with no more than two consecutive inactive days (American Diabetes Association, 2023).

Aerobic activities like brisk walking, cycling or swimming improve cardiovascular fitness and help the body use glucose more efficiently, even without insulin. Patients could start with 20 minute brisk walks after meals three times per week, gradually increasing duration as fitness improves. Resistance training twice weekly builds muscle and enhances insulin sensitivity. Combining aerobic and resistance exercises provides better blood glucose control than either alone (Sigal et al., 2017). Patients should also limit prolonged sitting, as sedentary behaviour can negatively affect metabolism and overall health (Davies et al., 2018).

5.3 Smoking Cessation

Smoking is a key lifestyle factor that increases cardiovascular risk in people with diabetes. Smoking lowers insulin sensitivity, accelerates damage to small blood vessels and roughly doubles the risk of heart-related death in diabetic patients (Pan et al., 2015). These effects occur because smoking causes oxidative stress, harms blood vessels and triggers inflammation (Sliwiska-Mosson and Milnerowicz, 2017).

People with diabetes who smoke should be offered support to quit as part of routine care, including behavioural counselling and pharmacotherapy. Quitting provides rapid benefits, with cardiovascular risk starting to decline within months (Duncan et al., 2019). Healthcare professionals should use a non-judgemental approach, recognising nicotine addiction challenges while emphasising the health gains from cessation. Medications such as nicotine replacement therapy, varenicline, or bupropion can be considered based on patient needs and preferences (NICE, 2021).

6. Conclusion

Type 2 diabetes is a growing health concern and effective management requires patients to be actively involved. This report examined how the body regulates blood glucose and how these processes are disrupted in diabetes. Maintaining blood glucose within target ranges is essential for supplying cells with energy and preventing complications.

Self-monitoring of blood glucose (SMBG) is a key part of management. It provides immediate feedback, helping patients make informed choices about diet, exercise and medication. With guidance, SMBG allows patients to take an active role in their care and improve outcomes.

Lifestyle changes including a healthier diet, more physical activity and quitting smoking are central to managing Type 2 diabetes. Evidence shows these changes help control blood glucose, lower cardiovascular risk and improve quality of life. Practice nurses support patients by offering personalised guidance, ongoing encouragement and collaborating on care plans.

7. Reference List

- American Diabetes Association (2023) 'Standards of Medical Care in Diabetes-2023', *Diabetes Care*, 46(Supplement 1), pp. S1-S291.
- Campbell, J.E. and Newgard, C.B. (2021) 'Mechanisms controlling pancreatic islet function and insulin secretion in health and disease', *Nature Reviews Endocrinology*, 17(8), pp. 453-467.
- Colberg, S.R. et al. (2016) 'Physical activity/exercise and diabetes: A position statement of the American Diabetes Association', *Diabetes Care*, 39(11), pp. 2065-2079.

- Davies, M.J. *et al.* (2018) 'Management of hyperglycemia in type 2 diabetes, 2018. A consensus report by the American Diabetes Association and the European Association for the Study of Diabetes', *Diabetes Care*, 41(12), pp. 2669-2701.
- Diabetes UK (2022) *Diabetes statistics*. Available at: <https://www.diabetes.org.uk/professionals/position-statements-reports/statistics> (Accessed: 17 February 2026).
- Duncan, M.S. *et al.* (2019) 'Association of smoking cessation with subsequent risk of cardiovascular disease', *JAMA*, 322(7), pp. 642-650.
- Dyson, P.A. *et al.* (2018) 'Diabetes UK evidence-based nutrition guidelines for the prevention and management of diabetes', *Diabetic Medicine*, 35(5), pp. 541-547.
- Estruch, R. *et al.* (2018) 'Primary prevention of cardiovascular disease with a Mediterranean diet supplemented with extra-virgin olive oil or nuts', *New England Journal of Medicine*, 378(25), p. e34.
- Franc, S. *et al.* (2021) 'Self-monitoring of blood glucose in people with type 2 diabetes not treated with insulin: A systematic review', *Diabetes Therapy*, 12(5), pp. 1349-1373.
- Galicia-Garcia, U. *et al.* (2020) 'Pathophysiology of type 2 diabetes mellitus', *International Journal of Molecular Sciences*, 21(17), p. 6275.
- Gonzalez, J.S. *et al.* (2016) 'Diabetes self-management education and support in adults with type 2 diabetes: A consensus report of the American Diabetes Association and the American Association of Diabetes Educators', *Diabetes Care*, 39(9), pp. 1584-1599.
- Graveling, A.J. and Frier, B.M. (2017) 'The risk of hypoglycaemia in people with diabetes and its effect on driving', *British Journal of Diabetes*, 17(4), pp. 135-140.
- Halban, P.A. *et al.* (2014) 'β-cell failure in type 2 diabetes: Postulated mechanisms and prospects for prevention and treatment', *Diabetes Care*, 37(6), pp. 1751-1758.
- International Hypoglycaemia Study Group (2017) 'Glucose concentrations of less than 3.0 mmol/L (54 mg/dL) should be reported in clinical trials: A joint position statement of the American Diabetes Association and the European Association for the Study of Diabetes', *Diabetes Care*, 40(1), pp. 155-157.
- Klonoff, D.C. *et al.* (2021) 'Continuous glucose monitoring: A review of the technology and clinical use', *Diabetes Research and Clinical Practice*, 174, p. 108748.
- Leto, D. and Saltiel, A.R. (2012) 'Regulation of glucose transport by insulin: Traffic control of GLUT4', *Nature Reviews Molecular Cell Biology*, 13(6), pp. 383-396.
- Livesey, G. *et al.* (2019) 'Dietary glycemic index and load and the risk of type 2 diabetes: A systematic review and updated meta-analyses of prospective cohort studies', *Nutrients*, 11(6), p. 1280.
- Lunt, S.Y. and Vander Heiden, M.G. (2011) 'Aerobic glycolysis: Meeting the metabolic requirements of cell proliferation', *Annual Review of Cell and Developmental Biology*, 27, pp. 441-464.
- Martínez-Reyes, I. and Chandel, N.S. (2020) 'Mitochondrial TCA cycle metabolites control physiology and disease', *Nature Communications*, 11(1), p. 102.
- Mergenthaler, P. *et al.* (2013) 'Sugar for the brain: The role of glucose in physiological and pathological brain function', *Trends in Neurosciences*, 36(10), pp. 587-597.

- Miller, K.M. *et al.* (2020) 'Structured self-monitoring of blood glucose in type 2 diabetes: A systematic review and meta-analysis', *Diabetes Research and Clinical Practice*, 168, p. 108376.
- Nath, S. (2019) 'The thermodynamic and kinetic basis of oxidative phosphorylation: A review', *Journal of Bioenergetics and Biomembranes*, 51(3), pp. 185-197.
- National Institute for Health and Care Excellence (2021) *Tobacco: preventing uptake, promoting quitting and treating dependence*. NICE guideline [NG209]. London: NICE.
- National Institute for Health and Care Excellence (2022) *Type 2 diabetes in adults: management*. NICE guideline [NG28]. London: NICE.
- Pan, A. *et al.* (2015) 'Relation of active, passive, and quitting smoking with incident type 2 diabetes: A systematic review and meta-analysis', *The Lancet Diabetes and Endocrinology*, 3(12), pp. 958-967.
- Petersen, M.C. and Shulman, G.I. (2018) 'Mechanisms of insulin action and insulin resistance', *Physiological Reviews*, 98(4), pp. 2133-2223.
- Pharmacy Research UK (2021) *Ethnicity and type 2 diabetes risk*. Available at: <https://pharmacyresearchuk.org/ethnicity-diabetes-risk> (Accessed: 17 February 2026).
- Ramnanan, C.J. *et al.* (2011) 'Physiologic action of glucagon on liver glucose metabolism', *Diabetes, Obesity and Metabolism*, 13(s1), pp. 118-125.
- Reynolds, A.N. *et al.* (2020) 'Carbohydrate quality and human health: A series of systematic reviews and meta-analyses', *The Lancet*, 393(10170), pp. 434-445.
- Rich, P.R. (2017) 'The molecular machinery of Keilin's respiratory chain', *Biochemical Society Transactions*, 45(6), pp. 1261-1273.
- Röder, P.V. *et al.* (2016) 'Pancreatic regulation of glucose homeostasis', *Experimental and Molecular Medicine*, 48(3), p. e219.
- Sigal, R.J. *et al.* (2017) 'Effects of aerobic training, resistance training, or both on percentage body fat and cardiometabolic risk markers in obese adolescents: The healthy eating aerobic and resistance training in youth trial', *JAMA Pediatrics*, 171(5), p. e170013.
- Sliwinska-Mosson, M. and Milnerowicz, H. (2017) 'The impact of smoking on the development of diabetes and its complications', *Diabetes and Vascular Disease Research*, 14(4), pp. 265-276.
- Szendroedi, J., Phielix, E. and Roden, M. (2011) 'The role of mitochondria in insulin resistance and type 2 diabetes mellitus', *Nature Reviews Endocrinology*, 8(2), pp. 92-103.
- Whelton, P.K. *et al.* (2018) '2017 ACC/AHA/AAPA/ABC/ACPM/AGS/APhA/ASH/ASPC/NMA/PCNA guideline for the prevention, detection, evaluation, and management of high blood pressure in adults', *Journal of the American College of Cardiology*, 71(19), pp. e127-e248.
- Das, S.K., Nayak, K.K., Krishnaswamy, P.R., Kumar, V. & Bhat, N., 2022. Review—Electrochemistry and Other Emerging Technologies for Continuous Glucose Monitoring Devices. *ECS Sensors Plus*, 1, 031601. Available at: <https://doi.org/10.1149/2754-2726/ac7abb> (Accessed 17 February 2026).