

MODULE TITLE: INTRODUCTION TO PHYSIOLOGY

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CASE STUDY REPORT: *Advancing Patient-Centred
Management of Type 2 Diabetes in UK Primary Care*

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1. INTRODUCTION

1.1 Epidemiology and Socioeconomic Inequalities in T2DM

T2DM is a chronic metabolic disease that is characterised by the persistent hyperglycaemia leading to the permanent hyperglycaemia due to the development of conjoint insulin resistance and progressive degradation of the β -cells of the pancreas (American Diabetes Association, 2023). Nevertheless, the previous history of T2DM as a metabolic dysregulation disease gradually fades away in the latest academic sources which view it as a socio-biological one and take structural determinants of T2DM such as deprivation, food conditions, and health disparities (Franco et al., 2023; Public Health England, 2023). The reframing is particularly applicable to the UK, which means that the prevalence is not evenly spread across the population in the lowest socio-economic and ethnically diverse populations, which shows that the current preventive measures are ineffective.

1.2 Physiological Basis of Glucose Regulation

Physiologically, a very close connection of insulin and glucagon is the way glucose homeostasis is performed. In healthy conditions, cells absorb and store the concentration of glucose with the help of insulin, and glucose is released under the influence of glucagon when the organism is in the fasting state (DeFronzo et al., 2023). In T2DM, however, this regulatory system becomes dysregulated, and this results in chronic hyperglycaemia and vascular damage. The accumulating evidence shows that the dysregulation is not only a pancreatic failure but a failure of metabolism, mitochondrial malfunction, and chronic low-grade inflammation of the body (Brownlee, 2022; Petersen and Shulman, 2018).

The risk factors of T2DM do not only avert to the individual behaviours and extend into the obesogenic environment, sedentary lifestyle, ultra-processed foods, and smoking (Schwingshackl et al., 2023; Pan et al., 2023). Notably, UK approaches to population health influencing imply an individual responsibility, which has been condemned owing to the failure to consider the structural underpinnings of disease and, therefore, obstructs the effectiveness of prevention programmes (Franco et al., 2023).

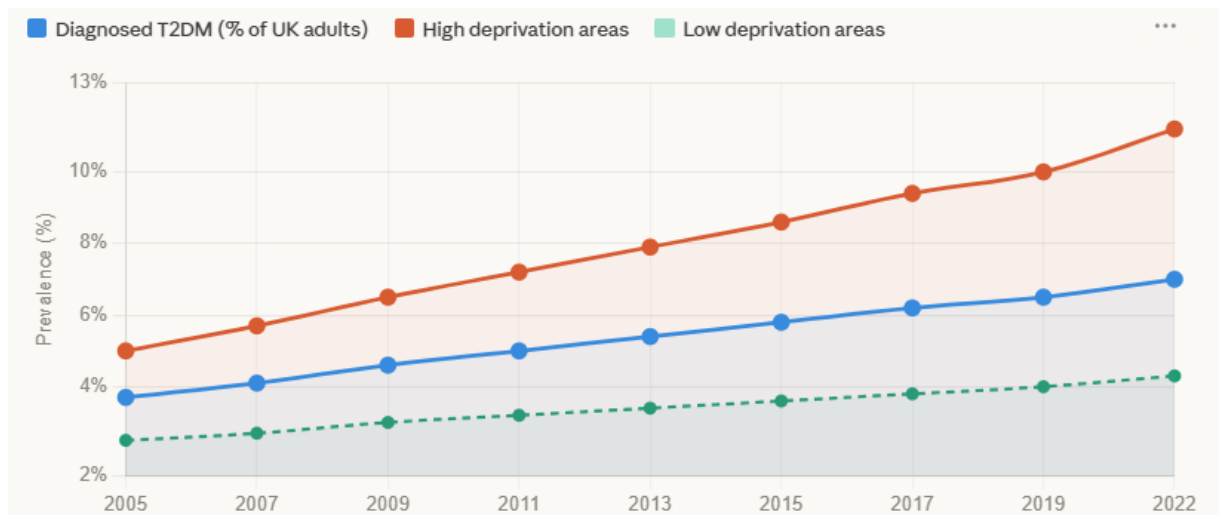


Figure 1 estimated T2DM prevalence (%) in UK adults by deprivation, 2005–2022. (Adapted from: Public Health England (2023) *Diabetes Prevalence Model*; Franco et al. (2023) *Lancet Diabetes Endocrinol*)

2. REGULATION OF BLOOD GLUCOSE: MECHANISMS AND DYSREGULATION

2.1 Normal Glucose Homeostasis

The fact that the blood glucose level should be kept within a tight physiological range is significant to make cells functioning and surviving possible. The intake of nutrients results in insulin secretion into β -cells of the pancreas where glucose enters the insulin-sensitive tissues via GLUT4 transporter and in the liver where it leads to the synthesis of glycogen (Roden and Shulman, 2019). When one is fasting, glucagon promotes liver production of glucose by breaking down the glycogen and making gluconeogenesis to maintain the flow of energy (DeFronzo et al., 2023).

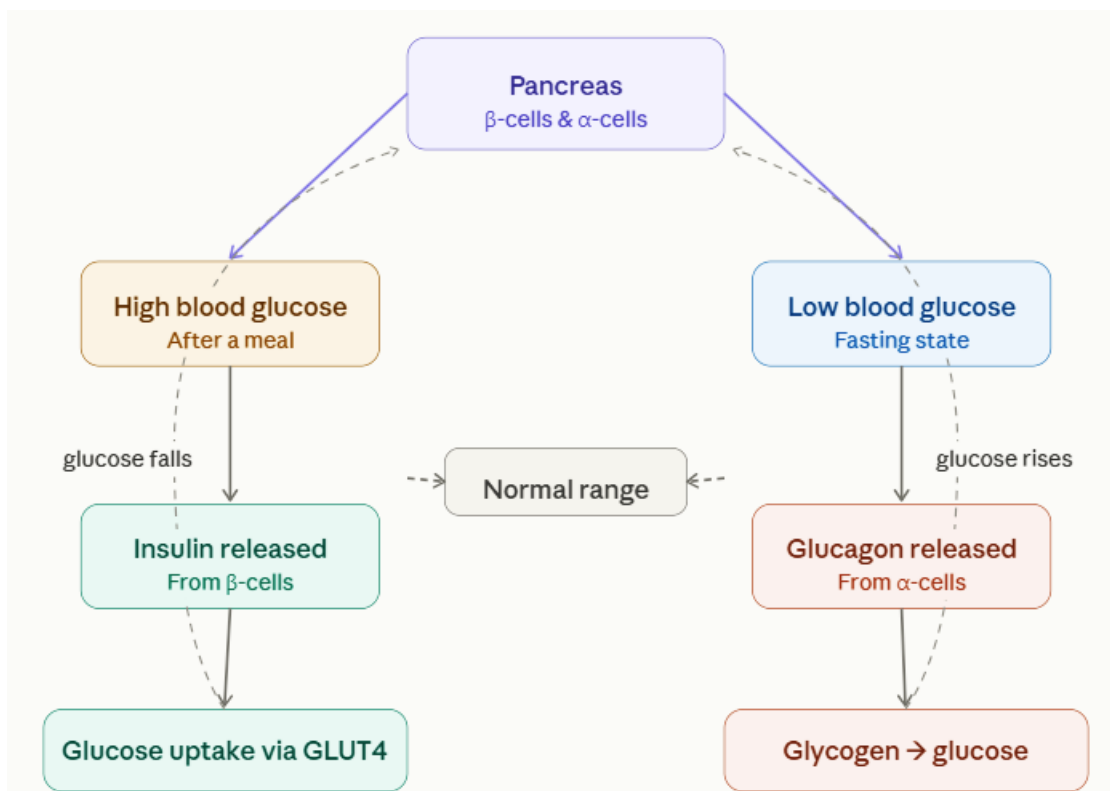


Figure 2 The Role of Insulin and Glucagon in Blood Glucose Homeostasis (Source: Adapted from Roden, M. and Shulman, G.I. (2019) 'The integrative biology of type 2 diabetes', *Nature*, 576, pp. 51–60.)

2.2 Pathophysiology of Type 2 Diabetes

This homeostatic mechanism is disrupted in T2DM, which occurs in a complex of peripheral insulin resistance, increased glucose secretion in the liver, and insulin secretory impairment. Notably, the current studies emphasize the fact that insulin resistance is not only the

impairment of the glucose transportation process, but a symptom of the overall metabolic defect, which manifests itself in the accumulation of lipids in non-adipose tissues and changes in intracellular signal transmission (Petersen and Shulman, 2018). This adds to a vicious cycle of glucotoxicity and lipotoxicity that further worsens the functioning of the β cells.

2.3 Critical Evaluation of Clinical Management (NICE Framework)

The existing clinical practices, namely in NICE (2023) guidelines, are oriented toward the pharmacological treatment along with lifestyle modification. Although based on evidence, this model has been criticised as being reactive in nature, instead of being upstream orientated and concentrating on determinants of disease. In addition, the strict compliance with biomarkers, such as HbA1c, can make the patient experience less challenging and decrease the complexity of metabolic health (Greenhalgh et al., 2022). Therefore, there is a need to have a more integrative strategy that entails biomedical administration as well as personalised care depending on the situation.

3. CELLULAR METABOLISM AND ENERGY PRODUCTION

3.1 Aerobic Respiration and ATP Production

At cellular level energy is generated through oxidation of glucose into the presence of oxygen to generate ATP through aerobic respiration. It is conducted through glycolysis, Krebs cycle, and oxidative phosphorylation of the mitochondria (Brownlee, 2022). The oxygen is the final electron donor in the electron transport chain hence the generation of ATP.

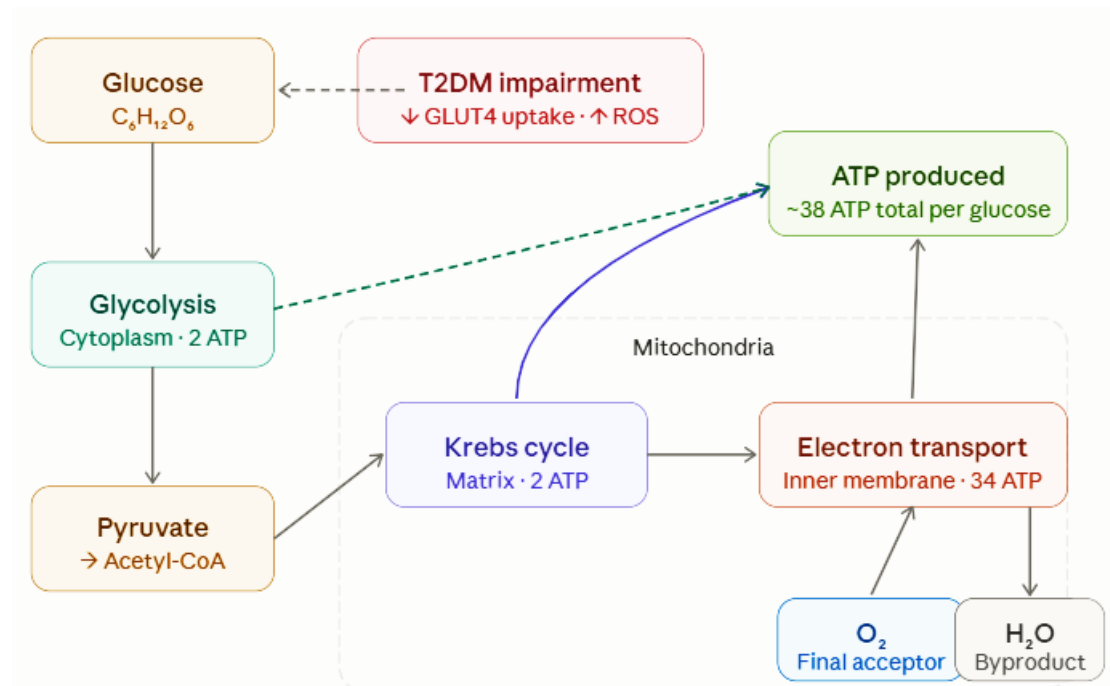


Figure 3 Aerobic Cellular Respiration and ATP Production in Mitochondria (Source: Adapted from Brownlee, M. (2022) 'Mechanisms of hyperglycaemic damage in diabetes', in: Kahn, C.R. et al. (eds.) Joslin's Diabetes Mellitus. 15th edn. Philadelphia: Lippincott Will

3.2 Metabolic Dysfunction in Type 2 Diabetes

The disrupted insulin signalling and inability to take up glucose to the cell in diabetic T2DM limit the access to substrates to produce energy (DeFronzo et al., 2023). However, in addition, recent studies suggest that the impairment of mitochondria is a major mechanism in the pathogenesis of diseases, undermining the oxidative ability and causing the formation of reactive oxygen species (Petersen and Shulman, 2018). This indicates that T2DM is not a glucose regulation disease but a more metabolic disease, which is a cellular energy system.

More importantly, the knowledge refutes reductionist diets of diabetes management, which concern only the level of blood glucose. Rather, it promotes a more integrated model, which incorporates physical activity, which improves the work of mitochondria and insulin sensitivity (Colberg et al., 2022). Therefore, physiological knowledge combined with lifestyle interventions is a must to make the management productive.

4. THE ROLE OF ROUTINE DATA IN DIABETES MANAGEMENT

4.1 Types of Glycaemic Monitoring (SMBG, CGM, HbA1c)

Routine data use is the focus of modern diabetes care and a general move toward data-based healthcare. Self-monitoring of blood glucose (SMBG), constant glucose monitoring (CGM), and HbA1c monitoring are crucial components of monitoring that provide information on the glycaemic trends and the effectiveness of the treatment (American Diabetes Association, 2023).

4.2 Benefits of Data-Driven Self-Management

It has been empirically proven that CGM has a high level of glycaemic control and patient engagement, especially in poorly controlled T2DM patients (Beck et al., 2023). These technologies also provide real-time feedback in which patients can learn how the choice of food and behaviour affects glucose levels (Polonsky et al., 2022). Theoretically, this is in line with self-regulation models of behaviour change in which feedback mechanisms increase motivation and adherence.

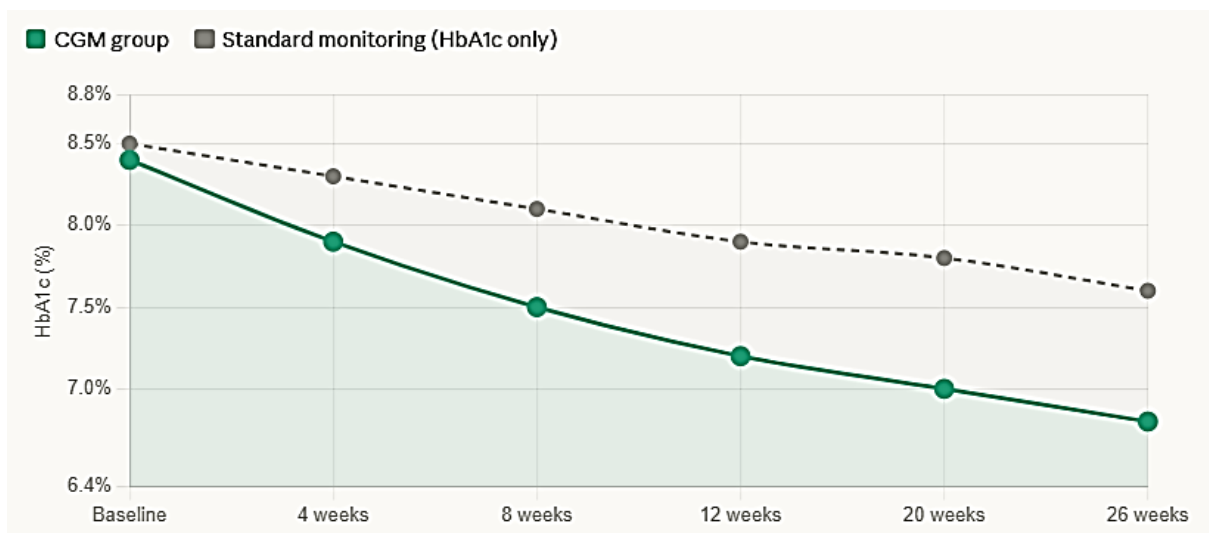


Figure 4 HbA1c (%) reduction over 26 weeks. Lower HbA1c = better glycaemic control (Adapted from: Beck et al. (2023) *Diabetes Care*, 46(2), pp.345–352; Martens et al. (2021) *JAMA*, 325(22), pp.2262–2272.)

Nevertheless, the growing use of digital health tools is important in terms of health inequalities. The availability of CGM and digital tools is not evenly distributed across the NHS, which may only increase the existing discrepancies (Greenhalgh et al., 2022). Moreover, data is not a

sufficient condition as patients should be able to interpret and use this information, which can be achieved only if they have the health literacy.

Guidelines by NICE (2023) support the use of systematic education and individualised care programmes but there is still a disparity in the application of these in practice within UK primary care. This creates a policy practice mismatch and therefore indicates the need to have more intensive integration of patient education and data interpretation capabilities.

5. EVIDENCE-BASED LIFESTYLE RECOMMENDATIONS AND CRITICAL EVALUATION OF INTERVENTIONS, THEORY AND POLICY

5.1 Lifestyle Interventions in T2DM Management

One of the weaknesses of traditional management of diabetes is that it is highly biomedical, and commonly, glycaemic results are emphasised to behavioural and psychosocial outcomes of health. To respond to this, the inclusion of theoretical models like Biopsychosocial Model (Engel, 1977) and Behaviour Change Theory, especially the COM-B model (Capability, Opportunity, Motivation -Behaviour) gives a more holistic picture on patient engagement and self-management (Michie et al., 2011; West and Michie, 2020).

5.2 Behaviour Change Theory: COM-B Model

The COM-B model especially applies well to the reason why most patients find it hard to comply with lifestyle interventions. As an example, patients could have the capacity (food and exercise knowledge), but they could have no opportunity because of socio-economic factors like food insecurity or accessibility to safe exercise areas (Franco et al., 2023). Equally, the chronicity of the condition and perceived low benefits of long-term lifestyle change may be demoralizing (Cradock et al., 2023). This puts into focus that competent diabetes care should not be limited to the information provision but rather to structured behavioural support, which is in line with findings that multi-component interventions are more effective than single-focus educational strategies (NICE, 2023).

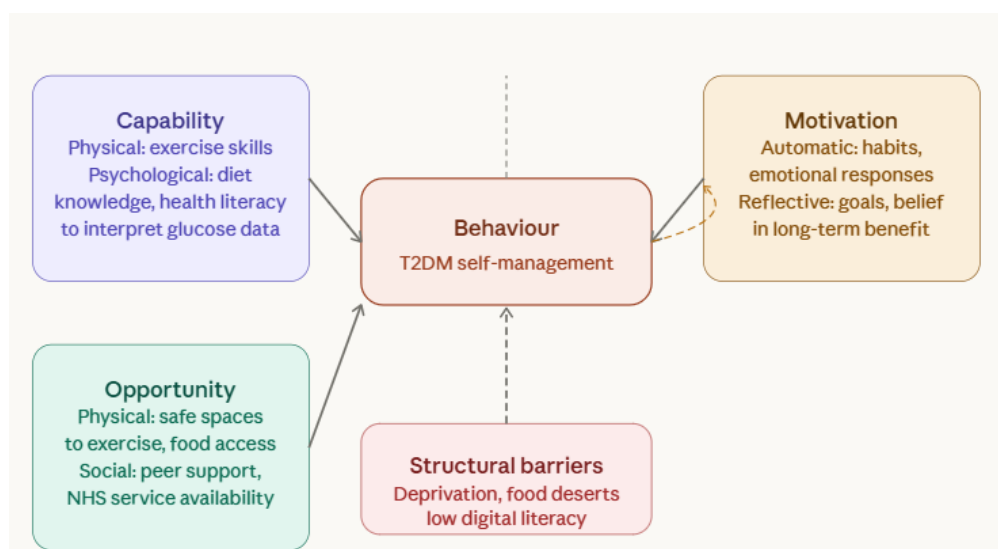


Figure 5 The COM-B Model of Behaviour Change Applied to T2DM Self-Management (Source: Michie, S., van Stralen, M.M. and West, R. (2011))

5.3 NHS Policy Context: Long Term Plan and NDPP

The NHS Long term strategy (2019) also focuses on preventing, and digital innovation in chronic disease control, such as diabetes, which is policy specific. Programs like NHS Diabetes Prevention Programme (NDPP) and more frequent use of digital devices to monitor diabetic states are taken to decrease the number of new cases and enhance self-management (NHS England, 2019). Nonetheless, the recent reviews indicate that such programmes have a slight positive effect on weight and glycaemic control, but the reach and sustainability are low, especially in high-risk and deprived groups (Valabhji et al., 2022; Howarth et al., 2023).

5.4 Integrated Care Systems (ICS): Opportunities and Challenges

Introduction of Integrated Care Systems (ICS) is a structural transition to a collaborative place-based healthcare delivery. Theoretically, the ICS frameworks can enhance the coordination of primary care and community services as well as the public health and community services, which is critical in tackling the multifactorial nature of T2DM (NHS England, 2022). Nonetheless, recent findings reveal that the implementation of ICS has difficulties associated with resource distribution, human resources capacity, and inconsistency in the delivery of services in different areas (Checkland et al., 2023). Therefore, although ICS structures can aid in the comprehensive treatment of diabetes, its success depends on proper financing and regular use.

5.5 Comparative Effectiveness of Interventions

An acute comparison of intervention measures also explains why the management of T2DM is complex. Among the most popular interventions to be used as the first line are lifestyle interventions, specifically dietary change, and exercise since they can change the underlying metabolic dysfunction (Lean et al., 2019; Colberg et al., 2022). Nonetheless, compliance is a major problem, as not all patients can maintain a long-term behaviour change (Presseau et al., 2022). Conversely, pharmacological therapies (e.g., metformin and newer medications e.g. GLP-1 receptor agonists) offer greater instant glycaemic regulation but fail to treat underlying disease causes and may have some side effects and costs (Davies et al., 2022; American Diabetes Association, 2023).

Of more recent emergence, digital health interventions, such as continuous glucose monitoring (CGM), and mobile health applications, have come to the forefront as an effective means of self-management. It has been indicated that CGM enhances glycaemic control and patient outcomes, especially in combination with formal education (Beck et al., 2023; Martens et al.,

2021). Nevertheless, digital solutions can contribute to the further development of health inequalities given the differences in digital literacy and access (Greenhalgh et al., 2022).

5.6 Towards Integrated Patient-Centred Care

Most importantly, the efficacy of such interventions cannot be considered alone and as an individual event but rather as a component of a complex care pathway. At present, there is evidence to support an integrated method, where medication is used to complement lifestyle changes and be aided by digital monitoring devices (Davies et al., 2022). The integration however needs to tackle systemic barriers in the healthcare delivery such as a fragmented service delivery and lack of support to the patient.

Altogether, the future of T2DM management is in a change of a rather biomedical perspective on the problem into a more comprehensive, theory-based, and policy-driven approach towards it. Practice nurses can be instrumental in providing equitable, effective, and patient-centred care by using behavioural science, focusing on social determinants of health and critically analysing the healthcare systems.

6. CONCLUSION

Diabetes type 2 is a complex disorder that needs a holistic approach in the study of human physiology, metabolism, and socio-environmental factors. This report has shown that the regulation of glucose and cellular metabolism is the basis of disease formation, and the importance of regular data in the process of patient self-management and clinical decision-making.

Most importantly, as the UK guidelines, including NICE reported, currently offer a sound evidence-based framework, such practice is limited by the propensity towards biomedical and individualised medical practice, which can overlook structural factors of poor health. In order to fill this gap, more holistic and patient-centred model based on physiological knowledge, data literacy and socio-contextual awareness will be required.

This would not only demand teaching the patient about his/her condition in the case of practice nurses but also granting the patient with the authority to process his/her data, lifestyle as well as react to it positively, with the involvement in meaningful discussions about his/her care plans. This can only be adopted to enhance the results and combat the increasing burden of the T2DM in the UK healthcare system.

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