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Assessing the Impact of mHealth on the Autonomy of Diabetic Patients: A Systematic Review

Minor Dissertation in [partial] fulfilment of the requirements for the degree:

MPhil in Health Innovation

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DECLARATION

I, *Shannon Pincus*, hereby declare that the work on which this dissertation/thesis is based is my original work (except where acknowledgements indicate otherwise) and that neither the whole work nor any part of it has been, is being, or is to be submitted for another degree in this or any other university.

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List of abbreviations

GDM	Gestational diabetes mellitus
HbA1c	Glycated haemoglobin
ICT	Information and communication technology
IDF	International Diabetes Federation
IVR	Interactive voice response
MeSH	Medical subject headings
Non-CT	Non-randomised controlled trial
PICO	Population, intervention, comparator, outcome
RCT	Randomised controlled trial
SDG	Sustainable development goal
SMS	Short messaging service
T1DM	Type 1 diabetes mellitus
T2DM	Type 2 diabetes mellitus
UDHR	Universal declaration of human rights
UN	Unites Nations

Chapter 1. Introduction

1.1Background

Despite overall trends towards improved health, the global burden of disease remains a constant threat to the health of individuals and health systems at large (GBD 2019 Disease and Injuries Collaborators [GBD], 2020). The World Health Organisation (WHO) has described an increase in life expectancy and a shift in the epidemiological patterns of disease, from communicable to non-communicable diseases as the primary cause of mortality and morbidity (World Health Organisation [WHO], 2021). By 2019, seven of the ten leading causes of death globally, were non-communicable diseases (WHO, 2021). As disease patterns have changed, so too have the interventions aimed at addressing them. Reduction of the risk-factors associated with non-communicable diseases as well as chronic management at all stages are essential strategies which can be implemented (at the individual or state level) to mitigate the burden posed by non-communicable diseases (World Health Organisation [WHO], 2022). As the burden of non-communicable diseases increases, the mechanisms that facilitate non-communicable disease management need to adjust accordingly. Digital technologies may provide a viable frontier in non-communicable disease management (Beratarrechea et al., 2017 & MacKinnon & Brittain, 2020). This is due to their ability to help with prevention and management of non-communicable diseases (Monaco et al., 2021).

Digital technologies, especially information and communication technologies (ICTs), have reshaped our relationship with information, ushering in a time of relatively easy access to information via numerous platforms. This shift is making itself known in the healthcare realm where healthcare technologies are being used to improve healthcare services and access thereto (Malila, Mutsvangwa & Douglas, 2019 & Peiris et al., 2014). Information and communication technologies in the healthcare realm have expanded to include a variety of applications and contexts with a resultant rise in concepts, definitions and labels associated with the wide range of applications (Bashshur et al., 2011 & Colucci et al., 2019). With each new application, so too came a corresponding conceptual understanding of the application, a label for it and a definition. As the applications of telemedicine widened, newer concepts were introduced to accommodate the specificities of each application (Bashshur et al., 2011 & Fatehi & Wootton, 2012). However, this has resulted in a confusing state regarding terminology where terms are used interchangeably and it is difficult to determine discrete definitions (Bashshur et al., 2011; Colucci et al., 2019 & Fatehi & Wootton, 2012).

Attempts have been made to separate the different applications into their own discrete domains. This has especially been done through the development of taxonomic structures. The taxonomy of telemedicine created by Bashshur et al. (2011), explains that the four main ICT health domains originated in unique time periods and contexts and thus have unique and distinct meanings. These domains are Telemedicine, Telehealth, eHealth and mHealth (Bashshur et al., 2011). Telemedicine can be considered the original, and most basic form of ICT in healthcare (Bashshur et al., 2011 & Fatehi & Wootton, 2012). Fatehi & Wootton (2012: 460), and Colucci et al. (2019: 448), explain that telemedicine refers to "the provision of medical services across distance". The term telehealth was developed to incorporate an extended scope of health-related activities such as education (for patients and providers) and administration (Bashshur et al., 2011 & Fatehi & Wootton, 2012). Telehealth involves the use of information and communication technologies in the provision of healthcare; this qualifies a device (either hardware or software) as a telehealth device when it communicates health information from a device over a network (Hall & McGraw, 2014). The last two domains are e-health and mHealth. They are newer concepts and emerged as a response to the rise of technology and technological advancements in healthcare (Bashshur et al., 2011). The concept of e-health has suffered from a lack of clarity when it comes to a clear, concise, generally accepted understanding of what constitutes e-health (Bashshur et al., 2011 & Boogerd et al., 2015). e-Health, at its core, refers to applications that are internet driven (Bashshur et al., 2011 Boogerd et al., 2015).

This dissertation focuses on the fourth domain, mHealth. mHealth (mobile digital health information technology) specifically has emerged as a major modality for the provision of healthcare, largely due to the ubiquitous presence of mobile phones that are cheap, powerful, portable, and powered by widespread wireless networks (Kreps, 2017; Laflamme et al., 2019 & Lucivero & Jongsma, 2018). According to the WHO, mHealth can be defined as "medical and public health practice supported by mobile devices such as mobile phones, patient monitoring devices, personal digital assistants (PDAs) and other wireless devices," (World Health Organisation [WHO], 2011). There are numerous proposed benefits of mHealth. Proponents of mHealth cite the mobile nature of devices as revolutionary for its ability to connect healthcare professionals to each other and their patients while also improving efficacy and accessibility through cost-effective mechanisms that can span a rural/urban divide (Laflamme et al., 2019 & Lucivero & Jongsma, 2018). Beyond increasing access to, and between, healthcare practitioners and patients, mHealth has the capacity to improve individuals' health literacy through the dissemination of healthcare information (Bashshur et al., 2011 & Malila, Mutsvangwa & Douglas, 2019). This then has implications for disease management and the provision of healthcare (Malila, Mutsvangwa & Douglas, 2019). When these benefits are considered critically it becomes apparent that mHealth has the potential to improve access to resources (for patients and healthcare providers), improve the flow of information, decrease the cost of care, improve monitoring for disease management and improve the scope and speed of care for patients despite their location to healthcare providers (Gleason, 2015 & Malila, Mutsvangwa & Douglas, 2019). mHealth also claims to improve autonomy – the right of an individual to self-determination- by allowing patients to manage and access their own health information (Lucivero & Jongsma, 2018 & Schmietow & Marckmann, 2019). mHealth is expected to empower patients by shifting the onus of understanding, controlling, and managing their health concerns from their healthcare providers to themselves (Laflamme et al., 2019; Lucivero & Jongsma, 2018 & Schmietow & Marckmann, 2019).

It is argued that mHealth may have the capacity to improve health literacy and patient autonomy. The reality of this relationship in practice will either allow it to deliver on or impede improved autonomy. Greenhalgh (2015: 1), explains that in 2015 the WHO defined health literacy as "the personal characteristics and social resources needed for individuals and communities to access, understand, appraise and use information and services to make decisions about health". From the definition, health literacy is the ability to interpret and utilise information in order to support health goals. Health literacy is a critical component of empowering patients (World Health Organisation [WHO], 1998). Low levels of health literacy result in an inability to fully understand health content, impeding patients' ability to make rational and autonomous decisions, thus mitigating the capacity of mHealth to improve patient autonomy. Health literacy is also about the accessibility of information, and mHealth does have the potential to increase accessibility to health information (Malila, Mutsvangwa

& Douglas, 2019). However, when it comes to health literacy and autonomy this ability to access information may be tempered by an inability to understand it.

These challenges around health literacy combine to form a complex web of fallibility for the ability of mHealth to meet healthcare needs and facilitate an oft envisaged scenario in which empowered users make informed and proactive healthcare decisions. Improved health and well-being is the third goal in the United Nations Sustainable Development Goals (SDGs) (United Nations [UN], 2015). From this we see that healthcare is an essential component of human development (UN, 2015). mHealth should consider the social factors, such as health literacy rates, which enable (or limit) patient autonomy. Capitalising on this will allow for mHealth to be utilised as a valuable tool for enhancing human development (McCool et al., 2022).

Understanding these social factors through the lens of diabetic management provides a wealth of information on the challenges facing mHealth in meeting its reported and intended outcomes. The benefits of mHealth namely, improved access to resources, the dissemination of health information and improved patient autonomy become essential when considered in the context of non-communicable disease management.

Diabetes, a chronic disease with an ever-increasing global prevalence (Bommer et al., 2018 & GBD, 2020) is well situated to provide a case study into mHealth and its effect on autonomy. Though critically assessing the realities of all the purported benefits of mHealth is important, it is the relationship mHealth has with autonomy that requires scrutiny. This is largely due to the nature of diabetes. Evidence suggests that diabetes (specifically type two diabetes) is caused by a complex web of factors with lifestyle choices and behaviours playing a central role (World Health Organisation [WHO], 2016; Zheng, Ley & Hu, 2018 & Zimmet et al., 2014). Moreover, diabetes requires chronic and active self-management (Marciano, Camerini & Schulz, 2019).

Self-management is a critical component of diabetes management (Marciano, Camerini & Schulz, 2019), where self-management is the active process of engaging with self-care activities with the aim of improving health behaviours and general well-being (Lambrinou, Hansen & Beulens, 2019). From this we see that health literacy has an important role to play in diabetic management. Diabetic patients need to engage in a series of daily self-management behaviours which can include a combination of medication consumption, physical activity and following and maintaining a healthy diet (Lambrinou, Hansen & Beulens, 2019; Lee et al., 2019 & WHO, 2016). For patients to be able to effectively and efficiently engage in the appropriate self-management behaviours, they need to be able to understand and implement the health information they are given (Marciano, Camerini & Schulz, 2019). The implications of diabetes mismanagement are severe on an individual and system level. The potential risk of increased morbidity and mortality on an individual level corresponds to an increase in direct (medical care) and indirect (loss of productivity and resultant earnings) costs, thus burdening the system in which diabetic patients exist and operate (Bommer et al., 2018).

The relationship between diabetes and autonomy, with mHealth at its nexus is the focus of this dissertation. Critically analysing mHealth in its current form and identifying if and where it faces problems with promoting autonomy for diabetic patients will advance mHealth as an effective, efficient, and viable healthcare solution. As diabetes is a costly disease which requires chronic management, being able to influence patient behaviour, and promote self-driven behaviour may help improve health outcomes. Understanding the relationship between mHealth and the autonomy of diabetic patients may drive a reduction in morbidity and mortality rates and the associated costs. In order for this to occur, researchers need to understand the interplay between autonomy and mHealth as well as what it is about mHealth interventions that promote and sustain behavioural change. This in turn will promote mHealth as a valuable tool which can be deployed in a multiplicity of situations to assist with the prevention and control of diabetes.

1.2 Aim

The aim of this systematic review is to assess the impact of mHealth on the autonomy of diabetic patients. It is essential to understand if and how mHealth impacts the autonomy of diabetic patients to capitalise on the benefits of mHealth and mitigate the risks of diabetes. Understanding the relationship between mHealth and the autonomy of diabetic patients can help provide insight and guidance into how to effectively leverage mHealth as a mechanism to promote the autonomy of diabetic patients. As a chronic disease that is heavily impacted by lifestyle, the ability of patients to manage their disease, (with health knowledge and corresponding skills) is crucial for general disease management (Sallay et al., 2021). Patients who are better able to manage their disease may mitigate the risk they face from diabetes complications (Sallay et al., 2021). The importance of 'self' in managing diabetes infers that autonomy is relevant and important for diabetic patients. Thus, it is essential for the development of mHealth interventions that suitably address the requirements for making mHealth a viable mechanism for (or added tool for) diabetes management.

The research question for this systematic review is as follows:

What is the impact of mHealth interventions on the autonomy of diabetic patients?

Two sub-questions are also addressed:

1) What mechanisms does mHealth use to advance the autonomy of diabetic patients?

mHealth interventions can include a number of mechanisms (singularly or in combinations) such as text messaging, interactive voice response calls (IVR) and mobile applications to deliver their service. To be able to understand how mHealth impacts autonomy, is important to understand what mechanisms constitute mHealth, how these mechanisms work and which of them advances autonomy.

2) In what ways does mHealth influence the autonomy of diabetic patients?

In order to claim that mHealth does, or does not, impact the autonomy of diabetic patients it is essential to understand how mHealth promotes or hinders autonomy. mHealth is designed to address a specific problem, in this case diabetes management. How does it do that? What applications or features does mHealth capitalise on to influence and possibly maintain behavioural changes intended to encourage diabetes management?

These research questions will be answered through a systematic review. In following with systematic review protocols, the PICO approach has been used (Lasserson, Thomas & Higgins, 2022). The PICO approach, which is an acronym for: population, intervention, comparison(s) and outcome is generally used when the research question considers the effect of an intervention on a population group (Lasserson, Thomas & Higgins, 2022). The PICO approach helps define the research question and determine the eligibility criteria for the studies to be included in the systematic review (McKenzie et al., 2022). It helps define the population (the types of people included in studies in the review, the intervention (what is being delivered, how, when and by who), the comparison (what the intervention is being compared to) and the outcome (outcomes that are meaningful with regards to the question) (McKenzie et al., 2022). For the research question for this systematic review the participants are human subjects who have a diagnosis of a type of diabetes mellitus and receive healthcare through mHealth interventions. The intervention is mHealth systems that are used to provide a type of healthcare service. The comparator is the use of conventional medical consulting and other healthcare related practices. The outcome is the promotion of patient autonomy. The Patient Intervention Comparator and Outcome (PICO) of the study is shown in Table 1 below.

Table 1: PICO statement for this systematic review.

Participant	Diabetic patients who receive healthcare through mHealth interventions • This systematic review will focus on mobile phones and mobile applications
Intervention	mHealth interventions
Comparison	Compared to conventional medical consulting practices
Outcome	Promote patient autonomy

1.3 Dissertation outline

This dissertation is divided into the following chapters:

Chapter 1 provides background information of the problem. It introduces the reader to the concepts of mHealth, autonomy and diabetes and contextualises the relationship between them. This chapter also presents the research question, the aim and Patient Intervention Comparator and Outcome (PICO) of the study.

Chapter 2 reviews the existing literature on the topic under review. It provides an overview on diabetic diseases; their pathophysiology and the burden they present. It then moves onto discussing autonomy as a concept, its emergence and importance. mHealth is discussed, namely its role and relationship with autonomy. Finally, this section discusses mHealth as a tool for improving the autonomy of diabetic patients to contextualise the undertaking of this systematic review.

Chapter 3 is an overview of the systematic review process and the methods used to produce this review. It explains all the stages of the review: study design, search strategy, study selection, data synthesis and analysis, risk of bias assessment and dealing with missing data. It also outlines what a thematic analysis is and how this dissertation utilised a thematic analysis in order to help answer the research question.

Chapter 4 presents the results of the review. This includes the studies that were selected, their characteristics and risk of bias.

Chapter 5 covers the emergent themes evident in the literature under review. It provides an outline of the nodes that were developed and an analysis of the themes that have emerged in the articles under review.

Chapter 6 provides the discussion. This chapter is a critical appraisal of the results and themes from the articles under review and contextualises them in the broader field of literature on the topic.

Chapter 7 discusses the implications for future research as well as the limitations of this dissertation.

Chapter 8 concludes the dissertation.

Chapter 2. Literature Review

2.1 Introduction

This chapter provides an overview of the literature as it pertains to the concept of autonomy for diabetic patients with regards to mHealth. It does so by outlining the three main concepts relevant to this study; diabetes, autonomy and mHealth as well as the relationship between them. It provides an overview of diabetes, the pathophysiology, the global cost of diabetes and the role of autonomy in diabetes management. The chapter further discusses autonomy; how it developed, its importance and constituent components such as health literacy and the idea of rationality. It also critiques ideas on autonomy. Further explanation into the ways in which mHealth is expected to promote the autonomy of diabetic patients and the challenges in doing so are discussed. To conclude the chapter, the role of mHealth in improving the autonomy of diabetic patients is reviewed and considered.

2.2 Diabetes

Diabetes mellitus is the general term for a group of metabolic diseases characterised by hyperglycaemia which results from defective insulin secretion, insulin action or both (American Diabetes Association [ADA], 2013 & Kerner & Brückel, 2014). Diabetes mellitus can be caused by a range of pathogenic processes including autoimmune destruction of the pancreas' β-cells which results in insulin deficiency to insulin resistance because of some abnormality (ADA, 2013). The general symptoms of diabetes mellitus include polyuria (excessive urination), hunger, thirst, fatigue, weight fluctuations and vision changes, though they may appear differently depending on diabetes mellitus type (World Health Organisation [WHO], 2022 and ADA, 2013). There are severe health repercussions due to diabetes complications. Hyperglycaemia can trigger acute ketoacidosis while hypoglycaemia can trigger seizures and a loss of consciousness (WHO, 2016). Chronic hyperglycaemia caused by diabetes mellitus can cause long-term damage, disease, dysfunction and even failure of organs including: the heart, kidneys, eyes, nerves, and blood vessels (ADA, 2013 & WHO, 2016). There are numerous subsets of diabetes mellitus, however, this study will focus on three sub-categories namely, type 1 diabetes, type 2 diabetes, and gestational diabetes.

Type 1 diabetes mellitus (T1DM) occurs when an immune mechanism results in the destruction (the rate and extent of destruction varies from person to person) of the pancreas' β-cells (American Diabetes Association [ADA], 2021 & Kerner & Brückel, 2014). This type of diabetes generally causes absolute insulin-deficiency (ADA, 2013 & Kerner & Brückel, 2014). Type 1 diabetes mellitus affects only 5-10% of the population and can be caused by various genetic predispositions, environmental factors (though those are poorly defined and understood) or an idiopathic aetiology (it can have no known cause) (ADA, 2021). Type 1 diabetes mellitus most commonly occurs in childhood and adolescence however, it can occur at any age (ADA, 2021).

Type 2 diabetes mellitus (T2DM) is a broader category of diabetes where individuals suffer from insulin resistance and relative insulin deficiency (ADA, 2021 & Kerner & Brückel, 2014). Type 2 diabetes mellitus is not caused by an autoimmune response which destroys β-cells (ADA, 2021), rather T2DM occurs due to a complex web of factors; behavioural, epigenetic and genetic which interact within societal structures (ADA, 2021; Zheng, Ley & Hu, 2018 & Zimmet et al., 2014). There are numerous behavioural risk factors associated with T2DM including: obesity, diet, a lack of physical activity, smoking and high rates of alcohol consumption (ADA, 2013 & Zheng, Ley & Hu, 2018). Type 2 diabetes mellitus is the most prevalent form of diabetes, affecting around 90-95% of diabetics (ADA, 2013 & International Diabetes Federation [IDF], 2021). Type 2 diabetes mellitus often goes undiagnosed due to a lack of early onset symptoms and the gradual hyperglycaemia, which increases the risk of diabetic health complications (ADA, 2013 & WHO, 2016). Type 2 diabetes mellitus is increasingly affecting young people which has implications for diabetes management, classification and prevalence (WHO, 2016 & Zimmet et al., 2014). Interestingly, the increased prevalence of T2DM has impacted gestational diabetes, the third sub-class of diabetics relevant to this study.

Gestational diabetes mellitus (GDM) used to be classified as any degree of glucose intolerance first identified during pregnancy (ADA, 2021 & Kerner & Brückel, 2014), however, there has been a shift in classification due to an increased prevalence of T2DM in women of childbearing age (American Diabetes Association [ADA], 2015). Gestational diabetes mellitus is now considered to be diabetes diagnosed in the second or third trimester that is not explicitly diabetes while diabetes identified in the first trimester is considered T2DM (ADA, 2015). Gestational diabetes mellitus is associated with the future development of T2DM in both mothers and their offspring (ADA, 2013 & Zimmet et al., 2014).

Despite overall decreases in the burden of disease globally, diabetes, especially T2DM remains a massive global health challenge. The International Diabetes Federation (IDF) estimated that there were 537 million adults between the ages of 20-79 that had diabetes in 2021 (IDF, 2021). The IDF estimates that this number will increase by 46% to reach 783 million by 2045 (IDF, 2021). Of the nearly half a billion diabetic adults globally, 240 million are undiagnosed with 90% of undiagnosed diabetics living in low-and-middle income countries (IDF, 2021). The economic burden imposed by diabetes effects can be seen at the individual and state level. The economic burden of diabetes is incurred through both direct costs (health expenditure) and indirect costs (the loss of productivity and associated earnings) (Bommer et al., 2018 & IDF, 2021). The IDF estimates that the global health expenditure for diabetes in 2021 was 966 billion US dollars which is set to increase to 1.03 trillion US dollars by 2030 (IDF, 2021). Zheng, Ley & Hu (2018), explain that there are limitations to the predictions and estimates set out by the IDF due to issues such as insufficient data and extrapolation based on contextual similarity. This does not however, take away from the seriousness of diabetes and its cost, rather the IDF’s estimates may be underestimates (Zheng, Ley & Hu, 2018).

2.3 Diabetes Management

Adequate management of diabetes is required to limit and possibly mitigate the cost burden of diabetes. Diabetes management is a multifaceted process that requires daily attention (Lambrinou, Hansen & Beulens, 2019 & Lee et al., 2019).

Diabetes management can vary depending on the type of diabetes diagnosis and individual factors and outcomes (IDF, 2021). All types of diabetes require a management protocol which can include a combination of lifestyle modifications such as eating a healthy diet, regular physical activity, not smoking, decreased alcohol consumption, medication and regular screenings and health check-ups to screen for diabetes related complications (IDF, 2021 & WHO, 2016). The exact management protocol depends on patient specific factors such as the type of diabetes the patient has, the stage the disease has progressed to as well as their adherence to treatment (IDF, 2021).

Type 1 diabetics require insulin injections to keep their blood glucose levels within an acceptable range, and this is combined with regular blood glucose monitoring, education, lifestyle modifications and support to manage their condition complications (IDF, 2021 & WHO, 2016). In contrast to type 1 diabetics, who rely on insulin, type 2 diabetics do not always require insulin and may, with adequate lifestyle modifications and adherence, not require any medication at all (IDF, 2021). Lifestyle modifications can be considered the first line of defence in the management of type 2 diabetes (Zheng, Ley & Hu, 2018). If lifestyle modification proves insufficient in managing blood glucose levels, then various oral medications can be used as treatment, with insulin deployed as a last resort (IDF, 2021 & WHO, 2016). What is clear is that the management of both type 1 and type 2 diabetes centres on self-management by the patient who needs to monitor their blood glucose levels, eat a healthy diet, exercise, adhere to their prescribed medication schedule and be cognisant of other developing health conditions (IDF, 2021; Lambrinou, Hansen & Beulens, 2019 & Lee et al., 2019). Improving health outcomes is vital for diabetic patients.

At its most basic level, self-management is the act of taking responsibility for one's own behaviour and well-being (IDF, 2021). With regards to diabetes, it relates to patient compliance with treatment programmes (WHO, 2016). Diabetes self-management is complex and does not exist in a vacuum. It requires input from other areas such as social support from family members (Zheng, Ley & HU, 2018), and healthcare professionals (Lee et al., 2019). Education can also impact diabetes self-management (Lambrinou, Hansen & Beulens, 2019 & WHO, 2016). Patients need to have information they can access and use effectively to facilitate an understanding of why they need to engage with self-management behaviours (Marciano, Camerini & Schulz, 2019 & WHO, 2016), and then act on them. This intentionality speaks to autonomy.

2.4 Patient autonomy

Autonomy is an incredibly complex, loaded concept which has different conditions and definitions depending on the lens through which it is considered. Dworkin (2015), explains that philosophers such John Rawls characterise principles of justice with the idea of autonomy while in moral philosophy the notion of autonomy became central to bioethical debates (especially around informed consent and rationale). The breadth and depth of debate on 'autonomy' as a concept are far beyond the capacity or scope of this literature review. It does not seek to outline the myriad conceptions of autonomy, rather it will discuss autonomy as it pertains to mHealth and diabetes management. This systematic review characterises autonomy as a combination of a Beauchamp and Childress' (1979) autonomy (in the Principles of Biomedical Ethics) (Takala, 2001), and Oshana's (1998), conception of autonomy and goal formation.

Derived from the Greek words *autos (*self) and *nomos* (rule), autonomy means self-rule when considered etymologically (Laceulle, 2018). In around 1800, Immanuel Kant's influence saw autonomy, which had previously been considered a feature of political states, also ascribed to humans (Laceulle, 2018). Kant's conception of autonomy is concerned with morality; that humans have the ability to act in a way that capitalises on their ability to reason, which in turn has a moral influence (Laceulle, 2018 & May, 1994). What is important is that Kantian conceptions of autonomy have heavily influenced Western conceptions of ethical applications, including bioethics (Laceulle, 2018 & May, 1994). It is this understanding of autonomy that typically underpins modern interpretations of freedom (Laceulle, 2018).

Health viewed as a human right, provides it with a set of freedoms (World Health Organisation [WHO], 2022) that is:

- The right to control one's body and
- To be free from interference.

The introduction and ratification of the Universal Declaration of Human Rights (UDHR) in 1948 formally recognised the inherent dignity of all, and subsequently granted inalienable rights (United Nations [UN], 1948). Article 25 of the UNDHR deals with healthcare and situates the right to health, and the conditions thereof, as a human right (UN, 1948).

Therefore, the freedoms we are supposed to enjoy through health as a human right, influence our views on autonomy.

In their seminal work, *Principles of Biomedical Ethics* (1979), Tom Beauchamp and James Childress set out an enduring and well-known theory on bioethics (Takala, 2001). This theory set out four main principles for a global framework on bioethics: autonomy, justice beneficence and non-malevolence (Takala, 2001). The patient as an autonomous and self-directing unit, and respect for patient autonomy has become a keystone bioethical consideration in biomedicine (Beever & Morar, 2016). With personal autonomy comes the right to employ first-order autonomy and make decisions for oneself or to employ second-order autonomy and cede decision making powers to another figure, such as a medical practitioner, in which case respect for second-order autonomy is crucial (Childress, 1990).

However, this is not without criticism. As Takala (2001), explains, autonomy on the surface level seems desirable but when critically assessed we need to grapple with fundamental issues related to conceptions of autonomy. Kant's rational autonomy has the pitfall that seemingly non-rational decisions could be met with paternalistic intervention and the overriding of autonomy (Takala, 2001). Even with the concern highlighted, there is still merit in the idea of personal autonomy, or something similar in medical ethics. This is especially true for diabetes management where the patient is central to their own disease management. The notion of an autonomous person as one who can formulate goals relevant to their life and pursue them to fruition (Oshana, 1998), is suitable for autonomy in relation to diabetes management.

Taylor (2018), also criticises the conception of autonomy through the bioethics lens by arguing that it limits the discussion on autonomy in health to a patient being able to understand one's actions when completing them and being free from undue influence. He queries the extent of understanding that is needed to be autonomous and what might qualify as being free from influence (Taylor, 2018). However, that is not to say that understanding is not an important component of autonomy. Making autonomous, rational decisions about one's health is heavily influenced by one's understanding of relayed health information (Marciano, Camerini & Schulz, 2019 & Schmietow & Marckmann, 2019). Health literacy seems to be the component of autonomy that appears the most frequently in the literature, however, authors such as Sallay et al. (2021), do mention other components of autonomy such as social support as a way to support patient constructions of autonomy. Though valid and useful, this dissertation does not focus on how patients construct autonomy but on how mHealth influences patient autonomy. Health literacy is a vital component of patient autonomy as it ensures that patients understand the health information they receive. This in turn informs their decisions and whether they can give fully informed consent to treatment, mobilising their autonomy.

The challenges faced by patients with inadequate levels of health literacy, which has consequences for informed consent, are a threat to patient autonomy in healthcare. Health literacy is the traits and learned skills (linked to education and literacy levels) of an individual as well as their condition at the time (mental and physical state) (Amann, Rubinelli & Kreps, 2015). All of which impact an individual's ability to communicate effectively and participate in rational decision-making processes regarding their health (Perrenoud et al., 2015). The complex and varied socio-cultural, socio-political and socio-economic realities of individuals have repercussions on their health literacy levels (Greenhalgh, 2015), with evidence showing that poor health literacy adversely affects patients' ability to exert their autonomy (Amann, Rubinelli & Kreps, 2015; Greenhalgh, 2015 & Perrenoud et al., 2015).

The ethical and practical concerns facing the sanctity of patient autonomy (and concerning health literacy and informed consent) could potentially be addressed by empowering patients through mobile digital health information technology, or mHealth.

2.5 mHealth

The digital nature of mHealth predisposes it to being a healthcare tool that is able to improve the health outcomes of people in a myriad of social, economic and geographical locations. mHealth generally involves the use of mobile phones, which depending on their model, have features such as audio support, geolocation, photography, video, internet access and the ability to support applications (Davis, DiClemente & Prietula, 2016). These features, when combined with the high penetration rate of mobile devices (Davis, DiClemente & Prietula, 2016), make mHealth a viable option for new avenues in the provision of healthcare. mHealth technologies ease communication between healthcare providers and their patients which in turn improves access to health care and health information in a cost-effective, timeous manner that does not rely on face-to-face consultations; lowering the required output of already constrained healthcare systems (Gleason, 2015; Kreps, 2017; Laflamme et al., 2019;

Lucivero & Jongsma, 2018; Malila, Mutsvangwa & Douglas, 2019; Schmietow & Marckmann, 2019 & Waldman & Stevens, 2015). mHealth offers opportunities for health care such as generating tailored messages which are sent out through short messaging service (SMS) or via the internet and epidemiological surveillance capabilities which are used to drive treatment decisions through the analysis of data gathered from apps (Davis, DiClemente & Prietula, 2016). The literature also explains that mHealth influences patient autonomy.

mHealth interventions largely promote self-management and self-monitoring, prompting users to participate in and take control of their health matters thus improving their autonomy (Bellur & DeVoss, 2018; Lucivero & Jongsma, 2018 & Schmietow & Marckmann, 2019). It is thought that the features inherent to mHealth (its technological capabilities) encourage and assist patients in monitoring their conditions at home, by themselves and communicating relevant information to healthcare providers through mHealth technologies (Lupton, 2013). Sundar, Bellur & Jia (2012), explain that self-monitoring through tracking health data (heart rate, number of steps taken, or calories consumed daily) enables an innate human drive to learn more about our habits and behaviours which improves perceptions on autonomy. Another example is where mHealth applications can be downloaded on smart devices and can be a site for self-monitoring (Bellur & DeVoss, 2018 & Lucivero & Jongsma, 2018). Song et al. (2021), explained that the sustained use of mHealth is important to adequately effect change. mHealth also proposes improving autonomy through the dissemination of health information, in many cases through the use of (SMS) technology which is capable of imparting health information to large numbers of people (Gleason, 2015; Malila, Mutsvangwa & Douglas, 2019 & Schmietow & Marckmann). Overall, it appears that the intention is to create an empowered mHealth user, who takes their health issues and subsequent treatment into their own hands (Schmietow & Marckmann, 2019). However, Lupton (2013), seems to question the salience of this move, explaining that self-monitoring expects lay people to develop routines for self-monitoring which arguably creates an unreasonable expectation that the patient has the expertise required to monitor their condition.

2.6 The role of mHealth in diabetes management and improved autonomy for diabetic patients

The published literature on the topic discusses the challenges, such as the cost and burden of disease posed by diabetes and the role of self-management in mediating this. It also discussed the theoretical potential of mHealth in improving access to healthcare as well as improving patient autonomy. Bellur and DeVoss (2018), explain how mHealth can improve patient autonomy, through the use of features which promote a perceived sense of interaction as a requirement for self-regulation. The literature promotes mHealth as a way to encourage patient compliance with treatment programmes through the use of regular reminders, and provides examples of such interventions (Malila, Mutsvangwa & Douglas, 2019 & Waldman & Stevens, 2015). Investigation of the link between this ability and advancing patient autonomy would provide a knowledge base from which mHealth interventions may be designed to promote the autonomy of diabetic patients.

mHealth supposedly sits at the nexus of two human rights, healthcare and autonomy, creating a reciprocal relationship between the two with the intention of improving both. The widespread and accessible nature of mobile technologies has positioned mHealth as a viable, contextually malleable option for changing and improving the global provision of healthcare. Moreover, mHealth's ability to shift the locus of control to patients and empower them to be active participants in their own care is a worthwhile endeavour which, if realised, could shift traditional methods of healthcare provision. This is especially pertinent for diabetes management.

The ambitions of mHealth as a mechanism to improve patient autonomy for diabetes management may need to be tempered by conceptual issues surrounding autonomy and the realities of self-monitoring and self-management. The underlying idea of enabling patients to be more informed on their condition and act on that information is a beneficial one. Perhaps it is an issue of reframing the statement as opposed to the fundamental intention. It is possible that by moving away from complicated, tenuous, and possibly loaded concepts, such as autonomy and instead engaging with more easily digestible concepts, such as self-management, we can harness the positives of the intentions of individuals involved in their disease management.

Chapter 3. Methods

This Chapter outlines the methodology used to undertake this systematic review.

Systematic reviews intend to inform social and health care through the presentation of evidence that has been collated using explicit, systematic methods to minimise the risk of bias (Lasserson, Thomas & Higgins, 2022). The evidence collated in a systematic review fit within pre-determined eligibility parameters and is thus used to answer specific research questions (Lasserson, Thomas & Higgins, 2022). The aim of this specific review is to collate data on the research question: What is the impact of mHealth interventions on the autonomy of diabetic patients? As proponents of mHealth cite that improved patient autonomy is a benefit of mHealth, it is important to critically assess the merit of this claim. Diabetes acts as a lens through which to assess the manner in which mHealth interacts with patient autonomy as it is a chronic disease which requires constant self-management.

3.1 Study design

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) (Page et al., 2021), as well as the Cochrane Handbook for Systematic Reviews of Interventions (Higgins et al., 2022). It was registered with the PROSPERO international registry of systematic reviews (registration number: CRD42021224536).

Inclusion and exclusion criteria were determined as the first step of the review process. The criteria were determined for the participant, intervention, comparison and intervention (PICO) statement.

3.2 Inclusion criteria

Articles were included if they met predetermined criteria based on the PICO statement.

Participants

1) Received healthcare through an mHealth intervention, either through their own efforts or on the advice of a healthcare worker.
2) Were diagnosed with a type of diabetes (type 1, type 2 or gestational).

Intervention

1) An mHealth intervention provided through a mobile phone, smartphone, tablet, or mobile application.

Comparison

1) The patient received healthcare through conventional practices, such as in person consultations.

Outcome

1) A measure of improved autonomy.

A measure of improved autonomy can be considered as outcomes such as: improved health outcomes and signs of self-monitoring and self-management.

2) Health literacy as a means to measure autonomy.

A health outcome was considered its own outcome in the PICO statement due to its prevalence in the literature and how it is referenced in the conception of autonomy that is used in this dissertation.

The concept of autonomy is difficult to define and condense into a singular definition. This is due to the varying contexts and lenses that define autonomy and their associated debates. For example, Kant's conception of autonomy which underpins the bioethical, rational autonomy is critiqued by Takala (2001), who queries the potential pitfall of rationality as a precedent for autonomy. Moreover, the literature does not seem to grapple with the concept of autonomy itself, rather it seems to imply that concepts linked to autonomy such as healthy literacy and improved health outcomes, constitute autonomy. As a result of this, the systematic review had to react in accordance with the literature as new information was revealed) to conceptualise the meaning of autonomy (and how it can be measured). As such, the measured outcomes included in this systematic review are based on the idea that autonomy has linked actions. Linked actions have been considered, for example, self-management, health literacy and improved health outcomes. Understanding autonomy and providing critical thought (which can be used to inform work on the topic) depends on understanding how autonomy is currently represented in the literature.

3.3 Exclusion criteria

Articles were excluded based on the following criteria:

Participants

1) Did not personally engage with the mHealth intervention as this constitutes 2nd order autonomy which was not under review.
2) Under the age of 18.
3) Not diagnosed with any type of diabetes.
4) Diagnosed with diabetes and another condition where it was unclear which condition was under review.

Intervention

1) The mHealth intervention was web-based (or web-based prior to the development of a mobile application).
2) The intervention was based on wearable devices.

Though it is understood that both web-based interventions and wearable technologies can be considered mHealth applications, they were excluded for the following reasons. Web-based technologies were excluded based off the WHO definition of mHealth which centres on mobile devices. While we acknowledge that mobile phones and even laptops are mobile devices, not all web-accessible devices (such as PCs) are mobile devices and thus we could not be certain how the mHealth application would be accessed. Wearable technologies were excluded based on some of their limitations, primarily cost and access (Lu et al, 2020). This review is not limited to a particular setting, and it was believed that articles focussing on wearable devices may prejudice low-and-middle income countries whereas cellular devices have become ubiquitous globally.

Outcome

1) No indication of improved autonomy as an outcome.
2) No indication of improvement in an outcome linked to autonomy.

3.4 Search strategy

This systematic review reviewed both randomised and non-randomised studies that have assessed the impact of diabetes related mHealth interventions on the autonomy of diabetic patients.

A specialist research librarian at the Health Science Library at the University of Cape Town was consulted to assist in the construction of a systematic search. Key search terms were determined based on the research question and thus concerned mHealth interventions that impacted the autonomy of diabetic patients. The search strategy included free text words and medical subject heading terms (MeSH). The following databases were searched for published literature: PubMed, Scopus, Cochrane Library, Web of Science, EBSCO, Africawide, Academic Search Premier and CINAHL and APA PsycInfo. Grey literature was obtained through the Scopus database which indexes grey literature.

Articles were limited to those published in the English language, and that were published between 1 January 1973 and 31 December 2020. Filters were applied during the search process to exclude letters, reviews, and editorials as they do not represent empirical studies as well as veterinary clinical studies and veterinary observational studies as this systematic review is limited to human participants.

The list of search terms used for each key component of the research question are shown in appendix A.

Table 2 outlines the search strategy used in this review. The same search query was used across the various databases. However, (MeSH) terms were used in PubMed due to the functionality of the platform. As CINAHL was accessed through EBSCOhost, along with other databases, the search strategy that was used suited all databases. The list of search terms used for each key component of the research question are shown in appendix A.

Table 2: Search strategies for PubMed and other databases.

Search Strategy	
Platform	Combined Search Query
PubMed	(((((“Smartphone” [Mesh]) OR “Cell Phone” [Mesh]) OR “Mobile Applications” [Mesh]) OR (mHealth OR m-health OR “mobile health” OR “mobile app” OR “mobile application” OR “mobile devices” OR “mobile phone” OR “mobile technology” OR smartphone)) AND ((“Personal Autonomy” [Mesh]) OR (“Personal autonomy” OR “patient autonomy” OR “personal agency” OR “patient agency” OR “patient knowledge” OR “health literacy” OR personhood)))) AND (((((“Diabetes Mellitus” [Mesh]) OR “Diabetes Mellitus, Type 1” [Mesh]) OR “Diabetes Mellitus, Type 2” [Mesh]) OR “Diabetes Mellitus, Gestational” [Mesh]) OR (diabetes OR diabetes mellitus OR diabetes mellitus, type 1 OR diabetes mellitus, type 2 OR diabetes gestational OR gestational diabetes OR type 1 diabetes OR type 2 diabetes OR diabetic))
Other databases	("diabet*" OR "diabetes mellitus" OR "diabetes mellitus, type 1" OR "diabetes mellitus, type 2" OR "diabetes gestational" OR "gestational diabetes" OR "type 1 diabetes" OR "type 2 diabetes") AND TITLE-ABS-KEY ("mobile app*" OR mhealth OR "m-health" OR "mobile health") AND TITLE-ABS-KEY (android OR "cell* phone*" OR iphone OR "mobile app*" OR "mobile device*" OR "mobile phone*" OR "mobile technolog*" OR smartphone) AND TITLE-ABS-KEY ("personal autonomy" OR "patient autonomy" OR "personal agency" OR "patient agency" OR "patient knowledge" OR "health literacy" OR personhood)

Two search strategies were run[1]. The first looking at the impact of mHealth on patient autonomy, to get a general sense of the literature and then a second to scope specifically for

[1] The initial search strategy looked at patient autonomy and mHealth more generally. The search strategy that was developed identified 1640 articles from literature searches. 1607 articles remained after removing duplicates. A basic search was done on these articles to see which (if any) focussed on diabetes. Those articles were then cross-referenced with the results from the main search. Outstanding articles were then included.

diabetes. In doing so it was realised that some articles from the initial search, that should have been included in the second search, were missing. A basic search was carried out in the general sample to collect all the articles that contained the word 'diabetes'. These were then included with the articles in the diabetes specific search and duplicates were removed. The review process carried on in accordance with the PRISMA protocol.

3.5 Article selection

Articles that were identified through the search were downloaded into the Endnote (version X9) referencing software where they could be sorted for inclusion. EndNote software was used to manage article selection. Articles were independently examined by the author and the second reviewer for inclusion based on the aforementioned eligibility criteria. The second reviewer's role was to act as a second reader of the articles and evaluate them for inclusion or exclusion in the systematic review in accordance with the systematic review process (Lasserson, Thomas & Higgins, 2022). A two-stage screening process was followed to identify articles that met the inclusion criteria. In the first stage of screening, articles were determined based on reading the title, abstract and keywords. Individual researchers had their own Endnote libraries in which they determined articles for inclusion or exclusion. After this, the researchers compared their sets of articles and discrepancies discussed. Agreed upon changes were made to either include or exclude articles.

A second stage of screening then commenced. All articles were read independently and in full by the author and second reviewer to determine whether they were eligible for inclusion. The two researchers compared their individual sets of articles and discrepancies were discussed. A third independent reviewer acted as an adjudicator in an instance where consensus could not be met on an article's inclusion.

A standardised data extraction form was developed and piloted by the author and the second researcher. The data extraction form was influenced by the PICO statement as well as readings pertaining to the topic. This data extraction form is presented in appendix B[2]. Data was extracted independently. At this stage articles were read in full, and extraction was only

[2] The full set of completed data extraction forms is available upon request.

completed on articles that fully met the inclusion criteria. Discrepancies were discussed between the author and second researcher, and the necessary adjustments were made.

The table below (Table 3) reveals the key data that was extracted via the data extraction forms as well as reasons for the inclusion of that information.

Table 3: Key data extracted from articles under review and the reasoning.

Key Data	Items within the data set	Reason for Inclusion
Article identification	• Author/s and year of study • Author association • Location of article • Type of study in article	This helped identify the articles and provide basic information about the articles.
Participants	Type of participant including population description and setting	This information was essential to understand the populations being studied in the articles. It was important to ensure the population matched the requirements determined in the PICO statement.
Intervention	Type of mHealth intervention	This information was essential to understand the mHealth interventions being studied in the articles. It was important to ensure the interventions matched the requirements determined in the PICO statement.
Outcomes	Type of measured outcomes	This information was essential to understand the types of outcomes being assessed in the articles. It was important to ensure the outcomes matched the PICO statement,

		at a minimum, based on the initial readings a set of predetermined requirements were generated for assessment in the data extraction forms.
Findings/results	Result	The results generated in the articles under review provide information that can help answer the review question.
Bias	What bias was present in the articles	The bias evident in the articles under review is important to take note of as this can alter the results of the systematic review.

3.6 Data synthesis and analysis

This systematic review assessed the impact of mHealth on patient autonomy and data was synthesised in narrative form following a thematic analysis process.

3.6.1 Thematic Analysis

It is essential to ensure readers have clarity on the manner in which analysis occurred, and what assumptions informed the analysis to reduce the risk of bias (Nowell et al., 2017). This is especially pertinent for a systematic review, where reducing the risk of bias is of the utmost importance. This review is qualitative in nature and uses a narrative format and thematic analysis to answer the research question. Qualitative research generates empathetic knowledge by grounding knowledge in human experiences (Nowell et al., 2017). The review pertains to a question; how mHealth influences autonomy and thus understanding the experiences of diabetic mHealth users is crucial to being able to answer the research question. According to Braun and Clarke (2006), a thematic analysis is a method for identifying, analysing and reporting the patterns or themes within data sets. Nowell et al. (2017), mention that Boyatzis (1998), explains that a thematic analysis also interprets the emergent themes.

A thematic analysis was chosen as the method of analysis for this review due to its ability to rigorously summarize the key features of large data sets (Nowell et al., 2017). It is important to note when doing a thematic analysis that the author plays an active role in the analysis process rather than themes simply emerging (Braun & Clarke, 2006). The researcher searches for themes in accordance with what they want to know. Moreover, the researcher's personal values and beliefs in relation to the research play a role in the decisions made when doing a thematic analysis (Braun & Clarke, 2006). Recognising the role authors play in a thematic analysis does not mitigate their use in a systematic review. Rather because of this, researchers must take precautions to minimise bias by following an analysis procedure that establishes trustworthiness. Braun and Clarke (2006), propose a six-phase method of analysis to ensure trustworthiness and Nowell et al., (2017) have added to the methods with the understanding that this process is iterative and not linear. Braun and Clarke's (2006), six-phases are:

1) Data familiarisation
2) Generating initial codes
3) Searching for themes
4) Reviewing themes
5) Defining and naming themes
6) Producing the report

This review has been guided by this iterative, phase-centred methodology. Some of the phases above (phases 3-5) were all conducted in phase 3 of this systematic review. What follows is an account of how a thematic analysis was conducted for this review.

3.6.2 Review Analysis Process

Analysis of the data from the articles under review was iterative and occurred across two platforms: Microsoft Excel and NVivo Qualitative Data Analysis Software (version 12 Pro).

3.6.3 Analysis platforms

Qualitative analysis for this review was conducted across two platforms. Each platform provided a different level of analysis and thus insight. The first level of analysis occurred by reviewing the data extraction forms (see section 3.5 for an overview of the key data extracted in the form and appendix B for the full form) for each article under review. An Excel table was created to document basic but crucial information on each article under review. This table is available in appendix C. The information included in the table indicates the author, type of diabetes, type of intervention used and the main outcome/s. This allowed for the visualisation of broad level commonalities and differences in the population, intervention, and outcomes. Using an Excel table as a first level of analysis was useful in providing a basic understanding of trends within the articles under review.

The second level of analysis was conducted via NVivo Qualitative Data Analysis Software. The articles under review were uploaded to NVivo Qualitative Data Analysis Software where they were analysed. This level of analysis was more in-depth and provided more detailed insight. NVivo supports the grouping of similar information and presents the data in themes (codes, or nodes as they are called in NVivo). It is possible to visualise and highlight the similarities and differences across articles. These trends or themes are essential for engaging critically with the articles under review and provide insight into general trends within the published literature. It is also possible to highlight important pieces of information to interrogate. Nodes were developed in NVivo to facilitate this deeper level of analysis. Using information derived from both levels of analysis, the author was able to determine the themes that would be analysed and discussed.

3.6.4 Analysis Process

The first phase of analysis was becoming familiar with the data (Nowell et al., 2017). Each study was read through thoroughly multiple times.

- Articles read in full to determine inclusion or exclusion in the systematic review: This step focussed on ensuring the article met the pre-determined inclusion criteria for the systematic review and allowed for a basic knowledge of the content contained within each article.
- The data extraction process: This step focussed on developing a more complete knowledge of the content contained within the article. By extracting essential

information, the data extraction forms could be populated. This allowed for a visual repository of information, as well as a means of comparisons between articles.

- Completed data extraction sheets: This step served to ensure that there was familiarity with the data presented in the articles under review.
- Analysis in Excel: This step allowed for a quick overview of basic, but important, information on each article under review.
- Analysis in NVivo: This step focussed on interrogating the articles under review to determine the themes that emerged in the literature. These themes are used to compare, contrast, and highlight commonalities and differences within the articles under review. Knowing the themes within the literature is then used to guide the thematic analysis.

The second phase involved generating codes in NVivo. NVivo (version 12 Pro) allows the development of hierarchies which can display relationships between nodes. This is useful as it allows the researcher to understand that themes can emerge within broader themes. Data familiarity helped predict which codes would be important to answer the research question. Each article was read through individually and coded accordingly, accounting for existing themes and incorporating emerging themes. Nodes were created to fit hierarchically under a main node and named according to the central topic of the theme. Nodes were given a description which explained what type of data was contained in the node, including statements about the type of information contained within and questions relating to the node topic. In some instances, pieces of information were compatible with more than one node. In those instances, they were coded in both nodes and an annotation on that piece of information was created to signal this fact. Annotations were used where necessary during the code generation process to help the author keep track of information and decisions made. This process was iterative and there were instances were nodes that had been developed were collapsed into other nodes or placed hierarchically under a more dominant node. For example, blood glucose, foot care, blood pressure and medication adherence were all placed under ‘health outcomes’. This was done in instances where two nodes contained information that answered the same question or fit together under a theme. Specific nodes were also made defunct as the coding process was carried on.

The third phase was developing themes (Nowell et al., 2017). After all the articles had been coded, the author assessed the nodes; their hierarchies, descriptions and the information they contained. This was to gain more insight into the themes contained within the literature, which would require analysis and discussion.

3.7 Risk of bias assessment

Internationally accepted criteria for determining bias were utilised, independently, by the author and second reviewer in order to assess bias (Viswanathan et al., 2017). These criteria were developed in compliance with the Cochrane Handbook for Systematic Reviews of Interventions (Higgins et al., 2022). This systematic review focussed on the following criteria for determining bias:

1) Precision
2) Applicability/external validity (especially generalizability)
3) Poor/inadequate study design, conduct or reporting
4) Reporting bias
5) Choice of outcome
6) Accurately following intervention protocol
7) Conflict of interest
8) Other

The first author determined the risk of the varying criteria when it came to article selection and supported the decision with reference to the text in each article. The second reviewer independently assessed the articles for bias.

3.8 Missing data

Articles that had missing data were excluded. This was due to the nature of the missing data. This issue appeared in the case of trial registries that did not contain results or written articles. In these instances, the corresponding articles were searched for and included (where applicable) or excluded based on the lack of results.

3.9 Ethics and data

This systematic review did not include contact with humans or animals therefore no ethical clearance was required.

Chapter 4. Results

The results of the systematic review are presented in this chapter. This will report the findings from the data extraction process.

4.1 Search Results

Upon executing the search strategy, 211 articles were identified for review. Thirty-six duplicates were found and removed from the data set leaving 175 articles.

The remaining articles went through a series of review sessions. The first review assessed eligibility based on their title, keywords, and publishing dates. From this review it was determined that 81 articles were not eligible for the systematic review. This left 94 articles that went through to a second stage of review which was based on their title and abstract. During the abstract-based review, 33 articles were excluded, leaving 61 articles that went to a final round of review; the full text review. The full-text review was conducted, and 43 articles were deemed ineligible for the purposes of this systematic review and excluded with reasons. Eighteen articles, which were deemed eligible, were thus included for analysis and synthesis in this systematic review. The steps undertaken in the review and selection process are represented in the PRISMA flow diagram (Figure 1) below.

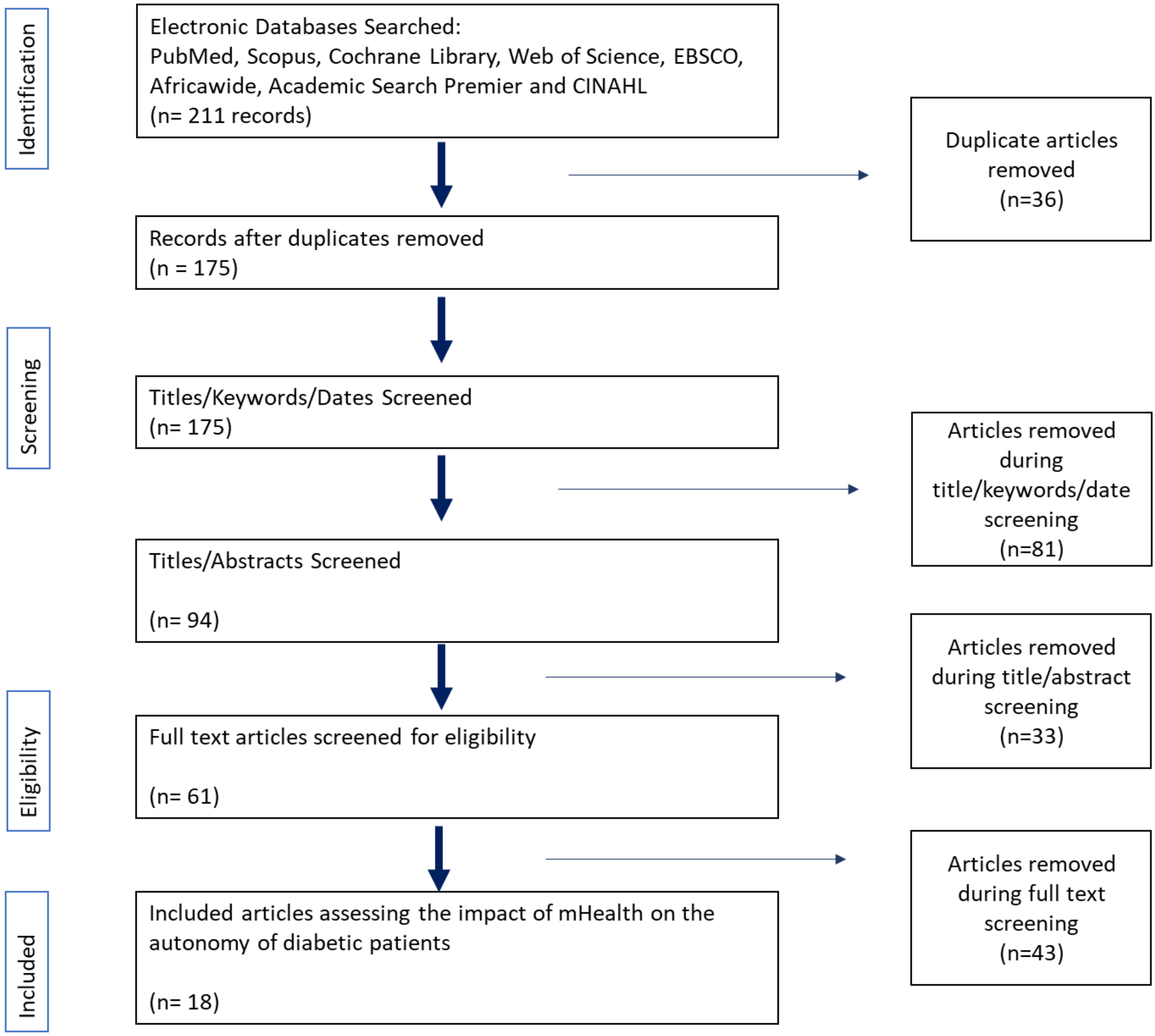

Figure 1: PRISMA flow diagram.

It is important to note that the article screening process was conducted independently by both the first author and a second independent reviewer. After both researchers had determined their dataset of articles eligible for the systematic review, the researchers discussed their reasonings. Disagreements were dealt with, and the final dataset of 18 articles was agreed upon.

4.2 Excluded Results

Throughout the review process, articles were excluded for various reasons. The following section will provide an overview of the reasons for exclusion during the review process.

4.2.1 Exclusion by title/keywords/dates and title/abstracts

In the first two stages of review, articles were excluded for various reasons where they did not meet the inclusion criteria. The table below (Table 4) displays the reasons for exclusion.

Table 4: Reasons for exclusion based on title/keywords/dates and title/abstracts.

Reason for exclusion	Articles excluded
Article did not focus on diabetes.	Bolton, 2020 Bosworth et al., 2018 Brega et al., 2013 Logan, 2013 McGillicuddy et al., 2019 Nemeth et al., 2016 Pai et al., 2019 Rothman et al., 2019 Sakpal et al., 2020 Stanifer et al., 2016
The articles fell outside of the predetermined publishing date.	Chen et al., 2021 Delva et al., 2021 Guo et al., 2021
The articles did not focus on patient autonomy.	Carter, Nunlee-Bland & Callender, 2011 May, Camp & Gamm, 2007 and Mayberry et al., 2019 Tudiver et al., 2007
The article did not address the topic under review.	Alhuwail & Abdulsalam, 2019

4.2.2 Full Text Review

Sixty-one articles underwent full-text review. This stage of review was more rigorous and thorough. After this process, 43 articles were deemed ineligible for inclusion into the next stage. This round of review required a higher level of critical analysis and discretion from the researchers. Moreover, in this stage of review numerous articles required a discussion between researchers. The table below (Table 5) illustrates these articles and the reasons for their exclusion.

Table 5: Reasons for exclusion after full text review.

Reason for Exclusion	Articles Excluded
Mixed -media approach that includes some type of digital health and coaching	Handley et al., 2016 Kim & Utz, 2019 Long and Gambling, 2012 Bohingamu Mudiyanselage et al., 2018 Sarfati et al., 2018 Threatt & Ward, 2017 Whittemore et al., 2020 Zeidi, Morshedi & Alizadeh Otaghvar, 2020 Bramwell et al., 2020
Intervention does not meet inclusion criteria of an mHealth intervention	Lamprinos et al., 2016
More than one disease was discussed made the focus unclear	Wu et al., 2017
Prevention programme for patients not yet diagnosed with diabetes	Kim et al., 2020
Looks at users' perceptions of mHealth interventions	Chen et al., 2018 Jeffrey et al., 2019 Lee et al., 2019
Theoretical overlook of mHealth	Faiola, Papautsky & Isola, 2019
Overview of mHealth mechanisms	Fagherazzi & Ravaud, 2018
Population group is children	Boyce, 2020
Protocol had no results	Ahmadvand et al., 2018 Lygidakis et al., 2019 O'Conor et al., 2019
Review article	Bingham et al., 2020 Chen & Carbone, 2017 Mignerat, Lapointe & Vedel, 2014
Trial registration information prior to study conduction	The effect of education (Cochrane Central Register of Controlled Trials [CENTRAL], IRCT20171125037620N3)

	Development of diabetes (Cochrane Central Register of Controlled Trials [CENTRAL], NCT04686201) Development and testing (Cochrane Central Register of Controlled Trials [CENTRAL], NCT04198857) Community and mHealth (Cochrane Central Register of Controlled Trials [CENTRAL], NCT03376607) The effectiveness of (Cochrane Central Register of Controlled Trials [CENTRAL], NCT03273140) The intergenerational (Cochrane Central Register of Controlled Trials [CENTRAL], NCT02971241)
Outlines design processes for app development	Felix et al., 2019 Pulman et al., 2013
Conference abstract and therefore not sufficient detail	Hacibekiroglu et al., 2013 Niblock et al., 2017 Taniguchi et al., 2017
Opinion piece	Lee, Hirschfeld & Wedding, 2016
Not in English	Garcia Viola, 2019
Date outside of pre-determined date range	Correia et al., 2021
Poor quality article	Barker, 2015 Chao, Lin & Ma, 2019

Three articles, Barker (2015) Chao, Lin and Ma (2019), and Bohingamu Mudiyanselage et al., (2019), were excluded after data extraction had been completed. Barker (2015) was assessed by the third reviewer to determine if it could be excluded safely. Eighteen articles were thus considered eligible for inclusion in this systematic review.

4.3 Included articles

Eighteen articles were eligible and included in this review. These articles underwent data extraction, as is mentioned in methods section 3.5 (article selection). Data extraction allowed for an overview of the results in the articles under review. The headings of the sections of the data extraction form are present below. The primary data extraction form is available in appendix B.

1) Reviewer Information
2) General Information
3) Article eligibility
4) Participants
5) Intervention/s
6) Outcomes
7) Results/findings
8) Bias

4.4 Findings from data extraction process

This section will provide an overview of the information contained in the 18 articles under review.

4.4.1 Study design and article setting

The most common study design was a pre and post-test study design (Guo, Chang & Lin, 2015; Hassan, 2017; Kilic & Karadağ, 2020 and Pichayapinyo et al., 2019). Three articles (Nelson et al., 2017; Watterson et al., 2018 & Wood et al., 2015), were pilot studies. There were two randomised- control trial (RCT) study designs (Sugita et al., 2017 & Valentiner et al., 2019), although Nelson et al. (2020), constitutes part of an RCT. Abbas et al. (2015) was a non-randomised controlled trial (Non-RCT). Other study designs include a feasibility study (Johnson & Berry, 2018), an observational study (Aikens et al., 2014) and analysis of data from another article (Bergner et al., 2017 & Ernsting et al., 2019).

The demographics of the settings the articles were conducted in is as follows: Nine were conducted in North America, four in Europe, three in the Middle East and four in Asia. None were conducted in Africa. This is represented in Table 6 below.

Table 6: Study settings of included articles.

Region	Country article is conducted in	Article	Number of articles

North America	United States of America	Aikens et al., 2014 Aikens et al., 2015 Bergner et al., 2017 Johnson & Berry, 2018 Morgan, 2015 Nelson et al., 2017 Nelson et al., 2020 Watterson et al., 2018 Wood et al., 2015	9
Europe	Germany	Ernsting et al., 2019	2
	Denmark	Valentiner et al., 2019	
Middle East	Saudi Arabia	Abbas et al., 2015	3
	United Arab Emirates	Al Omar et al., 2020	
	Jordan	Hassan, 2017	
Asia	Taiwan	Guo, Chang & Lin, 2015	4
	Turkey	Kilic & Karadağ, 2020	
	Thailand	Pichayapinyo et al., 2019	
	Japan	Sugita et al., 2017	

4.4.2 Participants

4.4.2.1 Age and Sex

All the articles under review recruited participants of various age ranges (all were 18 years or older in accordance with the exclusion criteria set out in section 3.3. Only Johnson and Berry (2018), explicitly mentioned the sex of the participants as it focussed on pregnant women.

4.4.2.2 Socio-economic status

As is evident given the study settings in the articles, the majority of participants came from high income countries (Denmark, Germany, Japan, Saudi Arabia, United Arab Emirates and the United States of America). The United States of America was the most common location, with half of the studies occurring there however, it appears that many of the participants in those studies came from rural and/or low-and middle-income backgrounds. The participants from 6 articles (Bergner et al., 2017; Morgan, 2015; Nelson et al., 2017, Nelson et al., 2020; Watterson et al., 2018 & Wood et al., 2015), were located in rural areas. Aikens et al. (2014) and Aikens et al. (2015), recruited participants from Veterans Outpatient Centres which also receive state funding. It is not distinctly clear as to the socio-economic status of the participants in the other high-income countries. However, Valentiner et al. (2019), and Sugita et al. (2017), recruited from University Hospitals while Al Omar et al. (2020), recruited from a private medical centre and Abbas et al. (2015), from the Security Forces Hospital.

The rest of the participants came from low-and-middle income countries. Participants were recruited from outpatient departments at hospitals (Guo, Chang & Lin, 2015 & Kilic & Karadağ, 2020), and primary care settings (Pichayapinyo et al, 2019). No mention is made of the socio-economic status of the participants. Only Hassan (2017), references socio-economic status as the participants were recruited from low-income, non-urban areas in Jordan.

4.4.2.3 Diagnosis

All the participants had a diagnosis of some type of diabetes. Twelve of the studies focussed solely on those with type 2 diabetes (Abbas et al., 2015; Aikens et al., 2014; Aikens et al., 2015; Bergner et al., 2017; Guo, Chang & Lin, 2015; Morgan, 2015; Nelson et al., 2017; Nelson et al., 2020; Sugita et al., 2017; Valentiner et al., 2019; Watterson et al., 2018 & Wood et al., 2015). Three studies featured participants with either type 1 or type 2 diabetes (Al Omar et al., 2020; Hassan, 2017 & Kilic & Karadağ, 2020). One study focussed on the development of gestational diabetes (Johnson & Berry, 2018), two studies were unclear where one referred to diabetic patients only (Ernsting et al., 2019), and another article alluding to type 2 (Pichayapinyo et al., 2019). Eight articles excluded patients who showed symptoms of or had a mental health or cognitive impairment diagnosis (Aikens et al., 2014; Aikens et al., 2015; Guo, Chang & Lin, 2015; Hassan, 2017; Kilic & Karadağ, 2020; Nelson et al., 2017; Nelson et al., 2020 & Sugita et al., 2017).

4.4.3 Interventions

4.4.3.1 Type of mHealth Intervention

The majority of the interventions included more than one facet, relying on multiple forms of mHealth to engage with participants. Twelve of the interventions featured some form of text messages (Abbas et al., 2015; Aikens et al., 2015; Al Omar et al., 2020; Bergner et al., 2017; Hassan, 2017; Johnson & Berry, 2018; Morgan, 2015; Nelson et al., 2017; Nelson et al., 2020; Sugita et al., 2017; Valentiner et al., 2019 & Watterson et al., 2018). Al Omar et al. (2020), explicitly states their use of Whatsapp messages, though the other 11 merely say text messages. Two studies combine IVR calls and text messages (Aikens et al., 2015 and Nelson et al., 2017). One study uses an app and text messages (Valentiner et al., 2019), and one combines text messages and phone calls from the researcher (Abbas et al., 2015). Four studies utilise applications only (Ernsting et al., 2019; Guo, Chang & Lin, 2015; Kilic & Karadağ, 2020 & Wood et al., 2015), and one uses an IVR app (Pichayapinyo et al., 2019). One study utilises only IVR calls (Aikens et al., 2014).

4.4.3.2 Diabetes content

The interventions all pertained to diabetes management however, the area of focus differed. Seven articles (Abbas et al., 2015; Al Omar et al., 2020; Guo, Chang & Lin, 2015; Johnson & Berry, 2018, Pichayapinyo et al., 2019; Watterson et al., 2018 & Wood et al., 2015), focussed on general diabetes care. Four articles assessed medication adherence (Aikens et al., 2015; Bergner et al., 2017, Nelson et al., 2017 & Nelson et al., 2020), with both Nelson articles looking at the barriers to medication adherence specifically. Kilic & Karadağ (2020), and Hassan (2017), specifically studied diabetic footcare while Valentiner et al. (2019), focussed on exercise. Morgan (2015), focussed on educational material, as did Sugita et al. (2017), however, Sugita also provided information on medication adherence to the control group as an ethical consideration.

4.4.4 Outcomes

This systematic review had a pre-determined list of five categories of outcomes. These are based on the PICO statement as well as the initial literature that informed this systematic review.

1. Improved patient autonomy
2. Improved ability to understand information/ health literacy
3. Ability to act on information
4. Sustained use of intervention
5. Other

These categories of outcomes were chosen as they were determined to be the best way to assess the manner in which mHealth impacts the autonomy of diabetic patients. These outcomes were also chosen in accordance with the definition of autonomy used in this systematic review. It was determined that categories would be used, as opposed to strictly defined measures as the outcomes that are being assessed have a wide range of actions which could be considered acceptable. Across the studies there seems to be a general lack of rigidity with regards to measurable outcomes and thus it was determined that categories, in which multiple actions were consistent with the desired outcome would be acceptable. The 18 articles measure (or make reference to) at least one of the predetermined outcomes. Sixteen out of the 18 articles report explicitly on pre-determined measured outcomes. In doing so they have clearly stated that what they intend to measure as being changed (or not changed) because their intervention was in alignment with the outcomes determined in the inclusion criteria for this systematic review. Three articles do not explicitly outline outcomes as set out by the pre-determined inclusion criteria however, they provide relevant information that can help answer the review question. Nelson et al. (2020), is primarily concerned with patient satisfaction as an outcome though it does provide data on patient autonomy. Nelson et al. (2017), seems to focus on user satisfaction however, it does provide information on health outcomes (medication adherence) and Ernsting et al. (2019), considers health literacy and health outcomes when critically analysed. Nelson et al. (2020), focussed on user engagement as the major outcome however, it does feature some data on outcomes such as self-management, self-efficacy, and health outcomes. Only two articles reported on a single measured outcome category (which is in comparison to the other articles which reported on more than one category). Aikens et al. (2014), measured health outcomes (though it does mention other categories of outcomes listed above, they do not seem relevant as measurable outcomes) while Johnson and Berry (2018), measured health outcomes (specifically medication adherence).

Moreover, the general lack of consensus and rigidity around what autonomy means in a practical setting for mHealth and diabetes management makes it difficult to categorically place outcomes within a category. For example, an outcome may appear as self-efficacy within one of the articles. Self-efficacy itself is not a pre-determined measurable outcome however, in some articles it fits under autonomy and in others under the ability to act on information. The same can be true for knowledge, which can be categorised under health information, but also may be categorised under 'other'. It is also important to notice that the categories do have some level of linkage as they all relate to this systematic review's definition of autonomy and therefore may be a component of autonomy. Most articles measure a combined set of outcomes, or broader category of outcomes. The problem with measurable outcomes will be further covered in the discussion chapter of the systematic review. Below is a breakdown of the outcomes measured in the articles reviewed.

4.4.4.1 Improved patient autonomy

No articles explicitly mentioned improved patient autonomy as a measured outcome. However, as previously mentioned, within the broader literature, autonomy is an indeterminate concept and as such autonomy as an outcome (or the components thereof) can arguably appear in varying formats throughout the articles under review. For example, Guo, Chang and Lin (2015), Kilic & Karadağ, (2020), and Wood et al. (2015), make reference to self-efficacy, which may constitute autonomy or at least a component of it.

4.4.4.2 Improved ability to understand health information/health literacy

Six articles under review (Abbas et al., 2015; Guo, Chang & Lin, 2015; Hassan, 2017; Kilic & Karadağ, 2020; Sugita et al., 2017 & Wood et al., 2015), feature improved ability to understand health information or health literacy as an outcome. Wood et al. (2015), and Sugita et al. (2017), both measure health literacy using different measurement tools. Wood et al. (2015), use the Rapid Estimation of Adult Literacy in Medicine (REALM test), Sugita et al. (2017), used a scale developed by Ishikawa et al. (2008), to measure health literacy. Aikens et al. (2014), and Al Omar et al. (2020), both measured health literacy levels in their participants. Five articles look at patient knowledge as an outcome (Abbas et al. 2015, Guo, Chang and Lin, 2015; Hassan, 2017; Kilic & Karadağ, 2020 & Wood et al., 2015). The type of knowledge does vary. Hassan (2017), and Kilic and Karadağ (2020), both focus on diabetic footcare, with Hassan specifically focussing on diabetic foot ulcers. Guo, Chang and Lin (2015), Abbas et al. (2015), and Wood et al. (2015), focus on more general diabetic knowledge and care.

4.4.4.3 Ability to act on information

Three articles measure the ability to act on information as an outcome. Guo, Chang and Lin (2015), looks at (self-reported) behavioural changes in terms of self-management (as a result of knowledge changes). Hassan (2020), looks at footcare practices and Morgan (2015), highlights self-management.

4.3.4.4 Sustained use of intervention

Sustained use of the intervention as an outcome was not a popular measure. Valentiner et al. (2019), featured self-reported adherence to their intervention (InterWalk) as the primary outcome. Pichayapinyo et al. (2019), measured call completion rate which gives some insight into sustained use of the intervention. Wood et al. (2015), does make reference to sustained use of the intervention however, they acknowledge that the two-week duration of their pilot study is not a sufficient length of time to determine the effect of the intervention on adherence or behavioural change.

4.4.4.5 Other

In terms of this category as an outcome, there were two main outcomes: health outcomes and medication adherence. Health outcomes, such as glycated haemoglobin (HbA1c), blood pressure and footcare, proved the most common outcome measured, as eleven articles (Abbas et al., 2015; Aikens et al., 2014; Aikens et al., 2015; Al Omar et al., 2020; Guo, Chang & Lin, 2015; Johnson & Berry, 2018; Pichayapinyo et al., 2019; Sugita et al., 2017; Valentiner et al., 2019; Watterson et al., 2018 & Wood et al., 2015), measured some type of health outcome. Health outcomes, describes a wide range of measures relating to the physical health and wellbeing of a person (typically relating to common issues with diabetes as a disease). Table 7 below outlines the health outcomes that were measured.

Table 7: Health outcomes measured in the articles under review.

Health outcome	Article mentioned in
HbA1c	Abbas et al., 2015 Al Omar et al., 2020 Pichayapinyo et al., 2019 Sugita et al., 2017 Valentiner et al., 2019 Watterson et al., 2018 Wood et al., 2015
Fasting blood glucose	Pichayapinyo et al., 2019
Blood glucose	Abbas et al., 2015 Aikens et al., 2014 Guo, Chang & Lin, 2015 Johnson & Berry, 2018 Wood et al., 2015
Blood pressure	Aikens et al., 2014 Watterson et al., 2018
Frequency of hypoglycaemic and hyperglycaemic attacks	Abbas et al., 2015
Body Mass Index/ Body composition	Valentiner et al., 2019 Watterson et al., 2018
Healthy eating	Aikens et al., 2014 Guo, Chang & Lin, 2015 Johnson & Berry, 2018 Pichayapinyo et al., 2019 Wood et al., 2015
Physical activity	Guo, Chang & Lin, 2015

	Johnson & Berry, 2018 Pichayapinyo et al., 2019 Valentiner et al., 2019 Wood et al., 2015
Footcare	Aikens et al., 2014 Guo, Chang & Lin, 2015 Wood et al., 2015
Aerobic capacity	Valentiner et al., 2019
Sleep	Pichayapinyo et al., 2019
Generic health	Guo, Chang & Lin, 2015

Various blood glucose measurements were the most common health outcome measured, with HbA1c being the most common. Medication adherence was also a measured outcome. Five articles (Sugita et al., 2017; Pichayapinyo et al., 2019; Bergner et al., 2017, Aikens et al., 2014 & Aikens et al., 2015), studied medication adherence. Ernsting et al. (2019), assessed the perceived efficacy of the intervention.

4.4.5 Bias

Overall, none of the articles under review posed a significant issue in terms of their bias assessment. As was explained in section 3.7, the bias assessment for this systematic review was done in accordance with internationally accepted guidelines. The most common issue with bias had to do with generalizability because of:

1. Small sample size (Aikens et al., 2015; Guo, Chang & Lin, 2015; Johnson & Berry, 2018; Morgan, 2015, Sugita et al., 2017; Valentiner et al., 2019 & Wood et al., 2015).
2. Homogeneity (Aikens et al., 2014; Aikens et al., 2015; Bergner et al, 2017; Nelson et al., 2017 and Nelson et al., 2020).

Other common issues were:

1. Self-reporting (Aikens et al, 2015; Guo, Chang & Lin, 2015; Hassan, 2017 & Valentiner et al., 2019).

2. No control group for comparison (Aikens et al., 2014; Guo, Chang & Lin, 2015; Hassan, 2017 & Pichayapinyo et al., 2019).

Lastly, bias issues were mostly related to study design. Watterson et al. (2018), reported that outcomes may be misrepresented due to the study design. Sugita et al. (2017), did not blind either participants or researchers, and Kilic & Karadağ (2020), lacked information on the statistical significance of their findings.

The above section outlines the findings of the articles under review in accordance with the PICO statement. This represents basic information relevant to answering the research question for this systematic review. As mentioned in section 3.6, a thematic analysis was also conducted to provide more critical information that can be used to answer the review question of how mHealth impacts the autonomy of diabetic patients.

4.4.6 Results from the interventions in included articles

The following section overviews the results generated by the articles under review. It focusses on the results that are relevant to answering the research question: What is the impact of mHealth on the autonomy of diabetic patients? As well as the sub-questions on the mechanisms used to do so and the ways mHealth impacts autonomy.

Overall, it does appear that the interventions in the articles under review did, in some ways impact the autonomy of diabetic patients. Behavioural changes seem to be the most common result amongst the results reported in the articles. These behavioural changes have to do with improved self-care behaviours and lifestyle changes. The table below (Table 8) shows the lifestyle and behavioural improvements reported in the articles.

Table 8: Results of changes in behaviour and lifestyle reported in articles.

Lifestyle/behavioural change	Article reported in
Physical activity	Ernsting et al., 2019 Guo, Chang & Lin, 2015, 2014 Johnson & Berry 2018 Pichayapinyo et al., 2019

	Valentiner et al., 2019
Healthy eating	Guo, Chang & Lin, 2015, 2014 Johnson & Berry, 2018 Pichayapinyo et al., 2019 Wood et al., 2015
Medication adherence	Aikens et al., 2015 Guo, Chang & Lin, 2015, Johnson & Berry, 2018 Pichayapinyo et al., 2019 Sugita et al., 2017
Checking blood glucose	Johnson & Berry, 2018
Schedule for checking blood glucose	Morgan, 2015
Footcare	Hassan, 2017 Kilic & Karadağ, 2020

From this it is possible to see that the biggest changes were reported in physical activity and medication adherence. However, it is important to note that Sugita et al. (2017), explained that there were no significant differences in the outcomes between intervention groups (intervention group and the control group), though there was a general trend towards maintaining medication adherence. However, this outcome may be due to the fact that the control group also received a reminder to take their medication (Sugita et al., 2017).

Participating in self-care behaviours is essential but articles also referenced attitudes towards engaging in behaviours. Self-efficacy (a patient's confidence in their ability to perform a task [Wood et al., 2015]), was reported and the trend was towards an improvement in self-efficacy scores (Wood et al., 2015; Pichayapinyo et al., 2019 & Kilic & Karadağ, 2020). Guo, Chang & Lin (2015), on the other hand, reported no increase in self-efficacy post-intervention.

Health outcomes were also reported. An improvement in HbA1c was reported in three articles (Al Omar et al., 2020; Pichayapinyo et al., 2019 & Watterson et al., 2018). Abbas et al. (2015), reported a decrease in fasting blood glucose. Other health outcomes were not reported as being changed positively. Watterson et al. (2018), report no significant reduction in blood pressure or body mass index post intervention and Valentiner et al. (2018), reported no change in body composition or metabolic risk factors.

As has been mentioned, health literacy is an important component of autonomy. Ernsting et al. (2019), reported that app users have higher e-health literacy levels and Wood et al. (2015), reported that health literacy levels improved post-intervention. Knowledge is also an essential component of autonomy. Improved knowledge seems to have an impact on the ability of patients to act on that knowledge and improve their self-care behaviours. Guo, Chang & Lin (2015), Hassan (2017), and Kilic & Karadağ (2020), all reported that self-care behaviours improved alongside increased diabetes knowledge. For Hassan (2017), and Kilic & Karadağ (2020), this is specifically related to diabetic footcare knowledge and behaviour while for Guo, Chang & Lin (2015), this is more related to general care behaviours. Interestingly, Bergner et al. (2017), explain that health literacy status did not impact the benefits derived from their mHealth intervention. Al Omar et al. (2020), did not see a correlation between health literacy scores and a reduction in HbA1c levels, rather they attribute this to the simple language and visual aids used in their intervention. This visual aspect of interventions was also reported as useful in Wood et al. (2015).

In terms of interventions, text-messaging systems were reported as being useful (Watterson et al., 2018).

Users appreciated text messaging-based interventions (whether interactive or not) for the following reasons:

1) They act as a reminder to engage in self-care behaviours (Bergner, 2017; Johnson & Berry, 2018; Nelson et al., 2020; Sugita et al., 2017 & Watterson et al., 2018).
2) They provide a sense of support (Morgan, 2015 & Watterson et al., 2018)
3) They provide a sense of accountability (Bergner et al., 2017 & Nelson et al, 2020).

Interactive voice response calls (IVR) were also cited as being helpful in reminding participants to perform healthy behaviours (Nelson et al., 2017 & Pichayapinyo et al., 2019).

Health outcomes were also reported. An improvement in HbA1c was reported in 3 articles (Al Omar et al., 2020; Pichayapinyo et al., 2019 & Watterson et al., 2018). Abbas et al. (2015), reported a decrease in fasting blood glucose. Other health outcomes did not see a positive change. Watterson et al. (2018), report no significant reduction in blood pressure or body mass index post intervention.

These results provide some insight that can be used to answer the research question. The following chapter will outline and discuss the themes that have emerged in the articles under review.

Chapter 5: Thematic Analysis

This section will outline the themes that emerged from the articles under review. These themes are the result of the third phase of analysis conducted on the literature, after data extraction and coding in NVivo.

5.1 Nodes

As was mentioned in section 3.6.4, nodes were developed in NVivo. These nodes contain information pertaining to emergent themes within the literature. Below is an overview of the nodes, and their hierarchies, that were developed. A full list of the nodes and their descriptions is evident in appendix D.

Four main (or parent) nodes were identified:

1) Autonomy
2) mHealth
3) Health education
4) Health outcome

These main nodes are representative of the research question as they focus on autonomy and mHealth (and what appear to be some of the main components and outcomes thereof.) When coding, it became apparent that these main nodes would not be sufficient to allow for a critical analysis of the information contained within the articles. As coding continued, new sub-nodes or child nodes were created. These sub-nodes are related to the main nodes but contain specific information regarding the main node. For example, the mHealth node has a sub-node for recommendations for mHealth. In the case of the sub-node for beneficial outcomes for mHealth, a sub-node was developed called participant likes. After all the coding had been completed, the set of codes were as follows:

1) Autonomy
    a. Carer involvement
    b. Self-management (and self-care)
2) mHealth

a. Autonomy and mHealth

b. Behaviour around mHealth

c. Beneficial outcomes for mHealth and diabetes

i. Participant likes

d. Concerns

e. Recommendations for mHealth

3) Health education

a. Health literacy

b. Importance of health education

4) Health outcomes

a. Blood glucose

b. Blood pressure

c. Foot care

d. Medication adherence

The nodes contain information mentioned in the articles that pertain to that topic. From there it was possible to develop themes. These themes are a way to analyse the discourse more critically about the research question presented in the articles under review.

5.2 Emergent themes from included articles

After all the articles had been coded, themes were developed. These themes allow for a deeper level of analysis and understanding of the information contained within the articles under review. This provides insight into the topic as a whole; the discourses within the literature, issues within those discourses, gaps that might exist and avenues for discussion and future progress.

What follows are the themes that emerged in the articles under review.

5.2.1 Conceptual shortfalls: lacking interrogation and conflations of concepts

To answer the research question in an accurate and engaging manner, it is important to interrogate the concepts at the heart of the research question, namely autonomy and mHealth. As was evident in the background section (1.1) and literature review chapter, both autonomy and mHealth are concepts that are complex and nuanced. This is more so for autonomy as there are stricter delineations for mHealth. However, there is often a conflation of terms or a mixing of terms in the literature. This issue of interrogating concepts was a prominent theme in the articles under review. There is essentially a dearth of conceptual explanation and/or interrogation for both autonomy and mHealth. This is explained further in section 5.2.1.1 Autonomy and section 5.2.1.2 mHealth below.

5.2.1.1 Autonomy

The concept of autonomy is central to the research question for this literature review. Autonomy was one of the key words used in the literature search and yet, autonomy is not dealt with at all in the articles under review. The word autonomy is mentioned twice in the articles under review. Once in Aikens et al. (2015), and once in Nelson et al. (2020). Neither article gives any type of definition for autonomy nor attempts to engage with the concept. In Aikens et al. (2015), autonomy is mentioned as part of an explanation for why participants would choose to include a carer (the desire for autonomy and privacy would prevent the choice of a carer). In Nelson et al. (2020), autonomy is mentioned as a reason why patients would not desire the assistance of mHealth interventions. In both cases, it seems the word autonomy is merely used as a throwaway term meant to infer agency while not interrogating what autonomy means.

None of the other 16 articles mention the word autonomy. The articles do mention concepts such as self-efficacy (Guo, Chang & Lin, 2015; Kilic & Karadağ, 2020; Sugita et al., 2017 & Wood, 2015), although only Wood et al. (2015), provides a definition for this term. Self-care and self- management are more commonly used in the articles. Again, these concepts are not interrogated, rather they are used as if readers should understand them implicitly. Across the articles mentioning self-care, self-care is followed by words such as behaviour and activities (Abbas et al., 2015; Aikens et al, 2014; Aikens et al., 2015; Bergner et al., 2017; Ernstig et al., 2019; Guo, Chang & Lin, 2015; Kilic & Karadağ, 2020; Morgan, 2015; Nelson et al., 2017; Nelson et al., 2020; Valentiner et al., 2019 & Wood et al., 2015). The implication here is that self-care is an activity that people engage in. Self-management is also a behaviour, but it arguably encompasses self-care. There is a definite link between self-management, self-care, and self-efficacy (the confidence to engage in self-care behaviours). There is also a link between the aforementioned concepts and autonomy, however, self-management is potentially a component of autonomy and not a replacement for autonomy. It is understandable that autonomy is a difficult concept to grapple with but the complete lack of interrogation, or even use of this term, when implying its importance in a discourse is concerning.

5.2.1.2 mHealth

mHealth is also a critical concept for the research question. As has been explained, mHealth has been defined (for example by the WHO) and there has been work done that attempts to provide a taxonomy of ICTs such as that of Fatehi and Wootton (2012). mHealth was also a search term and yet the resulting articles seem to struggle with the concept of mHealth. Only four articles mention the word mHealth, (Aikens et al., 2014; Nelson et al., 2017; Nelson et al., 2020 & Pichayapinyo et al., 2019). Only Aikens et al. (2013), provides an explanation for mHealth. In the other articles it simply mentioned that mHealth stands for mobile health. Moreover, there is a sense that terms are easily confused and conflated. Johnson and Berry (2018), and Kilic & Karadağ (2020), speak about telemedicine when referencing studies that have informed their articles. Hassan (2017), speaks about telemedicine and health, seeming to equate telemedicine and mHealth when Bashshur et al. (2011), explain that they are separate domains with mHealth filling a conceptual gap that developed alongside newer technologies. Guo, Chang & Lin (2015), explain mHealth as mobile e-health which seems superfluous and confusing when mHealth exists as its own concept. Interestingly, instead of delving into the concept of mHealth and explaining what it is to the reader, the articles move straight to mentioning the types of mHealth intervention used (which is article specific). It is arguable that when a concept is defined by the WHO and there is work done regarding the separate domain of mHealth, there should be little reason for confusion.

5.2.2 Components of autonomy

The second theme to emerge relates to the perceived components of autonomy. As has been mentioned, the articles do not engage with autonomy in any way. Rather they speak about self-management, self-care, and self-efficacy. These concepts are interlinked and are arguably components of autonomy. It appears self-care is the set of actions involved in managing diabetes such as eating healthily, adhering to medication regimes, checking feet, and exercising (Hassan, 2017 & Nelson et al., 2020). Self-management generally appears to be linked to health education and health literacy (Al Omar et al., 2020; Bergner et al., 2017; Ernsting et al., 2017 & Wood et al., 2015). From this we see that the articles under review conceive of and speak about components of autonomy without delving into how or why they relate to autonomy and what they do not cover when thinking of autonomy.

5.2.3 The relationship between autonomy and mHealth in the management of diabetes

Despite the issues that are present in the articles under review with regards to thinking critically about autonomy and mHealth, they do seem to generally agree that mHealth is a valid (and perhaps valuable) tool in promoting what can be considered the components of autonomy. This is largely due to the impact the mHealth interventions have in promoting self-care behaviours and thus self-management. The extent of this can be seen in the results from the interventions in the articles discussed in section 4.4.6 of the results chapter. It is interesting that this also provides some support for the general rhetoric in the broader literature on mHealth and autonomy, pertaining to the supposed benefits of mHealth. However, these benefits must be considered along with the conceptual issues raised above. This will be discussed further in chapter 6.

Chapter 6: Discussion

Assessing the impact of mHealth on the autonomy of diabetic patients is a more complicated endeavour than the literature on mHealth would promote. Understanding how mHealth impacts autonomy and the mechanisms that best impact autonomy (or the components of autonomy) can arguably be seen in the literature.

6.1 How does mHealth promote autonomy?

Due to the less complex natures of the answer to the sub-questions of the mechanisms mHealth uses to promote autonomy and how this occurs, these answers will be discussed first.

The utility of mHealth for improving autonomy in diabetic patients lies in the mechanisms used. From the articles under review, we see that text messaging based mHealth interventions and IVR deliver positive results for diabetic patients. This is due to their ability to provide reminders to engage in self-care behaviours (Bergner et al., 2017; Johnson & Berry, 2018; Nelson et al., 2017; Nelson et al., 2020; Pichayapinyo et al., 2019; Sugita et al., 2017 & Watterson et al., 2018). The articles under review also explain that text-messaging based interventions make patients feel accountable for their actions (Bergner et al., 2017 & Nelson et al., 2020). McCool et al. (2022), explain that text-messaging based mHealth interventions provide in-the-moment accountability. Both Morgan (2015), and Watterson et al. (2018), assert that text-messages assist patients in feeling supported, which is another way that mHealth seems to support patients. This is backed by Kruse et al. (2019). This capacity for text-messaging remains essential to the user experience of mHealth (McCool et al., 2022). Educational measures often constitute support mechanisms for patients (Woods et al., 2019).

Moreover, in their systematic review, Kruse et al. (2019), found that text-messaging based mHealth applications are the most common. Kruse et al. (2019), found that text-messaging based systems (such as SMS) provided benefits beyond providing reminders and a sense of support. They found that text-messages also provide benefit by promoting and disseminating health knowledge and disease awareness (Kruse et al., 2019). All of this combined points towards how mHealth can promote autonomy. Reminders and accountability promote self-care behaviours and self-management while the dissemination of information may help improve health knowledge and health literacy, empowering patients to self-manage.

However, as mobile phones have evolved to have new and more powerful features, there is room for change in the mechanisms. For example, mHealth apps may prove more beneficial for their recording and promotional abilities (Song et al., 2021). New technologies can and should be included in mHealth mechanisms however, the way they provide support will need to be further evaluated.

6.2 The premise, promise and problem of autonomy and mHealth

This section will deal with the main research question on the impact of mHealth on the autonomy of diabetic patients. It will discuss the challenges with the thinking around this question, answer it and propose an alternative.

The notion that mHealth improves the autonomy of patients is one that appears in the literature on the benefits of mHealth as a modality (Lucivero & Jongsma, 2018 & Schmietow & Marckmann; 2019). The literature claims that mHealth can improve autonomy; the right of an individual to self-determination; by allowing patients to manage and access their own health information, therefore empowering them by shifting the onus of understanding, controlling and managing their health concerns from their healthcare providers to themselves (Laflamme et al., 2019 & Lucivero & Jongsma, 2018). However, this claim, especially with reference to autonomy is tenuous, largely due to the conceptual gaps with autonomy itself.

The issues with the concept of autonomy are multiple and start with a lack of engagement with the concept as it is intended. None of the articles under review define autonomy and most articles do not engage with the concept at all. In fact, only two articles mention the word autonomy (Aikens et al., 2015 & Nelson et al., 2020). Autonomy seems to be a term that authors think is understood but is not in practice. This lack of engagement comes to a head when you consider how autonomy is conceived of in the healthcare space. In healthcare the generally accepted conception of autonomy stems from the seminal bioethics work "The Principles of Biomedical Ethics" by Beauchamp and Childress' (1979). However, that conception of autonomy was influenced by a specific understanding of autonomy (a Kantian conception which is underpinned by the idea of the rational man). This idea of rationality arguably limits who can engage in autonomous behaviour. Oshana (1998), also speaks about conditions of autonomy and mentions that autonomy is about goal setting and reaching those goals. However, this goal reaching must not be prevented by physical or psychological disabilities (Oshana, 1998).

This raises questions about the saliency of using autonomy as a relevant and useful concept in healthcare settings for multiple reasons. Firstly, the issue with disability, which is brought into focus when we consider that eight articles under review excluded participants with mental health illnesses. Is the assumption then that autonomy is only suitable for the group of people free from any form of disability or mental illness? A notion which seems incongruous with a healthcare setting aiming to prevent, treat and manage such occurrences. The second issue comes into play when you also consider that rational decisions hinge upon the complete understanding of health information (Marciano, Camerini & Schulz, 2019 & Schmietow & Marckmann).

If this complete understanding of health information is essential to autonomy, then many diabetics (especially in low- and middle-income countries or communities) may be excluded from the rational ideal (due to issues around health literacy). This would then categorise them as not autonomous. This relationship is further complicated when you consider that health literacy is not autonomy but a component thereof. This systematic review has spoken about the relationship between health literacy and autonomy. Articles under review have pointed to positive relationships between health literacy and measured outcomes (Ernstig et al., 2019 & Wood et al., 2015), but it is insufficient to say that improved health literacy equates to improved autonomy. Improved health literacy only promotes the ability to make more informed decisions and could lead to improved autonomy however, this is not guaranteed. It is arguable that the literature seems to fall prey to this understanding of autonomy however in doing so they do not engage with the concept. The literature does however, mention other concepts such as self-efficacy, self-care and self-management. These can be seen as components of autonomy.

As was seen in the thematic analysis on the components of autonomy the relationship between autonomy and mHealth in the management of diabetes, the articles under review concentrate on other concepts which can be conceived as components of autonomy. The articles under review paint a picture where mHealth is a valid tool in promoting the components of autonomy by bettering self-care behaviours to improve self-management (which is supported by health education and health literacy). Kumar et al. (2013), talk about the use that mHealth has in supporting chronic disease self-management and McCool et al. (2021), talk about the relevance of mHealth in supporting behaviour change for disease management. Drawing from this focus on the components of autonomy and the conceptual issues with autonomy it is arguable that we remove autonomy from the discourse completely. Looking at the articles under review, we can say that mHealth does promote what this review calls the components of autonomy in diabetic patients. Thus, we posit that the concept of autonomy should be removed from the discourse. It is more worthwhile and inclusive to talk about the components of autonomy which can be summarised as self-management strategies.

The complexity of the narrative around autonomy notwithstanding, it is evident that mHealth, especially text-messaging bases systems are valid mechanisms for the promotion of self-management in patients with diabetes.

Chapter 7: Recommendations for future research and limitations

7.1 Recommendations for future research

The conceptual issues inherent in answering this research question offer the biggest area for further research. To add valuable content to the discourse around mHealth as a tool for improving healthcare, as well as mHealth and autonomy it is essential for authors to take the time to consider the concepts they are using. mHealth is an easier concept to grapple with as there are usable definitions and taxonomies which assist in ensuring that there is the correct delineation when referring to ICTs. Autonomy as a concept requires a lot of interrogation from authors who choose to engage with it. The underpinnings of the concept and the implications behind the term are integral in creating meaning and boundaries. Authors need to contend with these meanings and boundaries in order to make meaningful contributions. The notion of autonomy is seemingly benign. It seems obvious in theory that championing patient autonomy is acceptable and desirable in healthcare spaces. However, the realities of the term may not make it so. As such this systematic review also suggests there be an open discussion about the utility and validity of the concept of autonomy in healthcare spaces.

Open discussion would be useful in creating a discourse around autonomy and the intentionality behind it. The understanding of autonomy in the healthcare space seems to be underpinned by the idea of the rational man. The conditions implicit in this arguably limit who can engage with autonomy. The implication that people need to be rational in order to benefit from autonomy in a healthcare space is limiting, as it does not consider the reasons that people may not be rational such as limited health literacy or physical or mental disability.

Moreover, given the challenges with defining autonomy and the conflicting uses of the term, there are no clear measurement pathways for tracking autonomy. By generating discussion on autonomy, it is possible to avoid the issues inherent to autonomy while still promoting positive health behaviours. Perhaps it is time to consider other terms, such as self-management, as an option for a meaningful ancillary term for autonomy. Self-management seems to be a viable option as the literature seems to provide ways to measure it. Self-management involves self-care activities such as healthy eating, exercise, and medication adherence. These are measurable outcomes. That is not to say that self-management is the only, or the best option. Rather the intention is that future work should be done on determining what is an acceptable concept to refer to what is now conceived of as autonomy, as well as how to measure it. It is possible that redefining autonomy specifically for the healthcare space and determining metrics to measure autonomy may be helpful. This would allow for the promotion of engaged, empowered patients while mitigating against the drawbacks of autonomy as it is currently conceived, namely the centrality of rationality. It is also recommended that there be further research into understanding how mHealth can impact autonomy, and what mechanisms yield the best outcomes so that new mHealth interventions can be designed for the best results.

7.2 Limitations

This systematic review serves as the fulfilment of the requirements of a minor dissertation. Due to the scope of the topic and the complexity, it could not cover all the issues that arose. Moreover, the indexing algorithms used in the platforms searched may impact the literature that resulted from the search. Despite a comprehensive search strategy that was developed with a specialist librarian, it is always possible that articles were missed. Selection bias is also a limitation although it was addressed by having multiple reviewers who discussed issues and made decisions together.

Chapter 8: Conclusion

This systematic review offers a comprehensive oversight of the literature around how mHealth impacts the autonomy of diabetic patients.

The research question for this systematic review was:

What is the impact of mHealth interventions on the autonomy of diabetic patients?

There were also two sub-questions which were addressed:

1) What mechanisms does mHealth use to advance the autonomy of diabetic patients?
2) In what ways does mHealth influence the autonomy of diabetic patients?

It has addressed the research questions by indicating that mHealth improves the components of autonomy in diabetic patients by promoting self-care behaviours as part of a self-management scheme. This occurs as mHealth interventions, specifically text-messaging systems act as reminders and provide support for users. It has also identified and exposed problems within the literature, specifically the challenges around concept usage and conflation surrounding mHealth and autonomy. Awareness of and the challenges surrounding autonomy and interrogation with the concept may help patients understand how to drive behavioural changes to support positive health outcomes. Healthcare providers may benefit from an improved, and challenged, understanding of autonomy which may change conventional usage of the term and methods of support. It has offered recommendations on how to mitigate against this and contribute to more meaningful discussions.

Understanding that autonomy is composed of various components, such as self-management and self-care, may assist with making mHealth a more valuable tool to effect change. It allows those designing mHealth interventions to use effective, targeted interventions to drive behavioural change and support users in the process. Diabetes is a serious, chronic health condition which has severe associated costs (to the individual and the state). Feasible avenues to assist with the management of diabetes are essential in the fight for sustainable and improved outcomes for diabetic care. This systematic review hopes to generate thought and discussion within the community and offer new insight and avenues for research.

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Downloads

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Appendices

Appendix A: Full list of search terms used in search strategy

Research question component	Search terms	Mesh terms
mHealth	Smartphone Cell phone Mobile applications mHealth m-health Mobile health Mobile app Mobile application Mobile devices Mobile phone Mobile technology Smartphone	Smartphone Cell phone Mobile applications
Personal autonomy	Personal autonomy Patient autonomy	Personal autonomy

	Personal agency Patient agency Patient knowledge Health literacy Personhood	
Diabetes	Diabetes Mellitus Diabetes Mellitus, Type 1 Diabetes Mellitus, Type 2 Diabetes Mellitus, Gestational Diabetes Diabetes mellitus Diabetes mellitus, type 1 Diabetes mellitus, type 2 Diabetes gestational Gestational diabetes Type 1 diabetes Type 2 diabetes Diabetic	Diabetes Mellitus Diabetes Mellitus, Type 1 Diabetes Mellitus, Type 2 Diabetes Mellitus, Gestational”

Appendix B: Data Extraction Form

1. Reviewer Information

Date form completed	

2.	**Name of person extracting data**	
3.	**Contact details of person extracting data**	

2. General Information

Article ID:

1.	**Title of article**	
2.	**Author of article**	
3.	**Institution of lead author**	
4.	**Location of article**	
5.	**Year of article**	
6.	**Type of study in article**	
1.	**Article funding source**	
8.	**Possible conflicts of interest**	
Notes:		

3. Article Eligibility

Article criteria	Eligibility criteria met	Location in text
Participants		
interventions		
Comparison		
Outcome		

4. Participants

	Description in article	Location in text
Population description		
Setting		
Inclusion criteria ● Patients who receive healthcare through mhealth interventions ● Patients who suffer from a form of diabetes		
Notes:		

5. Intervention/s

Types of intervention	**Description in the article**	**Location in text**
Mhealth		
Diabetes		
Notes:		

6. Outcomes

Measure	**Marker (describes the measure)**	**Present?**	**Description**	**Location in text**
Improved patient autonomy				
Improved ability to understand information/health literacy				
Ability to act on information				
Sustained use				
Other Health information				
Notes:				

7. Results/Findings

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8. Bias

Type of Bias	**Bias criteria explained**	**Risk of bias** **Low, high unclear**	**Support for judgement**	**Location in text**
Precision	Free from random errors			
Applicability/external validity	Directness Applicability Generalizability			
Poor/ inadequate study design, conduct or reporting				
Reporting bias	• Publication bias • Time lag bias • Location bias Selective outcome reporting			
Choice of outcome measures				
Accurately followed intervention protocol				
Conflict of interest				
Other bias				

Notes:

Appendix C: Excel table for data extraction

article identifier	type of diabetes	interventions	outcomes
Abbas et al., 2015	T2	educational SMS phone calls to check	health outcomes health literacy
Aikens et al., 2014	T2	IVR calls	health outcomes
Aikens et al., 2015	T2	IVR calls with a tailored self-management message	health outcomes (primarily medication adherence)
Al Omar et al., 2020	T1 or T2	whatsapp broadcasts that also allowed bidirectional messaging with experts	health outcomes health literacy ability to act on information
Bergner et al., 2017	T2	interactive text messages	health literacy ability to act on information
Ernstig et al., 2019	just says diabetes	an mhealth app	
Guo, Chang & Lin, 2015	T2	mobile diabetes self-care system - app	knowledge, behaviour and efficacy
Hassan, 2017	T1 or T2	text messages	health knowledge ability to act on information
Johnson & Berry, 2018	gestational diabetes	daily text messages	adherence -- a feasibility study
Kilic & Karadağ, 2020	T1 or T2	web-based mobile app (downloaded onto phone)	knowledge, behaviour and efficacy on footcare
Morgan, 2015	T2	text messages	health outcomes
Nelson et al., 2017	T2	text messages IVR calls	primarily a satisfaction article but you can see some information on autonomy
Nelson et al., 2020	T2	text messages	part of a bigger trial measuring engagement but there is information on medication adherence and self-efficacy and self-management
Pichayapinyo et al., 2019	seems to be T2	IVR app	health outcomes self-management

Sugita et al., 2017	T2	text messages	health outcomes health literacy self-efficacy
Valentiner et al., 2019	T2	Interwalk App - includes text messages	health outcomes adherence -self reported
Watterson et al., 2018	T2	text messages	health outcomes health literacy
Wood et al., 2015	T2	native app	health information health literacy self-management

Appendix D: Nodes, nodal hierarchies and descriptions from NVivo

- Autonomy: How do articles define autonomy - what does it consist of, what other terms may fit in this concept? How can this be improved?
    - Carer involvement: Why would patients chose to have a carer or support system involved in their care?
    - Self-management (and self-care): How is this defined? How do patients go about doing this? How does it help and what are some barriers to it?
- Health education:
    - Health literacy: How do the researchers define this? How is it measured? What are its uses?
    - Importance of health education: What is the reason that the researchers tried to improve health education?
- Health outcomes: What types of health outcomes were measured in these articles?
    - Blood glucose: Self-monitoring of levels, HbA1c and other measures.
    - BP (blood pressure)
    - Footcare: Diabetic footcare assessments, diabetic foot ulcers, general foot care.
    - Medication adherence: Patients comply with the medication regiments they have been prescribed.

- mHealth: How do the authors define mHealth? what do they include as being a part of mHealth?
    - Autonomy and mHealth: How does mHealth link to autonomy or other health outcomes (which may be interpreted as improvements in autonomy)?
    - Behaviour around mHealth: What behaviours do participants display in their interaction with mHealth - ways in which people use mHealth, don't use mHealth etc what types of behaviour are required for mHealth to succeed?
    - Beneficial outcomes for mHealth and diabetes: What do the articles explain/mention as being beneficial outcomes of using mHealth for DM management? What are the positive attributes of mHealth in the literature- how can it be used to improve care?
        - Participant likes: What do participants feel mHealth helps?
    - Concerns: What concerns are there around mHealth and improved behavioural outcomes?
    - Recommendations for mHealth: What does the literature suggest that mHealth provide the user?