SCREENING FOR FOOD INSECURITY IN PRIMARY CARE TO ENHANCE THE MANAGEMENT OF DYSGLYCEMIA IN INDIVIDUALS WITH TYPE 2 DIABETES

by

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Abstract

Type 2 Diabetes (DM 2) is increasingly prevalent worldwide. Its potential for debilitating long-term sequelae and subsequent burden on healthcare systems highlight the importance of adequate diabetes management. Glucose control remains central to treatment and often includes nutritional therapy, pharmacotherapy and self-management strategies. Individuals with DM 2 who experience food insecurity (FI) are at an increased risk of poorly managed diabetes. Nurse practitioners in primary care are specifically skilled at identifying patient difficulties in making, adopting and adhering to lifestyle changes, thus are ideally positioned to address barriers to chronic disease management. However, it remains unclear how FI influences DM 2 and how it is accurately identified in the primary care setting. An integrative literature review was completed to identify which strategies nurse practitioners can employ in primary care to identify and thus enhance the management of DM 2 among patients experiencing FI. With the guidance of Whittemore and Knalf's approach to integrative reviews and the incorporation of Maslow's Theory of Motivation (MTM), a literature analysis was conducted revealing a complex relationship between FI and the management of DM 2. The review highlights how FI interferes with an individual's capacity to self-manage their DM 2 by influencing food behaviors, medication use and mental health. MTM highlights prerequisite needs necessary for diabetes self-management amongst individuals experiencing FI. Challenges in identifying FI in practice are identified, along with strategies to incorporate into practice. Important interventions and clinical recommendations are discussed including: assessing for dysglycemia, assessing for depression and distress, pharmacological management, social support and resource allocation. All are important approaches that nurse practitioners can incorporate in the primary care setting. Finally, limitations and areas for future research are discussed.

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Glossary of Terms

Canadian Community Health Survey (CCHS): National survey comprised of both pan-Canadian annual surveys and focused surveys directed at 35,000 Canadians every 3 years. The purpose is to extract population-level information on the health determinants, health status and health system utilization of Canadians. The CCHS is a collaborative effort between Health Canada, the Public Health Agency of Canada (PHAC), Statistics Canada (SC), and the Canadian Institute for Health Information (CIHI) (Government of Canada, 2017).

Diabetes Canada (DC): The national association for diabetes in Canada that advocates on behalf of individuals with diabetes and supports Canadians, their care providers and research, which is aimed at living healthy lives, preventing diabetes-associated complications and finding a cure. (Diabetes Canada, 2019).

Diabetes Distress (DD): Negative emotions and feelings such as despondency and turmoil, and the perceived burden of living with and managing diabetes. Particularly, diabetes distress usually refers to the pressure felt to monitor, treat, and worry about complications on a continuous basis (Robinson et al., 2018)

Depression: Refers to the experience of individuals who present with persistent depressive feelings and feelings of low mood, which interferes with daily living, as well as of individuals meeting the DSM-V criteria for major depressive disorder (MDD).

Fair Pharmacare: The only Pharmacare plan eligible to all residents of B.C. with active Medical Service Plan (MSP) B.C. accounts. Fair Pharmacare is income-based, meaning families with lesser income receive more help with the cost of Pharmacare-approved drugs, supplies and dispensing fees (Government of British Columbia, 2018a).

Food Insecurity: Defined differently throughout the literature. With respect to diabetes it generally refers to uncertain access and consumption of nutritionally adequate food in sufficient quantities, and usually the result of many complex sociopolitical interactions.

Glycated Hemoglobin (A1C): HB A1C is used as an estimate of mean plasma glucose (or glucose control) over the previous 8-12 weeks. Fifty percent of the value is derived from the preceding 30 days, while only 10% of the value is derived from the prior 90 to 120 days. The A1C is used for diabetes diagnosis, and monitoring of treatment effectiveness. DC provides evidence-based guidelines for A1C monitoring (Berard, Siemens, & Woo, 2018).

Medical Services Plan (MSP): The name of publicly funded health insurance in British Columbia, which covers the costs of all medically-necessary care provider services. All residents of B.C. are eligible (Government of British Columbia, 2018f).

Nurse Practitioner: A graduate-prepared registered nurse who obtained advanced knowledge for autonomous practice by completing either an accredited family or acute care nurse practitioner (NP) master's program. NPs possess competencies in health management provision, ordering and interpreting diagnostic tests, diagnosing and treating, providing disease prevention, health promotion and health management (Canadian Nurses Association [CNA], 2010).

Pharmacare: A publicly funded medication and supply program through the government of B.C., assisting its residents with active Medical Services Plan of B.C. (MSP) coverage, with the costs of prescription medications and supplies that are eligible within the program. Residents are eligible under one of several plans (Government of British Columbia, 2018a).

Primary Care Provider: Health care provider (physician, nurse practitioner or) who is most responsible for the care of a patient in the community setting, usually over an extended period of time.

Special Authority (SA) Coverage: Refers to when Pharmacare provides full or partial benefits to a drug or medical supplies previously not covered, and when the drug's eligibility criteria has been met and SA forms have been sent to Pharmacare. The level of reimbursement is still dependent upon annual deductible requirements (Government of British Columbia, 2018g).

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Chapter 1

Introduction

Type 2 diabetes mellitus (DM 2) is a chronic metabolic disease with increasing worldwide prevalence (Vas et al., 2017). In Canada, the prevalence of DM 2 is projected to reach 10.8% by 2020 (Canadian Diabetes Association and Diabetes Quebec, 2010). Individuals with diabetes access primary care at significantly higher rates and have higher rates of comorbidities (Greiver et al., 2014). Vasculopathies, retinopathies, neuropathies and nephropathies are often the long-term sequelae of DM 2 (Nield et al., 2017), meaning the potential for burden on healthcare systems is substantial. Managing DM 2 is lifelong and requires ongoing monitoring, interventions and follow-up from both the patient and healthcare provider (Vas et al., 2017). Current evidence establishes that individualized, provider-supported, patient-focused strategies are key to DM 2 treatment and management (Ferguson, Swan, Swaldone, 2015; Vas et al, 2017).

According to the Canadian Guidelines on Diabetes (DCG), pharmacological and lifestyle interventions remain the cornerstone of treatment (Lipscombe et al., 2018). The significance of nutrition in management of DM 2, for example, cannot be overstated. The DCG endorse a variety of nutritional eating patterns, and recommends setting nutritional goals best suited to the individual's preferences (Sievenpiper, Chan, Dworatzek, Freeze, & Williams, 2018). A poor diet can have detrimental effects on the management of DM 2 and the prevention of its complications (Seligman, Jacobs, López, Tschann, & Fernandez, 2012).

Definitions of food insecurity (FI) are varied in the literature. FI may arise from several causes, although common antecedents include uncertain access to food (Essien, Shahid, & Berkowitz, 2016; Seligman et al., 2012; Silverman et al., 2015) resulting in inadequate consumption (Essien et al., 2016; Gucciardi, Vogt, DeMelo, & Stewart, 2009). In Canada, FI

presents a significant social and health burden. It also is closely linked to financial constraints and poverty. In fact, poverty is the single most important predictor of FI in Canada (Tarasuk, Mitchell, & Dachner, 2016). While poverty may co-occur commonly with FI, other possible determinants of FI remain unknown. Antecedents and other determinants are examined in the literature review in order to suggest possible solutions.

An estimated one third of individuals with diabetes experience FI (Montgomery, Lu, Ratliff, & Mezuk, 2017). The impact of FI on the management and control of DM 2 has been documented (Heerman et al., 2016). Food insecurity is an independent predictor of glycemic control (Patil, Craven, & Kolasa, 2017; Seligman et al., 2012) and presents a significantly heightened risk of dysglycemia (Essien et al., 2016). For example, individuals with DM 2 experience an increase in hypoglycemic events, subsequent hospitalizations and also higher glycated hemoglobin (A1C) levels at disproportionate rates (Gucciardi, Vahabi, Norris, Del Monte, & Farnum, 2014). What is challenging is that the mechanisms through which FI influences DM 2 are unknown and not commonly identified in practice. Thus, its impact has remained invisible to the practitioner. Establishing management strategies for individuals with DM 2 without a clear understanding of the patient's underlying struggle with FI may result in both ineffective and unsafe treatment plans (Essien et al., 2016). In order to enhance the management of DM 2 in individuals experiencing FI, it is imperative that providers understand how food insecurity influences the management of DM 2, and how it can be correctly identified in practice.

Primary care providers (PCP) are well-situated to address intimate issues such as FI, due to the trust and respect that frequently develops between patients and PCP. The chronicity of the professional relationship provides opportunities for the PCP to identify the patient with DM 2

experiencing food insecurity. Further, PCPs primarily manage the individual with DM 2, thereby allowing the PCP to monitor the effects and outcomes of management plans. Nurse practitioners (NPs) are positioned to address barriers to patient health. NPs have the ability to grasp crucial aspects of a patient's perspective, motivations, issues, barriers and goals (Bartol, 2012). In British Columbia (B.C), NPs are trained to work with diverse populations, identify disparities in health outcomes, and address challenges to making, adopting and adhering to lifestyle changes (British Columbia College of Nursing Professionals [BCCNP], 2018a). B.C-trained NPs possess the competencies necessary to play a comprehensive role in healthcare, working with patients, families, communities and policymakers in order to improve health outcomes (BCCNP, 2018a). By identifying FI as a barrier to well-managed diabetes, NPs can adapt their expectations and co-management strategies to safely meet the needs of the patient to improve dysglycemia and overall outcomes.

Addressing FI in its entirety is complex, requiring consideration of socioeconomical and political contexts. Certain primary care interventions, however, can offer fairly immediate relief to an otherwise highly complex situation. A comprehensive strategy to improve all aspects of FI requires a multipronged approach consisting of individual, community, policy and political interventions, which are beyond the scope of this paper.

Project Purpose

This integrative literature review arose from graduate research on FI in diabetic populations and key conversations with NPs managing diabetes in primary care. Shanda Rojas, a primary care NP who specializes in diabetes care, highlighted a population of individuals with DM 2 who appeared to suffer additional difficulties in managing their diabetes. Subsequently, these difficulties led to additional risks and consequences to the patient's overall health. This

trend was evidenced in my graduate research throughout my NP program. Regrettably, what the literature supported was the providers' overall unawareness of the patient's struggle with FI and thereby an inability to create an effective management plan consisting of safe, patient-centered pharmacological and non-pharmacological recommendations.

Although there are clear guidelines for the treatment and management of DM 2 (Imran, Agarwal, Bajaj, & Ross, 2018; Lipscombe et al., 2018; Sievenpiper et al., 2018; Sigal et al., 2018), it is unclear how providers can identify and safely manage individuals with DM 2 experiencing FI without understanding its impact on food consumption and other self-management behaviors. Diabetes Canada recognizes the influence of FI on diabetes and has subsequently published a position statement (Diabetes Canada, 2017a). However, it does not provide any recommendations or guidance for the practitioner managing individuals' FI. This project aims to answer the question: "How can nurse practitioners use the identification of FI in primary care settings to enhance the management of DM 2 among adults experiencing dysglycemia?". In order to establish this aim, this integrative review examined key background areas through the following three questions: (1) How is food insecurity defined in the context of DM 2?, (2) How does food insecurity influence the management of DM 2?, and, (3) What tools presently exist to identify food insecurity and how can they successfully be applied to the Canadian healthcare context?

An integrative literature review methodology was used to explore each subtheme of the research question. For each theme, a preliminary search was conducted, and followed the establishment of inclusion and exclusion criteria to narrow each search strategy. Finally, a strategical analysis was conducted of the retrieved literature. A literature review matrix presents key information and findings, as well as strengths and limitations. Practice recommendations

elicited through an analysis and synthesis of the findings are described. Clinical implications and potential areas for future research are highlighted. By outlining the impact of food insecurity on DM 2 and emphasizing how screening can be used to modify DM 2 management, the findings of this integrative review will assist future PCNPs in managing patients with DM 2 experiencing FI.

Chapter 2

Background

Food insecurity (FI) can significantly affect the management of type 2 diabetes (DM 2). Poorly managed diabetes is a significant problem in healthcare and leads to several long-term consequences. PCP can help mediate some of the burden and risk associated with FI to improve the management of DM 2. In this chapter, the incidence and prevalence of DM 2 in Canada is reviewed, followed by the pathophysiology, assessment, diagnosis of DM 2, along with its complications. Following this, the pharmacological and non-pharmacological clinical guidelines from Diabetes Canada are discussed, proceeded by a short discussion on Pharmacare and the coverage of antihyperglycemic medications. This is followed by a discussion on FI, its influence on health and the management of DM 2, along with barriers to identifying FI in practice. Further, Maslow's Theory of Motivation (MTM) is discussed along with its relevance to patient behaviors, motivation and managing DM 2 in individuals with FI. Lastly, the role of the NP as a PCP is discussed, and their capacity to identify and mediate the risks associated with FI in DM 2.

Overview of Type 2 Diabetes Mellitus

Diabetes Mellitus 2, or Type 2 Diabetes (DM 2) is a chronic metabolic disease affecting the entire body. Traditional clinical indicators of DM 2 include: (a) insulin resistance in the liver, muscle and adipose tissue; (b) decreased insulin production in the pancreas secondary to beta cell dysfunction and loss; which (c) results in inappropriate metabolism of glucose throughout the body (Brashers, Jones & Huether, 2014b). Recently, multiple organs and hormones have been implicated in the development of DM 2 (DeFronzo, 2009). And, the onset of DM 2, historically between 40-70 years, has shifted to much younger populations in recent years (Brashers, Jones & Huether, 2014b).

Incidence and prevalence.

Over the last three decades, the incidence of DM 2 has doubled across all age groups (Brashers, Jones & Huether, 2014). DM 2 accounts for 90-95% of incidence rates of diabetes (Canada Institution for Health Information, 2015; Centre for Disease Control and Prevention, 2017; Diabetes Canada, 2017; International Diabetes Federation, 2014 & PHAC, 2011). In 2016, the estimated incidence of DM 2 in Canada was approximately 6.3%-6.65%, and occurred more frequently in males than females (Statistics Canada, 2016).

Despite this uniform increase in incidence, some age groups have experienced a sharp rise in prevalence. Between 1999-2009, the prevalence of DM 2 doubled in individuals aged 35-49 years (Public Health Agency of Canada [PHAC], 2011), meaning that DM 2 is becoming more prevalent in younger age groups. In 2015, the estimated prevalence of DM 2 in Canada was between 8.4-8.8% (Diabetes Canada, 2017a). In 2017, the prevalence of DM 2 in British Columbia (B.C.) was 9.5% (Diabetes Canada, 2017b). A steady increase in prevalence is projected for Canada (Diabetes Canada, 2017b) to an estimated 10.8% by 2020 (Canadian Diabetes Association and Diabetes Quebec, 2010). It is estimated that treating DM 2, its complications, and associated productivity loss will cost greater than $19 billion a year by 2020 (Canadian Diabetes Association, 2009).

The incidence and prevalence of DM 2 varies by age, gender, income, ethnicity and geographical region (PHAC, 2011; Shah, 2013). The incidence and prevalence of DM 2 is likely underrepresented as a third of cases are estimated to be undiagnosed (Diabetes Canada, 2017a), and up to a third of people with known diabetes do not feel comfortable disclosing their diagnosis (Canadian Diabetes Association, 2015).

Pathophysiology.

DM 2 involves complex interactions between the environment and individual genetics, resulting in dysfunction of multiple organs and hormones which cause: (a) insulin resistance secondary to liver (DeFronzo, 2009), muscle cell (Brasher, Jones & Huether, 2014b) and adipose tissue dysfunction (Yazıcı & Sezer, 2017); (b) reduced insulin production secondary to beta cell dysfunction and loss in the pancreas (Brasher, Jones & Huether, 2014b); (c) dysregulated signalling of insulin secretion by the incretins in the gastrointestinal tract (Tasyurek, Altunbas, Balci, & Sanlioglu, 2014) and brain (Kleinridders, Ferris, Cai, & Kahn, 2014); (d) dysregulation of blood glucose levels by the kidneys (Brasher, Jones & Huether, 2014b); (e) dysregulated signalling of glucose production by adipose tissue (Stinkens, Goossens, Jocken, & Blaak, 2015), dysregulated signalling of incretins in the gastrointestinal tract (Tasyurek, Altunbas, Balci, & Sanlioglu, 2014) and the pancreas (Brasher, Jones & Huether, 2014b); (f); dysregulated glucose production in the liver (Petersen, Vatner, & Shulman, 2017); (g) dysregulated glucose homeostasis from disrupted glucose sensing in brain (Brashers, Jones & Huether, 2014a, p.734); and (h) dysregulated leptin (Meek & Morton, 2016) and ghrelin secretion (Chabot, Caron, Laplante, & St-Pierre, 2014).

Assessment, diagnosis and monitoring.

Diabetes Canada (DC) provides national guidelines for the assessment, diagnosis and management of individuals with DM 2. According to the DC guidelines, diabetes is diagnosed when two of the following criteria are met: (a) The glycated hemoglobin (A1C) is greater than 6.5 %, (b) a fasting plasma glucose is greater than 7mmol/L, (c) a random plasma glucose is greater than 11 mmol/L, or (d) a 2-hour plasma glucose with a 75 gram oral glucose tolerance test is greater than 11.1 mmol/L (Punthakee, Goldenberg, & Katz, 2018). Only one positive test

is required for the individual presenting with symptomatic hyperglycemia (Punthakee et al., 2018).

Glycated hemoglobin (A1C).

The A1C is a reliable surrogate marker of glycemic control, representing the mean plasma glucose for the previous 8-12 weeks (Berard et al., 2018). Chronically elevated A1C's are associated with an increased risk of diabetic complications, such as retinopathies, nephropathies, neuropathies and cardiovascular disease (Seligman & Schillinger, 2010), and therefore the guidelines recommend measuring the A1C every 3 months until target A1C levels are reached (Berard et al., 2018). The target A1C for most individuals is less than 7%, and when clinically indicated, select individuals target A1C levels between 7.1 to 8.5%, or greater than 8.5% (Imran et al., 2018). While A1C is a reliable mean, it does not capture individual episodes of hyperglycemia and hypoglycemia.

Self monitoring of blood glucose (SMBG).

Using a glucose meter to SMBG provides isolated blood glucose values, and therefore can accurately identify individual episodes of dysglycemia and provide immediate information on the effects of pharmacological and non-pharmacological interventions (Berard et al., 2018). The DC guidelines recommend an individualized approach to SMBG considerate of diabetic type, pharmacological regimen, treatment changes, illnesses, hypoglycemia awareness or risks and occupational requirements (Berard et al., 2018). SMBG is most successful at promoting behavior change, improving blood glucose levels and preventing hypoglycemia when paired with structured education (Berard et al., 2018).

Complications.

Several complications are associated with diabetes: (a) macrovascular complications including hypertension, coronary artery disease, peripheral vascular disease and cerebral vascular disease; (b) microvascular complications including retinopathies, nephropathies, peripheral neuropathies and gastroparesis; (c) infections; and (d) amputations (Brashers, Jones & Huether, 2014a). Diabetes Canada (2017b) estimates that 30% of cerebral vascular events, 40% of myocardial infarctions, 50% of end-stage renal failure and 70% of non-traumatic amputations are attributable to diabetes (p.3). Optimal diabetes management, including maintaining target A1C levels, is key in the prevention of complications.

Management.

The Canadian diabetes guidelines for the treatment and management of DM 2 recommend a multifaceted pharmacological and non-pharmacological approach that: (a) manages and prevents hyperglycemia and its associated symptoms, and (b) decreases the risks of microvascular and macrovascular complications (Lipscombe et al., 2018). Even with optimal management and strict adherence to successful treatment strategies, DM 2 usually progresses over time resulting in increased use of non-pharmacological and pharmacological interventions (Lipscombe et al., 2018).

Non-pharmacological management.

Non-pharmacological strategies are the first-line treatment in the management of DM 2, and recommended as monotherapy for the first 3 to 6 months when an individual's A1C is less than 8.5% at diagnosis and they present with no signs of metabolic decompensation (Lipscombe et al., 2018). Some individuals achieve target A1C levels using lifestyle interventions only.

DM 2 Self-management education (SME) and support (SMS).

DM 2 SME and SMS use patient-provider collaboration and clinical support that focuses on educating, motivating and empowering individuals to problem-solve and use goal setting strategies to modify behaviors and self-monitor their chronic disease (Sherifali, Rabi, et al., 2018). SME and SMS improves glycemic control, self-efficacy, SMBG and healthy eating while decreasing diabetes-related distress and complications (Sherifali, Rabi, et al., 2018, p. S36).

Weight management.

An increased body-mass index (BMI) and abdominal adiposity impairs glycemic control, contributes to hypertension and dyslipidemia, and increases the risk of diabetic complications (Wharton, Pedersen, Lau, & Sharma, 2018). An estimated 80 to 90% of individuals with DM 2 are overweight (Wharton et al., 2018), but substantial improvements in insulin sensitivity, cellular glucose uptake, and hepatic glucose regulation are noted with as little as 5% to 10% loss of initial body weight (Wharton et al., 2018). The DC guidelines recommend a combination of physical activity and nutritional interventions to target a minimum weight loss of 5 to 10% in individuals who are overweight (Wharton et al., 2018). Addressing barriers to weight loss including depression, food behaviors or physical impediments to exercise is key to creating a successful weight loss strategy (Wharton et al., 2018).

Nutrition.

Healthy dietary strategies can significantly lower an A1C approximately 1 to 2% (Sievenpiper et al., 2018). The DC guidelines endorses healthy food choices from 4 major food groups, based on *Eating Well with Canada's Food Guide*: (1) fruits and vegetables, (2) grains, (3) milk and alternatives, and (4) meat and alternatives (Health Canada, 2007; Sievenpiper et al.,

2018). Meals should be a mix of macronutrients and distribution should be flexible to allow for individual preferences (Sievenpiper et al., 2018)

Moderate and consistent intake of carbohydrates (CHO) comprised of varied, low glycemic, high fiber and whole food options are key in lowering A1C levels, controlling dysglycemia, managing weight, controlling lipids, improving clinical and metabolic outcomes and preventing micro and macrovascular complications such as cardiovascular events (Sievenpiper, Chan, Dworatzek, Freeze, & Williams, 2018, p. S64). Fruits, vegetables, legumes and whole grains are preferred choices (Sievenpiper et al., 2018). Maintaining CHO at 45% to 60% of daily intake appears to demonstrate the greatest benefit in glycemic control and the prevention of diabetic complications (Sievenpiper et al., 2018). Added sugars, in particular high-fructose corn syrup, sucrose and fructose at greater than 10% of daily intake, should be avoided as much as possible due to their impact on fasting blood glucose levels and triglycerides (Sievenpiper et al., 2018).

Preferred selections exist for several non-CHO macronutrients: Unsaturated fat is recommended over saturated fat to reduce risk of cardiovascular events (Sievenpiper et al., 2018); Vegetable protein is recommended over animal protein, as vegetable protein substitutions have demonstrated reduced A1C levels, fasting plasma glucose (FPG) and improved fasting insulin (Viguiliouk et al., 2015).

Other dietary strategies include: (a) reducing caloric intake and increasing daily protein intake to target weight loss and increase satiety (Sievenpiper et al., 2018); (b) carbohydrate counting to regulate the timing, constancy and quantity of CHO (Sievenpiper et al., 2018); (c) limiting sugar-sweetened foods and beverages (SSFB) to less than 10% of total daily intake to maintain weight and glycemic control (Sievenpiper et al., 2018); (d) minimizing refined sugars

and fast foods due to dysglycemia, weight gain and diabetic complications (Sievenpiper et al., 2018); and (e) regular consumption of legumes, beans and lentils to lower A1C, promote glycemic control and reduce various serum markers associated with cardiovascular disease (Sievenpiper et al., 2018). Dietary patterns most closely aligning with these recommendations include the Mediterranean diet, DASH diet and a vegetarian diet (Sievenpiper et al., 2018). Consideration to values, preferences and goals helps a person adhere to dietary strategies over the long term (Sievenpiper et al., 2018).

Research examining the effects of intermittent fasting and energy restriction on weight loss has become prevalent in the general population, but its effects in on glycemic control is limited. In a recent pilot trial, Carter, Clifton and Keogh (2016) compared the effects of intermittent severe energy restriction versus a moderate continuous calorie restricted weight loss diet and found glycemic control and weight reduction were similar (Carter, Clifton, & Keogh, 2016). However, the individuals who severely restricted their intake required significant medication adjustments or discontinuation, particularly with insulin and sulfonylureas, to prevent hypoglycemic events (Carter et al., 2016). De-prescribed sulfonylureas produced inconsistent results, with some participants experiencing rebound hyperglycemia (Carter et al., 2016). Diabetes SMS and SME should work to identify and mediate barriers to healthy food behaviors (Sievenpiper et al., 2018) for individuals experiencing involuntary restriction of nutritional intake.

Physical activity.

Aerobic exercise, i.e. continuous movement of large muscle groups for a minimum of 10 minutes (Sigal et al., 2018, p. S55) and resistance training, i.e. repetitive weighted movements to increase muscle strength or mass (Sigal et al., 2018, p. 55) assist in the regulation of blood

glucose, insulin resistance, lipid regulation, blood pressure, weight loss and reduction of macrovascular complications (Sigal et al., 2018). The DC guidelines recommend at least 150 minutes of aerobic activity a week, a minimum of 2 days per week of resistance exercise (Sigal et al., 2018), and physical movement every 20 to 30 minutes (Sigal et al., 2018).

Pharmacological management.

The guidelines recommend that pharmacological management be commenced when non-pharmacological options are insufficient in reducing the A1C to target levels within the first 3 to 6 months, or if the individual's A1C is greater than 8.5% at diagnosis (Lipscombe et al., 2018). Metformin is preferred as first line treatment in the pharmacological management of DM 2 because it is safe, inexpensive, effective at reducing A1Cs, and is associated with a low risk of hypoglycemia, weight gain and adverse effects (Lipscombe et al., 2018). Metformin is a biguanide that decreases hepatic glucose production and improves hepatic insulin sensitivity by activating AMP-activated protein kinase (Lipscombe et al., 2018). However, when symptomatic hyperglycemia or signs of metabolic decompensation such as weight loss or ketosis are present at diagnosis, insulin should be initiated, irrespective of A1C (Lipscombe et al., 2018).

Second line agents are added to metformin when: (a) initial A1C or symptomatology at diagnosis indicate the need for more aggressive therapy or (b) the A1C remains above the patient-specific target after 3-6 months of monotherapy (Lipscombe et al., 2018). The DC guidelines recommend adding an agent every 3 to 6 months until target A1C levels are reached (Lipscombe et al., 2018). Traditionally, insulins and insulin secretagogues, such as sulfonylureas, have been first-line treatment for add-on therapy. However, the risks of hypoglycemia and weight gain are greatest in these classes and should not be the first choice in populations at increased risk of hypoglycemia (Lipscombe et al., 2018).

Over the last decade, newer pharmacological options have become available, meaning there is greater flexibility in individualizing treatment plans to the needs of a patient (Diabetes Canada, 2017b). Further, these newer agents have fewer side effects (Diabetes Canada, 2017b), provide superior glucose control and A1C stability (Diabetes Canada, 2017b), and have a superior safety profile (Lipscombe et al., 2018). Approach and selection of antihyperglycemic therapy should consider clinical presentation, patient risk factors, values and preferences in order to provide a treatment regimen most appropriate for the individual (Lipscombe et al., 2018). Key to this process includes understanding the individual's disposition, their social needs and their ability to afford or observe a particular pharmacological regimen (Lipscombe et al., 2018). Treatment should be promptly modified when adherence issues are present (Lipscombe et al., 2018).

The DC guidelines recommend dipeptidyl peptidase-4 (DPP-4) inhibitors, glucagon-like peptide-1 (GLP-1) receptor agonists or sodium-glucose linked transporter-2 (SGLT-2) inhibitors over traditional agents due to their negligible risk of hypoglycemia and weight gain, and non-inferior A1C-lowering capacity (Lipscombe et al., 2018). Additionally, select GLP-1 agonists and SGLT-2 inhibitors are associated with reduced microvascular and cardiovascular complications in individuals with identified cardiovascular risks (Lipscombe et al., 2018).

Insulins.

Insulins are an exogenous source of insulin, and when injected, stimulate insulin cell receptors to normalize the metabolism of carbohydrate, fat, and protein (Lipscombe et al., 2018) through cellular uptake. Insulins offer the greatest potential for a reduction in A1C; however, all pose some risk of hypoglycemia when food intake is inconsistent or reduced (Lipscombe et al., 2018).

When commencing insulins, long-acting or intermediate-acting insulins are generally commenced first, and given at night to offer basal or glycemic control and improve fasting morning blood sugars (Lipscombe et al., 2018). Long-acting insulins are preferred over intermediate-acting insulins because they do not have a peak effect, i.e. there is a decreased risk of symptomatic or nocturnal hypoglycemia (Lipscombe et al., 2018). When bolus or mealtime insulin is commenced, sulfonylureas should be de-prescribed due to concomitant risks of hypoglycemia (Lipscombe et al., 2018). Rapid acting insulins pose less risk of postprandial hypoglycemia than short-acting insulins and should be preferentially prescribed wherever affordable and appropriate (Lipscombe et al., 2018). Concomitant prescribing of other antihyperglycemics is encouraged: Regimens consisting of combination insulin and non-insulin agents reduce the level of weight gain and risks of hypoglycemia associated with insulin only regimens (Lipscombe et al., 2018).

Sulfonylureas.

Sulfonylureas are an insulin secretagogue which acts on β-cell sulfonylurea receptors and stimulates the release of endogenous insulin (Lipscombe et al., 2018). Sulfonylurea work fairly rapidly and do not work in a glucose-dependent fashion, meaning they can pose a moderate risk of hypoglycemia (Lipscombe et al., 2018) especially with reduced glucose intake. Certain sulfonylureas are more problematic over others (Lipscombe et al., 2018). Glyburide offers the greatest risk of hypoglycemia; however, prescribing habits are likely influenced by Pharmacare coverage, as glyburide remains the only unrestricted sulfonylurea in the public formulary (Government of Canada, 2018b). Gliclazide poses the least risk of hypoglycemia, cardiovascular events and overall mortality and is the preferred choice of sulfonylurea (Lipscombe et al., 2018).

Weight gain is a common side effect due to their insulin-releasing properties (Lipscombe et al., 2018).

Dipeptidyl peptidase-4 (*DPP-4) inhibitors and glucagon-like peptide-1 (GLP-1) receptor agonists.*

Incretins exert their effect only when glucose is ingested, meaning they possess a near negligible risk of hypoglycemia. Both DPP-4 inhibitors and GLP-1 receptor agonists increase the signalling and release of insulin when glucose is sensed in the gastro-intestinal tract. They also slow gastric emptying and inhibit glucagon release (Lipscombe et al., 2018). All GLP-1 receptor agonists are associated with weight loss; however, additional weight loss is seen at higher doses of liraglutide (Wharton et al., 2018). Liraglutide and semaglutide are the only cardioprotective GLP-1 receptor agonists (Lipscombe et al., 2018). Pharmacological complications are rare, however, gastrointestinal side effects such as nausea, or diarrhea, are common especially in GLP-1 receptor agonists (Lipscombe et al., 2018).

Sodium-glucose linked transporter-2 (SGLT-2) inhibitors.

SGLT-2 inhibitors block the sodium-dependent glucose cotransporters responsible for renal glucose reabsorption back into the bloodstream (Lipscombe et al., 2018). The net action is increased glucosuria and decreased blood-glucose levels (Lipscombe et al., 2018). SGLT-2 inhibitors possess nearly a negligible risk of hypoglycemia, and a potential reduction of 2 to 3 kg of body weight (Lipscombe et al., 2018). This class' diuretic-like properties offer an additional benefit of a reduction in systolic blood pressure, and a reduced or slowed progression of nephropathy (Lipscombe et al., 2018). In individuals with known cardiovascular disease, they are associated with: (a) reduced heart failure; (b) with empagliflozin and canagliflozin only, a reduction in major adverse cardiovascular events; and (c) with empagliflozin only, a decrease in

cardiovascular death (Lipscombe et al., 2018). There is a significant increase in the occurrence of genital mycotic and urinary tract infections, hypotension and volume depletion (Lipscombe et al., 2018). There are some adverse outcomes attributed to canagliflozin in particular, which include increased fractures, lower extremity amputations and acute renal injury (Lipscombe et al., 2018).

Thiazolidinediones (TZDs).

TZDs target insulin resistance by increasing peripheral tissue and hepatic insulin sensitivity in a variety of cell receptors (Lipscombe et al., 2018). Subsequently they are associated with weight gain, but a negligible risk of hypoglycemia (Lipscombe et al., 2018). The use of TZDs has substantially diminished over the past decade due to an increased incidence of edema, heart failure, significant risk of fractures, and possible risk of myocardial infarctions with rosiglitazone (Lipscombe et al., 2018). Pioglitazone remains the only TZD available in B.C. (Government of British Columbia, 2018b).

Alpha glucosidase inhibitors (acarbose).

Acarbose works by preventing pancreatic α-amylase and intestinal α-glucosidase from breaking down and absorbing carbohydrates (Lipscombe et al., 2018), which reduces and delays the absorption of glucose into the bloodstream. Gastrointestinal side effects such as bloating, gas and diarrhea are common and require three times a day dosing (Lipscombe et al., 2018). B.C. is the only province where Acarbose is de-listed and no longer available (Diabetes Canada, 2017b).

Orlistat.

Orlistat is used as a weight loss agent by preventing lipase from breaking down fats. By assisting with weight loss, Orlistat improves glycemic control and subsequently results in dose reduction of antihyperglycemic medications (Wharton et al., 2018). It is associated with

gastrointestinal side effects such as nausea and diarrhea. However, due to its mechanism of action, it produces a negligible risk of hypoglycemia (Lipscombe et al., 2018).

Pharmacare

Pharmacare is British Columbia's public drug insurance program. Pharmacare is comprised of several publicly-funded drug plans for whom select individuals are eligible depending on each plan's criteria (Government of British Columbia, 2018a). Select populations have 100% of the drugs in the Pharmacare's formulary covered. This includes permanent residents of licensed residential care facilities (Plan B), recipients of B.C. income assistance (Plan C) and First Nations (Plan W). Fair Pharmacare is B.C' s only public drug plan eligible to all B.C. residents with active Medical Services Plan of B.C. (MSP). Fair Pharmacare is dependent upon household income (Government of British Columbia, 2018a). An annual minimum deductible must be reached before 70% of the drug cost will be covered, and a family maximum deductible must be reached before drugs are 100% covered (Government of British Columbia, 2018a). While Plan C offers 100% coverage to British Columbians living below the poverty line and who are receiving income assistance, many Canadians not receiving income assistance live below the poverty line and must spend money before they receive assistance from Pharmacare. For example, a family of four in B.C. living on wages equivalent to the average poverty line in B.C[1], must spend approximately $950.00-$1100.00 to reach their deductible and $1350-1500.00 to have medications fully covered (Government of British Columbia, 2018c).

While eligibility and deductibles vary from person to person, the list of antihyperglycemics available through Pharmacare's formulary is the same across all plans:

[1] Calculated using Statistics Canada's (2018a) estimated Market Basket Measure (MBM) for a family of four living in B.C. ($37,153- $39,951 depending on rural versus urban living). Canada has recently structured and developed an official poverty line called the Market Basket Measure (MBM) and is currently being validated throughout Canada (Statistics Canada, 2018b).

Metformin, glyburide and select short and intermediate-acting insulins are listed restriction-free on the formulary (Government of Canada, 2018b). Rapid-acting insulins are available to individuals capable of paying the cost difference between short and rapid-acting insulins (Government of Canada, 2018b).

Presently, B.C. remains the only province where none of the newer more expensive antihyperglycemic medications such as SGLT-2 inhibitors, GLP-1 agonists, or DPP-4 inhibitors are listed on the public formulary without Special Authority (Diabetes Canada, 2017b). Further, Special Authority (SA) coverage only exists for linagliptin and saxagliptin[2] when maximum tolerated doses of metformin and sulfonylureas have been tried and insulin NPH was found to be ineffective or inappropriate (Government of British Columbia, 2018d). Subsequently primary care providers have had to find creative strategies to provide the pharmacotherapy most suitable for the patient while working in conjunction with Pharmacare and patient income.

Therefore, individuals with financial constraints and without additional private coverage are more likely to rely on Pharmacare-covered medications due to the prohibitive costs of newer medications (Diabetes Canada, 2017b). They may experience significant restrictions in pharmacological options, subsequently resulting in greater difficulty and risks in managing his or her DM 2. Lastly, Pharmacare funds blood glucose strips solely based on pharmacological regimen (Government of British Columbia, 2018b), which presents a challenge to individuals who cannot afford additional strips, possess additional challenges in monitoring their blood glucose, and are at increased risk for dysglycemia. Under special circumstances, specific healthcare providers may apply for additional strips if the patient is not on insulin and: (a) is not meeting target glycemic levels after 3 months, (b) has present or concomitant illnesses which

[2] Includes combinations with metformin

interfere with glycemic control, (c) is undergoing medication changes which affect glycemic control, (d) has a vocation where dysglycemia presents a significant safety risk, or (e) the patient is a gestational diabetic (Government of Canada, 2019). If SA is approved, individuals are eligible for 100 extra strips annually.

Overview of Food Insecurity (FI)

FI exists when individuals have uncertain access to adequate amounts of nutritious food (Essien et al., 2016; Montgomery et al., 2017; Seligman et al., 2012) It is a worldwide epidemic, reaching all corners of society (WHO, 2018). Several Canadian studies have identified poverty and financial constraints as antecedents to FI in Canada (Beryl Pilkington et al., 2010; Chan, DeMelo, Gingras, & Gucciardi, 2015; Li, Dachner, & Tarasuk, 2016; Tarasuk et al., 2016; Thomas, Fitzpatrick, Sidani, & Gucciardi, 2018). In Canada, the prevalence and severity of FI does not exist exclusively among the impoverished (Patil et al., 2017): FI increases as income decreases in a near linear fashion (Li et al., 2016). The "Research to Identify Policy Options to Reduce Food Insecurity" (PROOF) is funded by the federal Canadian government to monitor the prevalence of income-associated food insecurity (IAFI) in Canada (2018), and defined FI as "the inadequate or insecure access to adequate food due to financial constraints (Tarasuk et al., 2016, p. 6)". Since 2005, FI has continued to increase in Canada and in British Columbia (Li et al., 2016; Tarasuk et al., 2016). Approximately 1 in 8 households in Canada are classified as "food insecure", which accounts for approximately 4 million Canadians (Tarasuk, Mitchell & Dachner, 2014); In B.C. approximately 1 in 10 households, or half a million British Columbians, are food insecure (Li et al., 2016). It remains unclear, however, what the prevalence rates and causes of other forms of FI in Canada are, but it is speculated to encompass significantly more of the Canadian population. Examples of other documented causes of FI include physical barriers to

access, geography, inability to safely prepare food, labile food prices, and variability to food crops (Strickhouser et al., 2014). Further, some populations appear to be at greater risk than the general population, including women, single parents, elderly and immigrants (Gucciardi et al., 2014).

FI affects health, though the relationship is complex and not necessarily causational (Berkowitz & Fabreau, 2015). FI impairs the prevention, treatment and management of several chronic diseases (Tarasuk et al., 2015), Though the mechanisms are not entirely understood, FI is independently associated with increased healthcare utilization costs, and both poorer physical and mental health (Tarasuk et al., 2015). FI interferes with self-care and functional health, and overall worse chronic disease outcomes (Tarasuk et al., 2015).

Food insecurity in type 2 diabetes.

The prevalence of food insecurity (FI) among Canadians with DM 2 occurs at disproportionate rates (Chan et al., 2015; Galesloot, McIntyre, Fenton, & Tyminski, 2012; Gucciardi et al., 2009). FI in individuals with DM 2 is associated with inferior glycemic control, and worsening A1C values (Ippolito et al., 2016). There is evidence that FI interferes with DM 2 self-management strategies (Ippolito et al., 2016), but the mechanism is not yet understood. Diabetic complications also occur at significantly higher rates (Montgomery et al., 2017; Seligman et al., 2012). There are no best-practice strategies for the management of individuals with DM 2 experiencing FI (Thomas et al., 2018), therefore the interface between FI and successful management of DM 2 remains unclear and is at the epicentre of this integrative review. Thus, an integrative review exploring how FI interferes with the management of DM 2 is necessary before an effective management approach can be established for the food-insecure

diabetic. Additionally, further exploration of the literature is required to examine how FI may best be identified in primary care.

Identifying food insecurity.

Presently, there is no standardized process or method for identifying all forms and measures of FI (Jones, Ngure, Pelto, & Young, 2013), nor is there a specific method for identifying FI amongst individuals with DM 2 (Thomas et al., 2018). Identifying food insecurity can be challenging for several reasons. Firstly, people who are food insecure do not represent a homogenous group (Strickhouser, Wright, & Donley, 2014). For example, based on Canadian data that monitors IAFI, 65% of the FIFC in British Columbia are employed (Li et al., 2016), 16% live on social assistance, 12 % are seniors relying on seniors' income, and the remaining rely on Employment Insurance, workers compensation or other sources as their main source of income (Li et al., 2016). Unattached individuals and individuals with no children represent over 40% of IAFI in B.C., but families with children and women have higher rates of FI overall (Li et al., 2016). Caucasians, Asians, and other ethnic groups in B.C. share similar rates of FI, but nearly a third of B.C.'s IAFI self-identify as Aboriginal (Li et al., 2016).

Secondly, FI screening is not routinely completed or well integrated into practice. There is no systematic evidence-based method for determining how FI screening should unfold in healthcare settings. In a recent systematic review examining the validity, acceptability and implementation of FI screening in healthcare, De Marchis, Torres, Fichtenberg and Gottlieb (2019) found that there is limited direction in healthcare settings on how to implement FI screening in practice.

Thirdly, while De Marchis et al., (2019) identified several FI screening tools validated in US healthcare settings, it is unclear whether Canadian providers have access to peer-reviewed,

standardized and validated tools to identify FI in the Canadian healthcare context. Furthermore, it is unclear how FI is defined in each screening tool: in a recent systematic review examining available tools for measuring FI, Ashby, Kleve, McKechnie and Palermo, (2016) found that most current tools were subjective in nature, had a limited scope in identifying FI and primarily identified access issues in FI. Identifying a standardized FI screening tool validated for use in Canadian healthcare is an essential aspect of this integrative review.

In Canada, IAFI has been routinely monitored through research grants by Policy Options to Reduce Food Insecurity (PROOF, 2018b), using a validated and standardized measurement called the Household Food Security Survey Module (HFSSM). The HFSSM is part of the Canadian Community Health Survey (CCHS), which Statistics Canada uses to collect health information on a sample of Canadians every two years (PROOF, 2018b). While the HFSSM was originally developed and used in the Unites States (US) by the US Department of Agriculture, it was later adapted and approved by Health Canada for its use in Canada (Health Canada Office of Nutrition Policy and Promotion 2007). It remains unclear if the Canadian-specific HFSSM has been validated for use in healthcare settings to identify FI at the individual level or whether it has been validated to identify other forms of FI.

Benefits of screening food insecurity in practice.

Clinicians have questioned whether routine screening for FI in clinical settings should be completed (Berkowitz & Fabreau, 2015). There is little evidence that screening and identifying food insecurity improves health outcomes (Berkowitz & Fabreau, 2015), but screening is supported by some clinical experts when it results in adjustments to clinical management and improves safety (Berkowitz & Fabreau, 2015). For example, Berkowitz and Fabreau (2015) indicate that identifying FI in healthcare is clinically significant for individuals with DM 2,

because it can directly support important pharmacological and clinical decisions when food behaviors may be causing dysglycemia. In this circumstance, identifying FI assists the provider with specific and appropriate SME and SMS, including self-titration of medication during low food periods (Berkowitz & Fabreau, 2015), or de-prescribing specific medications which pose a specific risk to the individual.

Maslow's Theory of Motivation (MTM)

It is important to consider an individual's capacity to be motivated to make health behavior changes and self-actualize in the face of long-standing FI. Maslow's *Theory of Motivation (MTM)* was developed in the 1940's, and describes motivation for human behavior (Maslow, 1943). While our understanding of human motivation and behavior has evolved over time, MTM continues to be influential in practice and offers insight to human behaviors with respect to health behaviors. Maslow's theory (1943) is based on 5 basic tenets: (1) We have five sets of basic needs, namely physiological, safety, love, esteem and self-actualization. Humans are motivated by a desire to satisfy these needs (Maslow, 1943, p. 394); (2) These 5 needs exist in a hierarchical, but not mutually exclusive manner: when the more basic needs are unmet, they dominate the conscious mind, while other 'higher' needs become irrelevant, minimized and sequestered from awareness (Maslow, 1943, p. 394). Only when a more basic need is adequately satisfied, can a higher need begin to dominate an individual's consciousness (Maslow, 1943, p. 394); (3) Any real or perceived threat to the security of these needs is perceived as a psychological threat (Maslow, 1943, p. 394); (4) these threats generate emergency or compensatory reactions in behavior (Maslow, 1943, p. 394); (5) some motivators of human behavior are not yet or cannot be explained by this model (Maslow, 1943, p. 394).

MTM postulates that food is one of the most basic physiological human needs (Maslow, 1943); Therefore, MTM may provide further insight into why individuals with FI may struggle with managing DM 2. Further, MTM may highlight how recommending self-management approaches in DM 2 when FI is present may be inadequate and even inappropriate. Lastly, MTM may highlight the enhanced value of individualized, FI-informed management strategies when patients are significantly limited in their capacity to self-manage their DM 2.

The Nurse Practitioner (NP)

In Canada, NPs are graduate level, master degree prepared advanced practice nurses (BCCNP, 2018a) working within a legislated scope of practice under the B.C. Health Professions Act (RSBC, 1996), and regulated by the British Columbia College of Nursing Professionals (BCCNP, 2018a). The NP scope includes diagnosing, ordering and interpreting diagnostic tests, prescribing pharmaceuticals, and providing holistic health management, health promotion and disease prevention strategies (BCCNP, 2018a).

Nurse Practitioners (NPs) in primary care.

NPs are trained as family nurse practitioner in B.C. As of 2018, over 500 NPs are registered in B.C, and approximately 60% work in primary care (Nurse and Nurse Practitioners of British Columbia [NNPBC], 2018) offering unique strategies in addressing barriers to patient health. Fundamental to this capacity is the NP's ability to grasp crucial aspects of a patient's perspective, motivations, issues, barriers and goals in order to effectively manage health (Bartol, 2012). NPs are specifically educated to identify difficulties in making, adopting and adhering to lifestyle changes and can partner with patients, families, communities and organizations to implement useful techniques (BCCNP, 2018a).

A recent evaluation of the integration of NPs into the B.C. healthcare system revealed that the majority of NPs are providing direct patient care in office settings for chronic conditions, including diabetes (Sangster-Gormley et al., 2015). Many of these patients have complex health conditions and several social issues (Sangster-Gormley et al., 2015). The review of data from B.C.'s NP demonstrate NPs are spending the majority of time managing these chronic health conditions by screening, providing pharmacotherapy, engaging in health education, and integrating preventive health approaches (Sangster-Gormley et al., 2015).

NPs are seen as an added benefit because they increase access to care, are effective at enacting behavior change, use a collaborative, comprehensive, team-based and patient-centered approach and deliver high levels of patient satisfaction (Sangster-Gormley et al., 2015). In B.C., NPs are delivering a high-quality care with patient outcomes similar to that of general practitioners (Prodan-Bhalla & Scott, 2016). The NP practice approach could facilitate the implementation of formal FI screening and modified patient-centered treatment strategies in practice. This integrative literature review will contribute to the growing interest in NPs and their unique contributions as PCPs by exploring how NPs can identify FI in the PC setting to enhance the management of individuals with DM 2 experiencing FI.

Chapter 3

Methods

As part of my prior scholarly work, an extensive initial literature search was executed to examine the best evidence and recommendations for the dietetic management of type 2 diabetes (DM 2). Several practice guidelines, systematic reviews and meta analyses were found describing nutritional recommendations for the management for DM 2. A follow-up literature search examined how food insecurity (FI) influenced a person's capacity to follow evidenced-based dietary strategies. However, there was a lack of specific literature guiding primary care providers (PCPs) in identifying and supporting individuals with DM 2 experiencing FI. Further, while it appeared clear that FI had a profound effect on glycemic control and subsequent complications, the effect of FI on food only partly explained the relationship. Other mechanisms of influence remained unclear. In order for providers to aid in the management of DM 2 amongst individuals experiencing FI, all mechanisms of influence must be understood and strategies to identify FI, elicited.

Through these prior findings, the following question was produced: "What strategies can nurse practitioners employ to identify FI in primary care to enhance the management of DM 2 amongst individuals experiencing FI?" An integrative review methodology (IRM) was selected since IRMs identify and amalgamate a vast array of literature to provide greater insight into clinical questions (Whittemore & Knalf, 2005). Whittemore and Knalf's (2005) approach to an integrative review was used to guide this paper.

Literature Search

A systematic approach was employed, using databases to search available literature. Afterwards, an additional search strategy was conducted for individual selection of key articles.

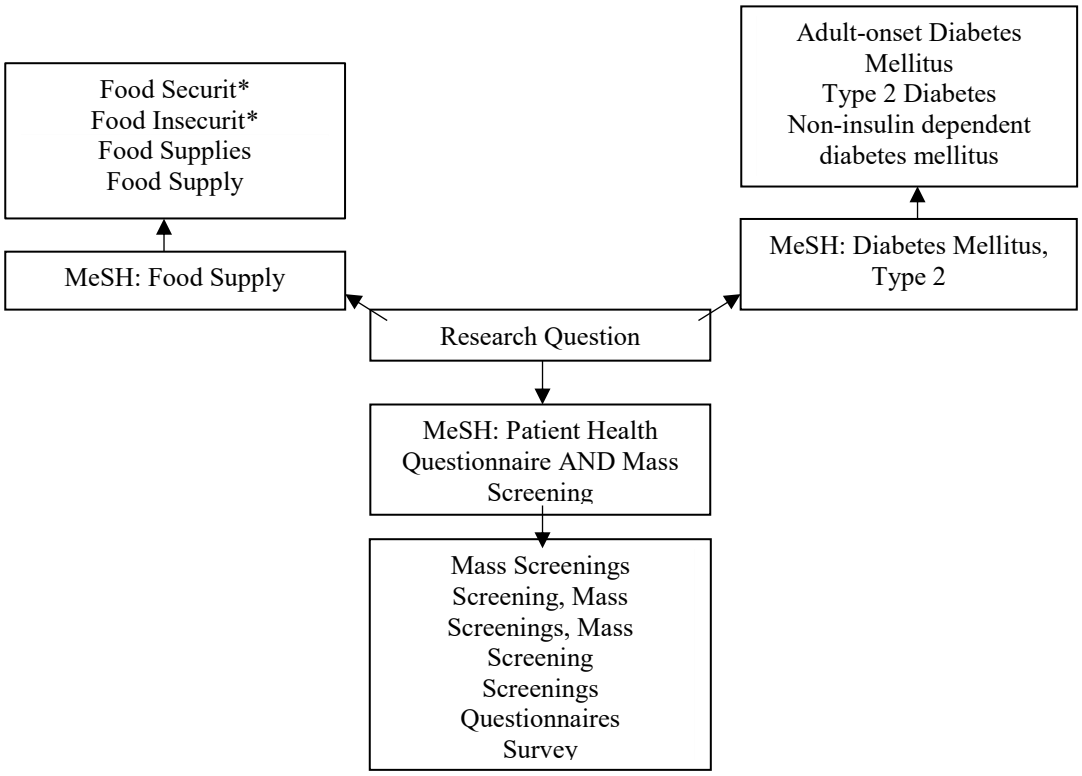
Inclusion and exclusion criteria were established that guaranteed a breadth of articles were selected that also focused the literature relevant to the topic. A descriptive analysis of the literature search strategy is provided followed by data evaluation and analysis using Whitemore and Knalf's (2005) approach to integrative reviews.

Preliminary Search Strategies

An initial scoping of the literature was conducted in PubMed to review pertinent keywords and medical subject heading (MeSH) terms used in articles discussing DM 2, FI and FI screening methodologies. Terms frequently used in the articles from prior scholarly work were also examined. Terms returning irrelevant literature were first cross-examined against other popular terms to ensure no relevant articles were missed. Some duplicate articles arose, but no new articles; therefore, terms returning a high volume of irrelevant literature were eliminated. Scope notes were examined for each MeSH heading. Reviewing keywords within MeSH terms and scope notes ensured terms were accurate, relevant to the project aim, suitable for the search strategy and not limiting to the search strategy by erroneous keyword selection or omission. A concept map with important keywords was used to guide the literature search strategy for each database. The concept map is presented in Diagram 1.

Diagram 1

Concept Map Driven by PubMed MeSH and Keywords[3]



Primary Search Strategies

For each aim of the integrative review, a combination of MeSH terms and keywords were used. Their appropriateness was verified for accuracy by comparing the scope note and cross-examining the terms and notes against the PubMed terms initially established. For each database, missing terms under the MeSH heading were added as keyword search terms. New terms discovered under MeSH headings were independently searched to establish if additional relevant articles were returned. If no extra articles were found, the term was eliminated. Combining search strategies for all aims returned zero articles. Therefore, the search strategy was divided as follows: For aim 1 and 2, the Cumulative Index of Nursing and Allied Health.

[3] "*" indicates word is truncated and includes all possible endings to the truncated word.

Literature (CINAHL), Medline (Ovid), PubMed, Cochrane Databases (EBMR), and Academic Search Complete (ASC) were searched. For aims 1 and 2, the following search terms were used in each database and verified with the university librarian. They are presented in Table 1.

Table 1

Search Terms Utilized in Specified Databases to Extract Articles for Aim 1 and 2

CINAHL	Medline OVID	PubMed	EBMR	ASC
MeSH terms Food Security Diabetes Mellitus, Type 2	*MeSH terms* Food Supply Diabetes Mellitus, Type 2	*MeSH terms* Food Supply Diabetes Mellitus, Type *2*	*No MeSH terms available*	*MeSH terms* Food Security Non-insulin Dependent Diabetes
Keywords Food Insecurity	*Keywords*	*No Keywords*	*Keywords* Food securit* Food Insecurit* Food Supply Adult-onset Diabetes Mellitus Type 2 Diabetes Non-insulin Dependent Diabetes mellitus NIDDM Diabetes Mellitus Type 2	*No keywords*

For aim number 3, PubMed, ASC and Web of Science (WOS) were used, following a discussion with the university librarian. Several adjustments were made in ASC due to the number of results returned, bearing no relevance to the review. Appropriate terms were identified searching MeSH headings and comparing scope notes with PubMed. For aim number 3, the results for the search strategy are presented in Table 2.

Table 2

Search Terms Utilized in Specified Databases to Extract Articles for Aim 3

PubMed	WOS	ASC
MeSH terms	*No MeSH terms*	*MeSH terms*
Food supply Patient health questionnaire Mass Screening		Food security Medical Screening Patient Screening Questionnaire
No Keywords	*Keywords*	*No Keywords*
	Patient health questionnaire Screening Questionnaire Food security Food insecurity	

Terms were then combined with the Boolean operators "AND" and "OR" when appropriate. The search strategy for each database was verified with the university librarian and is presented in Table 3.

Table 3

Sequential Search Strategy Utilized for the Database Searches

Search	Search Terms-Keyword and MeSH
#1	"Food Security" OR "Food Insecurity" OR "Food Supply"
#2	"Diabetes mellitus, Type 2" OR "Non-insulin dependent diabetes" OR "NIDDM" OR "Adult-onset Diabetes Mellitus" OR "Type 2 Diabetes"
#3	#1 AND #2
#4	"Patient Health Questionnaire" OR "Mass screening" OR "Medical Screening" OR "Patient Screening" OR "Screening" OR "Questionnaire"
#5	#1 AND #4

Inclusion and exclusion criteria.

Inclusion and exclusion criteria assisted in isolating and identifying relevant literature that addressed: (a) methods available to identify FI, and (b) how FI influences the management of DM 2. Inclusion and exclusion criteria are presented in Table 4.

Table 4

Inclusion and Exclusion Eligibility Criteria for the Selected Literature

Inclusion Criteria	Exclusion Criteria
The study was published in the last 10 years	The study addressed age-specific or cultural-specific populations
The study critically examined questionnaires, screening tools & surveys that identify FI	The study did not critically assess the FI screening method
Study examined the influence of FI on type 2 diabetes	The study examined the influence of FI on the development of DM 2
The study contained any definition or concept of food insecurity (including individual and household food insecurity)	The study exclusively focused on screening and identifying food insecure pediatric patients
Study was in English	Study was in a language other than English

Articles included in this review examined either one of the following: (a) the influence of FI on the management of DM 2 or (b) methods of identifying FI. Articles examining methods of identifying FI were not restricted to individuals with DM 2, since there was a paucity of literature noted during preliminary search strategies when terms were combined. Furthermore, there was a dearth of literature examining the identification of FI in primary care in Canada. Therefore, the search strategy was expanded to include all methods and environments where food insecurity was identified. Similarly, preliminary search strategies revealed that methods for identifying FI were varied and often contingent upon the study's specific interest in FI. For example, some studies examined food insecurity secondary to financial constraints using tools

only validated to identify the same. Therefore, all tools, methods, questionnaires and surveys were considered.

While some consensus on the definition of food insecurity has been established internationally (WHO, 2018), there is no established consensus in the literature and definitions remain quite varied. Subsequently, no limitations were placed on the basis of definitions used. Furthermore, part of the review aimed to conceptualize the definition of food insecurity in the context of DM 2, therefore a breadth of literature examining the relationship of FI and DM 2 was sought. No limitation was placed on age as DM 2 is almost exclusively adult-onset (Brasher, Jones & Huether, 2014b). For this reason, any study examining methods of identifying FI among pediatric populations were excluded. To avoid difficulty in generalizing and applying results to a Canadian context, articles discussing either DM 2 or FI within a specific cultural or social context were eliminated. The relationship between DM 2 and FI is complex (Essien et al., 2016), interacting at various levels of disease. In order to extract data pertaining to the influence of FI on the management of DM 2, articles examining the risk of developing DM 2 with FI were excluded.

Only articles published in English and within the last 10 years were included. Our understanding of DM 2 has significantly changed over the last 20 years (Defronzo, 2009). Subsequently, management strategies have also changed, especially over the last decade (Diabetes Canada, 2017b; Lipscombe et al., 2018). Literature was limited to reflect our current understanding and management of DM 2.

Secondary Search Strategies

The cumulative search returned a total of 532 articles following the exclusion of articles related to the date and language exclusion criteria. Following the removal of all duplicate

articles, a total of 411 remained. Next, each title and abstract were screened to determine their relevancy to the review, using the eligibility criteria from Table 4. This process yielded 55 articles that were eligible for full text review.

Several hand searches were completed. Firstly, Pubmed database was searched by observing “related searches” in the side bar. Next, the UNBC library general search database was searched using various combinations of the keywords from Tables 1 and 2. Lastly, google scholar was searched using the same method as with the UNBC library database. The cumulative hand search efforts yielded three more articles.

A review of the references of the remaining articles was completed to establish whether any relevant articles were missed in the database search. The reference search did not elicit any additional articles. The remaining 60 full articles were carefully examined using the full inclusion and exclusion criteria. Further, the references of review articles were screened to ensure that articles included in the full text review had not been previously included, evaluated and summarized in one of the extracted review articles. Fifteen articles in total were extracted for the literature review. Two search diagrams are presented in Appendix A. Combined, they represent the results of this literature search.

Data Evaluation and Analysis

A review matrix was used to assess and classify data from the final literature set of articles. An extensive appraisal of literature is required for a robust integrative literature review (Whitemore & Knalf, 2005). The Critical Appraisal Skills Programme (CASP) systematic review, case control, and qualitative study checklists were utilized to evaluate the quality of the literature (CASP, 2017). As there was no cross-sectional analysis checklist, the case control checklist was utilized in its stead to evaluate cross-sectional studies. Each article was evaluated

and assigned a quality rating using the guidelines and prompts provided by the CASP tools. The literature review matrix and ratings are found in Appendix B.

In order to guarantee bias is not introduced by the evaluator, data analysis requires both a synthesis of literature and systematic review (Whitemore & Knalf, 2005). The first step in Whitemore and Knalf's (2005) data analysis is data reduction. Data reduction was accomplished in this literature review by classifying the methodologies used in each article.

Details extracted from the literature review matrix were included under the headings: "aim", "study design and sampling", "methods and analysis" and "strengths and limitations". Findings particular to each study aim were displayed in a separate column of the review matrix titled "findings". Findings included in the matrix were: (a) how FI is defined in the context of DM2, (b) how FI influences the management of DM 2, and (c) methods used to identify FI. Whitemore and Knalf (2005) indicate that validating and drawing conclusions from condensed data sets can assist in interpreting findings. Data comparison, the final step of analysis, highlighted patterns within the literature. This was accomplished by creating an additional table, whereby all study findings were re-arranged into common themes and subthemes. The following chapter discusses the findings and data synthesis from the literature.

Chapter 4

Findings

Through a comprehensive search, nine articles were identified that addressed food insecurity (FI) in connection with Type 2 Diabetes (DM 2), and six were identified that addressed methods of identifying food insecurity. The final set of articles included: 5 reviews (3 systematic, 2 focused literature reviews), 1 combined systematic review with a qualitative study, 1 longitudinal observational study, 1 case control study, and 6 cross sectional studies.

This literature review sought to explore food insecurity with relevance to a Canadian context. As such, Canadian and countries of similar context were sought wherever possible. Thirteen percent of articles were conducted in Canada, 53% of the selected articles were conducted in the United States (US) and the remaining 34% were conducted in various other countries. Of the remaining 34%, all but one of these articles were reviews covering articles from multiple countries. Combined, the reviews extracted accounted for most of the literature available from Canada and the US. The methods, key findings, strengths, and limitations were extracted from each article and are displayed in the literature review matrix in Appendix B. The CASP tool was used and modified as necessary to assist in critiquing and appraising the content and quality of the selected articles. Four themes arose from the literature review highlighting how DM 2 is affected by FI, and how FI screening can be used to improve the management of DM 2. These themes were:

1. Underlying mechanisms between FI and the management of DM 2
2. Hierarchies of need and motivation
3. Strategies to identify FI
4. Clinical approaches

The research question was indirectly addressed by highlighting three underlying mechanisms of influence (food behaviors, medication use, mental health) and three established hierarchical needs (food consistency, social support, self-efficacy). The research question was directly answered by focusing on strategies that effectively identify food insecurity (selecting corresponding definitions, measurements, and tools), and discussing clinical approaches. The identified themes are discussed in the following sections.

Underlying Mechanisms of Influence

This review highlights that the influence of FI on the management of DM 2 is significant: There is a near independent effect of FI on diabetes control (Shalowitz et al., 2017), which occurs in an increasing dose-response manner (Ippolito et al., 2016). As a result, individuals are at a significant increased risk for both hyperglycemia, hypoglycemia and overall poor diabetes control (Essien et al., 2016). Ippolito et al (2016) found that hypoglycemic episodes are more frequent and severe with FI, and Shalowitz et al. (2017) found that glycemic control and A1C are more challenging to manage as the severity of FI increases. Understanding the mechanisms through which FI influences DM 2 is critical to its optimal management. Common underlying mechanisms arose from the literature regarding FI and its influence on the management of DM 2. These mechanisms include changes in food behaviors, medication adherence and mental health.

Changes in food behaviors.

The literature highlighted that DM 2 was more likely to be poorly controlled as a result of changes in food behaviors secondary to FI. Two separate studies attempted to examine food behavior changes amongst individuals with DM 2 experiencing FI (Bawadi et al., 2012; Essien et al., 2016). Essien et al., (2016) examined the influence of FI on DM 2 an extensive focused literature review. They defined FI as uncertain or limited access to adequate and safe amounts of

food" (Essien et al., 2016, p. 78). They found that when food affordability was the main driver for FI, food behavior changes may occur as a compensatory strategy. For example, individuals may frequently engage in binge-fast cycles coinciding with pay cycles, subsequently experiencing widely varied dysglycemia throughout the month (Essien et al., 2016). Hypoglycemic episodes occur more frequently when individuals fast in times of low income, but their medication regimens remain unchanged (Essien et al., 2016). Several studies examined by Essien et al. (2016) found that hypoglycemia occurred significantly more often individuals with income-associated FI (AIFI). In one study, Essien et al. (2016) found hospital visits secondary to hypoglycemic episodes increased by 27% at the end of the month amongst low-income individuals, compared to the first week of the month. Furthermore, hyperglycemic events also appeared to occur according to pay-cycles, resulting in food binging when it is available. The exact cause for binging remains unclear in the literature, but appears partly driven by FI-associated stress and anxiety and sudden availability of food following a fast (Essien et al., 2016). It is unclear whether binge-fast cycles occur in other FI groups who are financially secure.

Essien et al. (2016) also found overall poor dietary choices are associated with FI: Individuals with AIFI consumed more saturated fats, simple carbohydrates, highly processed foods and less fruits and vegetables contributing to overall inferior glycemic control (Essien et al., 2016). Most studies were cross-sectional designs; therefore, the relationship is associative. However, it is speculated that these changes in food behaviors occur in IAFI because they are cheaper and consumed more readily (Essien et al., 2016). Essien et al., (2016) do not describe the food behaviors of income secure-food insecure individuals. Distress associated with FI and interferes with the management of DM 2 (Essien et al., 2016). However, Essien et al., (2016) do not comment on whether poor self-management interferes with food behaviors.

While this focused literature review covered a substantial amount of material, the strength of the findings is limited by several factors: This literature review did not explain individual study strengths and limitations, therefore it is difficult to comment on the strength of the findings. Most studies were of cross-sectional or longitudinal design, meaning no cause and affect can be established, nor can the complex relationship between FI, food behaviors and DM 2 be further explained. Further, it is difficult to generalize the results because studies came from varying countries. Each nation's healthcare model, coverage, insurance and circumstance influence overall diabetes control. Lastly, these particular findings are limited to the IAFI subgroup. No conclusions can be drawn about food behaviors amongst income-secure individuals with DM 2 experiencing FI.

Bawadi et al. (2011) found similar results in their cross-sectional study examining the relationship of FI to glycemic control. Nearly 100% of individuals with severe FI engaged in compensatory food behaviors to avoid running out of food at the end of the month including meal skipping or cutting portion sizes, and that there was a corresponding worsening of glycemic control with increasing FI severity ([$p < 0.04$], Bawadi et al., 2011). The authors also found that worsening FI was associated with increasing difficulties in consuming a balanced meal: approximately 70% of individuals who identified as food insecure could not afford balanced meals (Bawadi et al., 2011). Additionally, increasing FI severity was associated with greater sugar intake, despite caloric intake remaining similar across food security groups (Bawadi et al., 2011). These findings suggest that the ratio of carbohydrates among FI groups is greater than food secure counterparts. This may account, in part, for worsening glycemic control. Interestingly, Bawadi et al., 2011 defined FI as "limited or uncertain availability of nutritionally adequate and safe foods in socially acceptable ways (p.250)." However, this study used the

HFSSM-sf questionnaire. While it is validated to use in multiple countries, it is only validated to measure AIFI. It is then, unclear, if the results were then intended to be generalized to all individuals experiencing FI. Irrespective of intent, the results of this study can be only applied to a subgroup of IAFI.

Unfortunately, several limitations exist: Most importantly, this study used cross sectional design, therefore the results are associative, not causational. Based on this study's parameters, no further understanding can be gleaned surrounding relationship between food behaviors, FI, and DM 2 management. Additionally, there was no power calculation. Power analyses are usually completed before a study begins, in order to establish the sample size required for the statistical analysis to reliably detect what it is aiming to measure (Sutherland, 2017b). Similar to other studies, the use of questionnaires is always subject to recall bias. It is also difficult to generalize the result from a Jordanian study as the healthcare system is a variable not controlled for across studies.

Changing food behaviors appears to occur primarily amongst individuals with IAFI, and can affect overall glycemic control and safety. Care should be taken to identify this subset population of FI individuals to ensure their unique risks are identified and mitigated. It is speculated that income influences the quantity, quality and temporal aspect of food consumption. Due to the nature of the studies, however, this relationship is not well understood and the research does not clarify how much less food is consumed, which specific foods and how frequently. Further the magnitude of impact of these food behaviors compared with FS counterparts is not well understood.

Hierarchy of eating patterns.

The compensatory food behaviors discussed by Essien et al., (2016) highlight a pattern of eating motivated by basic physiological needs rather than from a desire to manage DM 2. Consuming food to managing DM 2 appears to be superseded by the immediacy of insufficient access to consistent food (Essien et al., 2016). Essien et al. (2016) found that when consumption of food is uncertain due to finances, eating what is accessible, available and affordable appears to take precedence (Essien et al., 2016).

FI may also re-prioritize an individual's motivations for eating in other ways: When hypoglycemia occurs, Essien et al. (2016) found that individuals experiencing FI may be forced to eat whatever is available to them to correct hypoglycemia or to prevent hypoglycemic risks associated with their medications, instead of eating to maintain proper glycemic control. Subsequently, this may increase the risk of reactionary hyperglycemia, poorer glycemic control over time, and more prescriptions (Essien et al., 2016).

Clinical approach.

A literature review by Thomas, Fitzpatrick, Sidani, & Gucciardi (2018) examined the management of individuals with DM 2 experiencing FI and suggest several important clinical approaches: (1) each individual who screens positive for FI be assessed for hypoglycemia risk and occurrence; (2) nutrition recommendations be individualized to respect the individual's capacity to manage a diabetic diet; (3) information on low-cost, but effective methods of treating hypoglycemia be provided; and (4) referrals to dietitians and social workers be considered as they may play a supportive role in managing FI (Thomas et al., 2018).

Thomas et al. (2018) recommend connecting identified patients with low cost food options within the community, including known local community food banks, kitchens, and low-

cost grocery stores. Depending on jurisdictions, application for Special Diet Allowance funding may be appropriate (Thomas et al., 2018). Unfortunately, this systematic review had several limitations: Firstly, the authors did not discuss their critical appraisal of the evidence, what level of evidence informed each recommendation, how the findings were synthesized and whether they were based on one or more studies. Therefore, the strength and level of evidence of the recommendations are unclear. Additionally, Thomas et al., (2018) defined FI as "inadequate access to food because of financial constraints (p.258)", but it is unclear whether the studies included in the systematic review measured and identified FI similarly. Lastly, if Thomas et al., (2018) restricted their studies to IAFI, then it is challenging to generalize these recommendations to the general population experiencing FI.

In support of these findings, the review by Essien et al. (2016) found that dietary quality and A1C levels improved with healthy supplemental food assistance programs (SNAP) and self-management education support programs both improve glycemic control amongst individuals with IAFI. These findings are limited by a lack of qualifying information describing the nature of the SNAP program (i.e. which foods) and which self-management education strategies result in glycemic improvements. These results are also limited to the subset population of individuals experiencing IAFI.

In contrast, Ippolito et al. (2016) examined the association between food security (FS) and diabetes self-management in individuals already accessing food pantries. Their findings suggest that food pantries and banks alone do not appear to mitigate food insecurity or its effect on the management of DM 2. Only 16% of individuals accessing the food bank self-rated as food secure, while the majority, 42%, continued to report very low food security (Ippolito et al., 2017). Further, compared to the food secure group, the very low food secure group continued to

report greater diabetes distress ($p < 0.001$), decreased diabetes self-efficacy ($p < 0.001$), medication adherence ($p < 0.001$), severe hypoglycemic episodes ($p < 0.001$; OR 2.63), and depressive symptoms ($p < 0.001$; OR 4.56], Ippolito et al., 2016). These findings suggest that access to food banks and food supply alone is insufficient in mitigating FI. The results of this study demonstrated strong statistical significance, and odds ratios demonstrates strong clinical significance. Similar to other studies, these results were limited by cross-sectional design, and the levels of food insecurity (food secure, low food secure and very low food secure) were decided by convention.

Changes in mental health.

While depression is common among chronic diseases, this review of the literature suggests that rates of distress and depression are elevated and are further compounded by chronic FI (Essien et al., 2016; Ippolito et al., 2016). These changes in mental health influence the management of DM 2 (Essien et al., 2016; Walker et al., 2018): In a cross-sectional study, Walker, Williams and Egede, (2018) examined direct and indirect pathways through which FI influences diabetes self care behaviors and glycemic control. Diabetic self-care behaviors were defined as healthy eating, exercising, self-monitoring of blood glucose and foot checks and glycemic control was measured by A1C levels (Walker et al., 2018). They found FI that is significantly associated with stress ($p <0.001$) and increased A1C levels ($p< 0.03$). Further the higher participants perceived their level of stress, the poorer their capacity to engage in self-care behaviours ($p < 0.001$). This study did not demonstrate statistically significant worsening of A1C from poorer self-care behaviors (Walker et al., 2018). However, poor self-care behaviors do not have immediate effects on glycemic control or diabetic complications, therefore this relationship may be difficult to capture in cross-sectional design. Similar findings were found by Essien et al.,

(2016) in their systematic review. One study in Essien's review found that depressive symptoms were associated with lower self-efficacy leading to poorer glycemic control. It is speculated that the superimposed stress of diabetes on FI creates feelings of powerlessness (Essien et al., 2016). Self-efficacy is not defined; therefore, it is challenging to understand how mental health specifically influence diabetes management in individuals with FI.

In another cross-sectional study, Montgomery, Lu, Ratliff and Mezuk (2017) found that a dose-response relationship exists between FI and depression ($p > 0.001$) Mild FI is associated with 2.5-fold increase in mild depression and severe FI with a 3.5-fold increase in depression (Montgomery et al., 2017). Unfortunately, this study does not draw connections between depression and to diabetes control, therefore its clinical significant to diabetes management remain unclear.

Hierarchy of social need.

Social support emerged as a requisite need amongst individuals with DM 2 experiencing FI. Kollannoor-Samuel et al., (2011) found increased depressive symptoms were associated with an increased perceived interference of FI on the management of DM 2 ($p <0.001$), and increased diabetes-related clinical symptoms ($p <0.001$). Social support, however, mitigated depressive symptoms ($p <0.01$). Social support was defined by Kollannoor-Samuel et al., (2011) as the participants' perceptions of consistent support when needed from friends and family, and was captured using validated 11-item questionnaire called the Multi-Dimensional Diabetes Questionnaire. FI was defined as "limited access, availability, or intake of nutritionally adequate foods" (Kollannoor-Samuel et al., 2011, p. 986). In their study, Kollannoor-Samuel et al., (2011) found consistent informal support from friends and family provided a buffering effect against depression and distress amongst individuals with FI. An inverse relationship between social

support and depression levels were noted (Kollannoor-Samuel et al., 2011). Further, as FI intensified, the influence of social support on depression was more profound (Kollannoor-Samuel et al., 2011). These results suggest that social support is an important buffer amongst the most food insecure individuals. An important strength to the findings was that a post-hoc alpha Cronbach demonstrated internal consistency and reliability of the surveys used. Important limitations to this study were its cross-sectional design, and an inability to control for underlying genetic predispositions for depression. Further, perceived social support is limited by recall bias and a limited generalizability of study findings because the study population consisted of mostly Puerto Rican female participants. Further, there was no power calculation, therefore it is difficult to ascertain if the study was sufficiently powered to demonstrate small variations for its sample size. Importantly, Kollanoor-Samuel et al., (2011) used the short-form Household Food Security Supplement Module (HFSSM-sf) as a FI screening tool. This tool is validated only to capture income-associated FI (IAFI), therefore these findings are limited to this subset population of FI individuals.

Walker et al. (2018) also found social support mitigated the effects of stress and depression on DM 2 amongst individuals with FI. In this study, Walker et al. (2018) defined FI as an "inability or limitation to accessing nutritionally adequate foods, or a dependence on emergency food supplies (p.3237)". Walker et al. (2018) examined the pathways through which FI influences glycemic control in individuals with DM 2, and found that FI is *directly* related to an increased glycated hemoglobin (Hb A1C) through increased stress. Further, Walker et al. (2018) found FI is *indirectly* related to an increased Hb A1C through poor self-care behaviors driven by stress and low social support. Social support appeared to mitigate these pathways ($p < 0.001$). Social support was defined as positive social interaction using a 3-item survey, and

included (1) when individuals could identify others with whom they could have a good time with, (2) with whom they could get together regularly and (3) with whom they could relax or do something enjoyable (Walker et al., 2018). Individuals scoring lower on this social interaction scale experienced a significantly higher level of stress directly interfering with diabetes management ([$p < 0.001$]; Walker et al., 2018). These findings suggest that facilitating social support can improve glycemic control in individuals with FI by increasing an individual's capacity to engage in diabetes self-care behaviors and by directly lowering stress levels.

The results by Walker et al., (2018) are more reliable. A calculated power indicates that the sample size was large enough to accurately capture the associations between FI, stress, and DM 2 management. The results of the findings were highly statistically significant (0.05-0.0001) within narrow confidence intervals. Further, well-validated questionnaires were used. Similar to Kollanoor-Samuel et al., (2011), the results are limited by cross-sectional design, the use of self-report questionnaires and are subject to recall bias.

Overall, both studies highlight how addressing nutrition choices alone in individuals with DM 2 experiencing FI is insufficient strategy and requires a multi-prong approach, considerate of strategies that mitigate stress and depression. The findings suggest social support as a requisite to well-controlled diabetes amongst individuals with DM 2 experiencing FI.

Clinical approach.

Walker et al., (2018) and Thomas et al. (2018) concluded that the benefits of social support should be considered in addition to dietary strategies when managing individuals with DM 2 who are food insecure. According to Walker et al., (2018) and Kollanoor-Samuel et al., (2011) even promoting informal social support amongst individuals with DM 2 experiencing FI may decrease an individual's overall risk of depression and therefore improve the individual's

capacity to perform diabetes self-care behaviours. Thomas et al. (2018), suggest that all individuals with FI should be assessed for social support, and that family members should be encouraged, wherever possible, to be included in education and management as a means of both social and logistical support. It is unclear what evidence informs this recommendation.

Lastly, income-associated (IAFI) or financially-driven FI is common in developed countries (Essien et al. 2016). Kollannoor-Samuel et al., (2011) highlighted that individuals with DM 2 with lower household income were especially vulnerable to increased rates of depression, in particular, because limited income impairs an individual's capacity to manage stress ($p < 0.03$). Individuals experiencing IAFI may be additionally vulnerable to the effects of stress and depression, since they may be juggling the cost of basic needs such as rent, electricity, and clothing on top of food (Kollannoor-Samuel et al., 2011). Identifying when finances are at the core of FI may be necessary to address additional barriers this population may be facing, and consider social work involvement, recommended by Thomas et al., (2018).

Changes in medication use.

FI appears to interfere with changes in overall medication use and safety. Several studies noted that medication underuse was significantly more likely to occur IAFI (Essien et al., 2016; Ippolito et al., 2016). "Food-medicine-health-supply trade-offs" (FMS trade-off) is a phenomenon that occurs when people have less money, and results in having to choose between purchasing food, medicine or health supplies, because the individual cannot not afford all three (Ippolito et al., 2016). In their study examining FI and diabetes self-management in individuals accessing food pantries, Ippolito et al. (2016) found that FMS trade offs were almost 7 times times more likely to occur in the very low food secure group, and medication affordability 4 times more likely compared with the more food secure group of individuals with DM 2 accessing

food banks ($p < 0.001$). The focused literature review by Essien et al. (2016) revealed similar findings: some included studies reported up to half of their participants with IAFI either stretched out medication prescriptions, delayed filling prescriptions or did not use the medications at all (Essien et al., 2016). Other studies in their review reported that individuals with FI were six times more likely to stretch out their medication prescriptions (Essien et al, 2016). Caution, however, must also be taken when comparing medication and supply affordability in comparison with American studies. For example, glucose monitors are free when tests strips are purchased in Canada, and test strips are part of Fair Pharmacare; meaning, low income patients will either have the majority or all of their strips covered based on their diabetic medication regimen (Government of British Columbia, 2018b). A select list of medications, previously discussed, is also covered under Fair Pharmacare for individuals with low income once deductibles are met (Government of British Columbia, 2018c).

Interestingly, in a cross-sectional study examining whether food insecurity is independently associated with delays in filling prescriptions, Bilimek and Sorkin (2012) found individuals with FI are two times more likely delay or not to fill their prescriptions even when all other variables are adjusted for ($p <0.01$). FI was defined as "limited or uncertain access to food due to inadequate financial resources (Bilimek and Sorkin, 2012, p.2160). However, the cause medication adherence issues without a financial drive remain unknown and are limited by study design. One important limitation to this study is that assume individuals below poverty line are only classified with IAFI, and does consider other populations of IAFI. The study also does not perform a power analysis to ensure enough participants were recruited to power the findings. Lastly, even though multivariable logistic regression analysis shows, medication adherence

issues is statistically significant for reasons other than finances, this has yet to be demonstrated as a primary outcome among all individuals with FI.

In contrast, Shalowitz et al. (2017), sought to determine whether FI is associated with poor glucose control over time, and found that insulin use increases over time ($p < 0.010$). The authors comment that insulin use and its initiation, however, is associated with and is a predictor of increasing A1C over time (Shalowitz et al., 2017). Therefore, increased insulin use in individuals with FI is a consequence of dysglycemia, rather than a demonstration of medication adherence (Shalowitz et al., 2017). Longitudinal study design does not prove causality of findings the findings. Further no power analysis was performed. Irrespective of reason, increased use of insulin over time, brings into question medication adherence amongst FI populations.

An important finding that emerged from the literature review by Essien et al., (2016): In considering changes to food behaviors, a significant risk of medication-glycemia mismatch exists when: (1) food becomes scarce but medication regimens remain unchanged, or (2) food consumption is maintained at the expense of discontinuing medications (Essien et al., 2016). A high risk of hypoglycemia can also contribute when the provider does not understand food consumption behaviors These findings highlight important safety concerns and the importance of addressing medication regimens and adherence in the presence of FI.

Clinical approach.

Thomas et al., (2018) suggest the following pharmacological approach of individuals with DM 2 experiencing FI. Firstly, understand a client's medication coverage, and then consider replacing antihyperglycemics with the greatest risk of hypoglycemia with safer alternatives (Thomas et al., 2018). If taking insulin, consider a regimen that is more flexible (Thomas et al., 2018). Further, consider scheduling medications with meals wherever appropriate, and

withholding when there is no food intake (Thomas et al., 2018). Lastly, Thomas et al. (2018) suggest that less stringent glycemic targets should be considered. Unfortunately, a lacking critical analysis of the evidence limits the strength of these findings.

Reduced self-efficacy.

Within the literature a theme emerged related to FI and an overall decreased self-efficacy. Ippolito et al., (2016) define self-efficacy as an individual's belief in his or her own capacity to manage his or her diabetes. Self-efficacy is a key aspect in chronic disease self-management (Essien et al., 2016; Ippolito et al., 2016). Decreased self-efficacy impairs self-management behaviors such as following a diet, resulting in inferior diabetes control (Essien et al., 2016). In their cross-sectional design examining the association between FI and diabetes self-management, Ippolito et al., (2016) used an eight-item instrument validated to measure self-efficacy and used Likert scale to establish mean result for each subset group of food security: Food secure, low food secure and very low food secure (Ippolito et all., 2016). Lower self-efficacy scores are usually correlate with worse A1C scores (Ippolito et all., 2016). This study found overall decreased self-efficacy interfered with diabetes self-management, on average, 36% more often in severe FI individuals, relative to food secure participants ($p < 0.001$). This, however, did not translate into inferior A1C control and the underlying mechanism is unclear due to the nature of cross-sectional studies. Further, it is unclear how self-management behaviors are affected.

These trends in self-care behaviors were also noted by Gucciardi et al., (2009), who found that FI was associated with decreased self-efficacy and individuals were more likely to be physically inactive, be overweight, eat less fruits and vegetables, be twice as likely to be a smoker, be twice as likely to report stress, and report lower general health, mental health and perceived stress. Essien et al. (2016) offer one mechanism through which self-efficacy may be

impaired: competing demands between food and managing DM 2 may precipitate chronic stress, distress, and depression contributing to a reduced mental capacity, and elicit feelings of powerlessness that diminish one's self-efficacy (Essien et al., 2016). Self-efficacy is not defined by Essien et al. (2016), affecting the clarity of findings.

Clinical approach.

Evidence is limited in providing strategies to improve self-efficacy; however, it appears that if depression, distress and stress are mechanisms through which self-efficacy is hampered (Essien et al., 2016), then social support as described by (Kollannoor-Samuel et al., 2011) may be one clinical approach to improve self-efficacy. Caution must be taken in these recommendations due to a lack of supporting evidence.

Screening for Food Insecurity

The findings from this literature suggest screening for FI can be successfully implemented in the healthcare setting. Studies demonstrated most patients and care providers involved in the FI screening felt the healthcare setting was both beneficial and appropriate (De Marchis et al., 2019; Thomas et al. 2018). In a systematic review examining the validity and acceptability of food insecurity (FI) screening tools and their implementation in health care settings, De Marchis et al. (2019) found that between 66-88% of patients screened for FI found it appropriate to be asked about FI in the healthcare setting. De Marchis et al. (2019) also found that between 80-89% of HCP felt FI screening was appropriate during healthcare visits. The strength of these findings were limited by low quality to very-low quality findings from two qualitive and four cross sectional studies (De Marchis et al., 2019). The generalizability of the findings are limited to income-associated food insecurity (IAFI), because all FI screening tools were validated against the United States Department of Agriculture Food Security Scale (USDA-

FSS) which is only validated to measure. Lastly, generalizability was also limited by inclusion of some pediatric studies in the systematic review.

The findings by De Marchis et al., (2019) were also in keeping with the results from a pilot project from Thomas et al. (2018), who examined the acceptability and feasibility of an implemented FI screening in healthcare using a qualitative pilot project based in a Toronto healthcare setting. Thomas et al. (2018) found 71% of participants were comfortable discussing their personal experiences of FI with their healthcare providers (HCPs). The HCPs found FI screening helpful in guiding care and support for patients. Further, the HCPs reported that FI screening brought meaning and understanding as to why patients may not follow diabetes management recommendations, how it impacts their ability to self-manage their diabetes and how they cope with FI (Thomas et al., 2018). Both the HCPs and patients found FI screening both relevant and non-intrusive in the healthcare setting. None of the patients reported negative experiences (Thomas, et al, 2018). In fact, strong rapport with their provider increased the likelihood of engaging in FI screening (Thomas et al., 2018).

Important caveats exist: De Marchis et al., (2019) found time required to complete FI screening tools was between 30 seconds to 10 minutes. Four out of 10 studies reported time as a barrier to FI screening (De Marchis et al., 2019). It is unclear whether an optimal screening time, or threshold existed. It should also be noted that not everyone who screens positive for FI wants care provider assistance, therefore judicious use of screening should be considered.

Clinical approach.

The literature review did not support one preferred method of identifying food insecurity. Instead, strategies emerged that focus on context-specific, individualized approaches to identifying FI. This strategy includes: (1) selecting a well-defined, context-specific definition of

food insecurity useful to the specific purpose, which (2) highlights the attributes of FI intended on being measured and studied, and lastly, (3) selecting a corresponding tool that measures these attributes.

Selecting a definition of food insecurity (FI).

A context specific definition was preferred over a comprehensive and universal definition of FI for two reasons: (1) A diversity of FI determinants or attributes exist unique to each circumstance, and (2) very few attributes are antecedents. These findings are corroborated by Jones et al. (2013). Their systematic review of the literature attempted to conceptualize a universal and comprehensive definition food (in)security and found that a universally acceptable definition of FI unlikely to be appropriate and applicable in all circumstances (Jones et al., 2013).

Lack of antecedents.

FI is not universally defined in the literature: Twelve out of fifteen articles provided a definition of food insecurity. Of the twelve definitions, seven different variations emerged and only two antecedents. The two antecedents included: (1) uncertain or inconsistent access, and (2) an inadequate amount of food (Bawadi et al., 2012; Billimek & Sorkin, 2012; De Marchis et al., 2019; Essien et al., 2016; Gucciardi et al., 2009; Ippolito et al., 2016; Jones, Ngure, Pelto, & Young, 2013; Kollannoor-Samuel et al., 2011; Makelarski, Abramsohn, Benjamin, Du, & Lindau, 2017; Montgomery et al., 2017; Shalowitz et al., 2017; Walker et al., 2018).

One antecedent emerged with respect to FI and DM 2: universal acknowledgement that FI interferes with proper diabetes management and control (Bawadi et al., 2012; Billimek & Sorkin, 2012; Essien et al., 2016; Gucciardi et al., 2009; Ippolito et al., 2016; Kollannoor-Samuel et al., 2011; Montgomery et al., 2017; Shalowitz et al., 2017; Walker et al., 2018). A final compilation of antecedents, “uncertain access to sufficient amounts of food which interferes with

diabetes management", has several limitations: (1) The terms "food", "access", and "inadequate amounts" are not adequately explored or explained (Jones et al., 2013), which limits applicability of results. More specifically, what foods are specifically limited in access and in which amounts? None of the literature explored these concepts in detail. Essien et al., (2016) discussed some changes to food group choices such as fruits and vegetables, as well as changes to food behaviors; however, these are non-specific. (2) How FI interferes with diabetes management is multifactorial, and specific to the factors causing FI. For example, income-associated FI (AIFI) is specifically associated with binge-fast cycles resulting in dysglycemia, but this trend has not been explored amongst the general FI population. Lastly, (3) based on this review, the literature suggests that diabetes management is also influenced by FI in several indirect ways including depression, distress, diminished self-efficacy and medication behaviors. These also have not been explored in the literature in ways that allows for sufficient understanding and concise definition. Study design is a significant limiting factor to understanding the complex relationship and details required to be capable of defining these terms.

Diversity of attributes.

Several FI attributes emerged from the literature review, but were not universal antecedents. Instead, these attributes were relevant and specific to the study to which it applied. Attributes (or determinants) are features inherent to, or associated with FI (Jones et al., 2013). Attributes differ from antecedents in that they do not need to be universal in all cases of FI. These determinants included: (1) lack of access to nutritionally appropriate food (Bawadi et al., 2012; Gucciardi et al., 2009; Jones et al., 2013; Kollannoor-Samuel et al., 2011; Montgomery et al., 2017; Shalowitz et al., 2017; Walker et al., 2018); (2) lack of access to safe foods (Bawadi et al., 2012; Essien et al., 2016; Gucciardi et al., 2009; Makelarski et al., 2017; Montgomery et al.,

2017; Shalowitz et al., 2017); (3) access to food in socially acceptable ways (Bawadi et al., 2012; Jones et al., 2013); (4) FI secondary to financial constraints (Billimek & Sorkin, 2012; De Marchis et al., 2019a; Ippolito et al., 2016; Jones et al., 2013; Shalowitz et al., 2017); and (5) having insufficient food to meet dietary needs to maintain a healthy and active life (Gucciardi et al., 2009). Similar to the antecedents, efforts to understand and adequately define these attributes are not found in the literature.

Context-specific approach.

Jones et al. (2013) suggest an individualized approach to FI definitions focused on pertinent attributes that can be defined by the clinic or provider, and managed by a particular program, clinic, or individual's resources (Jones et al., 2013). Jones et al. (2013) suggest disassembling the definition of FI into smaller, more manageable concepts. For example, income-associated FI (IAFI) or FI secondary to financial constraints occurs very frequently, but does not occur in all cases of food insecurity (De Marchis et al., 2019; Ippolito et al., 2016; Jones et al., 2013; Shalowitz et al., 2017). Identifying IAFI is important because there are several IAFI-specific diabetic consequences that can arise (Essien et al., 2016). Medication underuse, for example, appears to be a problem primarily among individuals with IAFI (Essien et al., 2016). Using a context-specific definition focused on particular attributes of interest helps identify specific issues related to FI (Jones et al., 2013). Further, using a context-specific definition for FI assists in selecting an appropriate FI screening tool: Marques et al., (2015) and Jones et al. (2013) found screening tools are validated to identify and measure specific attributes of FI, rather than FI as comprehensive concept. For example, several tools exist that are specifically validated only to identify IAFI (Marques et al., 2015). Defining FI as secondary to financial constraints (IAFI) points to which screening tools are more appropriate for selection.

Selecting attributes and screening tools.

According to Jones et al. (2013), definitions, attributes, and screening tools should all align in order adequately and accurately capture what is intended on being measured. The literature highlighted significant limitations to this process: In their systematic review examining 24 different FI tools from 184 different articles, Marques et al., (2015) found all included screening tools measured income-associated FI (IAFI) and that most key attributes of FI remain unanalyzed in the literature (75% of evidence rated positive or neutral). Similarly, another systematic review by Ashby et al., (2016) examined the attributes of eight different FI screening tools used in developed countries and found physical and economic access to food were only measured (Ashby et al., 2016).

Few tools attempt to measure other attributes of FI (Marques et al., 2015): The Radimer/Cornell tool attempts to measure food utilization, and enquires about anxiety secondary to required assistance in preparing food (Ashby et al., 2016). The Kuyper tool attempted to measure food stability or insecurity over time (Ashby et al., 2016), and only one tool attempted to measure both household level FI, and individual level FI (Ashby et al., 2016). A final systematic review by Jones et al., (2013) examined the attributes of 17 different FI screening tools (evidence rated low) and also found most attributes of FI were not captured in screening tools. Jones et al. (2013) also found food measures are not always clear about what attributes they are measuring, nor are the attributes consistently defined. For example, access to food can be further broken down to access, acquisition, consumption (Jones et a., 2013). However, this is often not well articulated in screening tools. It could be speculated that the lack of clarity surrounding attributes in screening tools may be, in part, a consequence of the lack of clarity surrounding FI definitions and concepts.

Another limitation to FI screening is that most tools have not been significantly analyzed (Marques et al., 2015). Marques et al. (2015) found the Core Food Security Measurement/Household Food Security Survey Module (CFSM/HFSSM) is one of the few FI screening tools significantly analyzed in literature, while the Self-Perceived Household Food Security Scale (SPHFSS) and the short-form HFSSM (HFSSM-6SF) have been moderately analyzed in the literature. The CFSM/HFSSM and HFSSM-6SF have been studied and validated in many countries worldwide (Marques et al., 2016). Half of the other tools examined by Marques et al. (2015) had only been tested or studied in the literature one or two times (Marques et al., 20165).

In general, several challenges remain in accurately capturing individuals with FI in practice: screening questionnaires will always be subject to a response or recall bias (Jones et al., 2013). Well-validated tools such as the Household Food Security Survey Module (HFSSM) and its short form have an internal consistency of 0.82-0.94 and have found to be valid and reliable (Marques et al., 2014); however, few screening tools have been so well analyzed. It remains a challenge that the only tools well analyzed only measure IAFI. Validating non-IAFI screening tools can also be challenging when they are so diverse in what they measure (Jones et al., 2013). FI cut-offs are also not standardized, with some studies establishing levels of FI by convention (Ippolito et al., 2016). Additionally, an important trade-off to consider when selecting FI tools is whether to use comprehensive versus short form (1 or 2 question) tools in the setting of time constraints. Comprehensibility and contextual detail need to be weighed against simplicity and comparability (Jones et al., 2013). Thus, it remains a challenge to ensure true capture of the FI population representative of what is intended on being identified. Based on these systematic reviews, there are no comprehensive tools identifying all attributes or domains of FI (Ashby et

al., 2016; Jones et al., 2013). While an individualized approach is certainly preferred (Jones et al., 2013), these findings suggest that selecting attributes of interest are significantly limited by a lack of diverse, well-analyzed, validated screening tools.

Chapter 5

Discussion

Through this integrative review, several themes were elicited that highlighted the mechanisms of influence through which FI impacts the management of DM 2. These included changes in food behaviors, mental health and medication use. Strategies to identify food insecurity were presented. Collectively, the findings addressed the integrative review question: "What strategies can NPs employ to identify FI and enhance the management of DM 2 in the primary care setting among adults experiencing dysglycemia?"

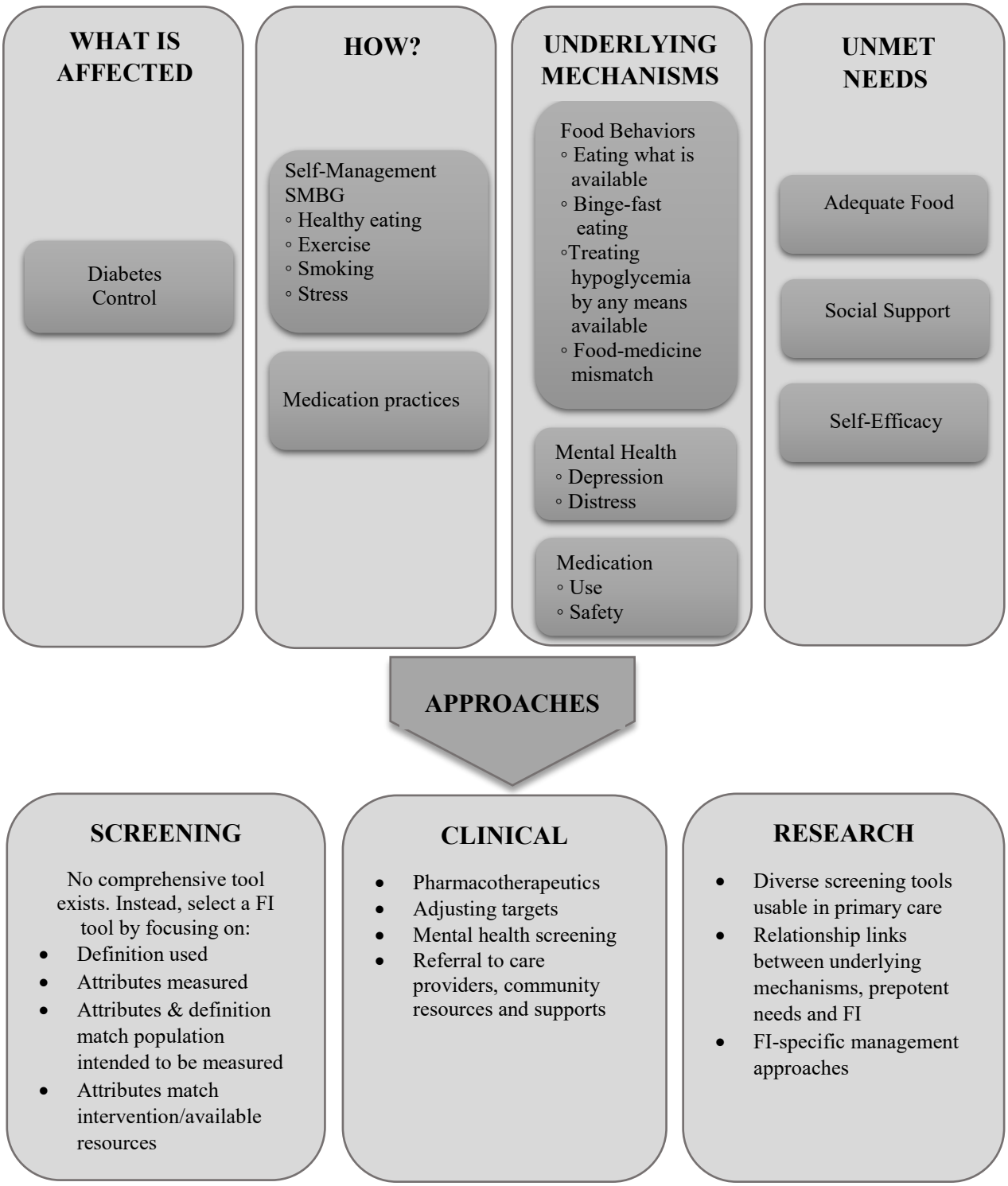
The literature highlighted unique motivations for behavior and hierarchies of need which appeared to take precedence in the lives of individuals with DM 2 experiencing FI. Such mechanisms of influence also reflect the chief tenets of the MTM. As discussed, MTM suggests that needs occur in a hierarchical, but not mutually exclusive, manner (Maslow, 1943), and that humans are motivated by a desire to satisfy these needs (Maslow, 1943, p. 394). Further, real or perceived threats to the security of these needs can generate either emergency or compensatory reactions in behavior (Maslow, 1943, p. 394).

In MTM, food is one of the most basic physiological human needs (Maslow, 1943), which provides further insight into why individuals with FI struggle with higher-level needs, such as self-management. MTM may highlight perspectives on how NPs can provide realistic, FI-informed strategies that can enhance the management of DM 2. Lastly, MTM may highlight the enhanced value of individualized, FI-informed management strategies when patients are significantly limited in their capacity to self-manage their DM 2.

The findings from the literature review are discussed in the following section, drawing connections to the significance for NPs in the PC setting. Included in the discussion are

recommendations for NP clinical practice, followed by a discussion of the limitations and future research recommendations. A diagram highlighting the review findings is presented below.

*Diagram II: The impact of FI on DM 2 and strategies to improve management***.**



Theme One: Mechanisms of Influence

Amongst the literature there is a dearth of evidence directly informing the management of DM 2 amongst individuals who are FI (Thomas et al, 2018). Findings from the literature set predominantly examined the underlying mechanisms through which FI influences the management of DM 2, and recommendations for practice were drawn from these findings. These mechanisms are discussed in detail in the following sections.

Changes in food behaviors.

The literature highlighted that DM 2 was more likely to be poorly controlled as a result of poor food behaviors secondary to FI (Bawadi et al., 2012; Essien et al., 2016). Specifically, affordability was a major driver to changes in food behavior and often were compensatory in nature (Essien et al., 2016). Individuals were found to binge and fast (Essien et al., 2016), cut meal sizes, and skip meals (Bawadi et al., 2012) according to pay cycles, subsequently placing them at increased risk for dysglycemia (Essien et al., 2016). In particular, a review highlighted a significant increase in hypoglycemia risk, and occurrence and severity secondary to decreased consumption of food while maintaining the same medication regimens (Essien et al., 2016).

Food behaviors also appeared to influence dietary choices. Individuals with FI appeared to consume more saturated fats, simple carbohydrates, highly processed foods and less fruits and vegetables, possibly linking food behaviors to overall inferior glycemic control. While the relationship is associative, several authors within an examined review speculate that these foods are cheaper and easier to access, therefore are consumed more readily (Bawadi et al., 2012; Essien et al., 2016).

Several important clinical approaches were suggested in the literature, including assessing for hypoglycemia risk and occurrence amongst individuals with FI; individualizing

nutrition recommendations based on the individual's resources and abilities; providing information on low-cost, but effective methods of treating hypoglycemia; and considering referrals to dietitians and social workers for additional support (Thomas et al., 2018). Additionally, connecting identified patients with low cost food options within the community has been recommend (Thomas et al., 2018). In particular, healthy supplemental food assistance programs paired with self-management support demonstrates evidence for improved dietary quality and A1C levels (Essien et al., 2016).

Importantly, increasing access to food may not be a sufficient strategy alone in managing FI. Studies examining individuals with DM 2 accessing food banks found the majority of individuals still identified as food insecure and reported most, if not all, issues highlighted in this integrative review, including diabetes distress, decreased diabetes self-efficacy, medication adherence, severe hypoglycemic episodes, medication affordability issues, medicine-supply-trade-offs, and depressive symptoms (Ippolito et al., 2016). It remains unclear whether these findings reflect the inadequacy of this particular food bank in providing sufficient food, in providing diabetic-friendly options, or whether access to food is insufficient in ameliorating FI amongst individuals with DM 2.

Recommendations for Practice.

These findings suggest that a multi-faceted approach is necessary in food behaviors amongst individuals with DM 2. Primary care providers should consider their familiarity with resources in the community, including food banks and low-cost food stores, and determine whether supplemental funding exists in their jurisdiction, especially for individuals experiencing IAFI. Thomas et al. (2018) found that establishing a list of community resources was useful in

the implementation of FI screening and management in diabetes clinics, and helped increase access to meaningful resources.

PCPs should also routinely assess for hypoglycemia risk and occurrence, and consider pharmacological strategies to prevent this from occurring[4]. The literature does not suggest a frequency for assessment, but the Canadian Diabetes Guidelines (CDG) do suggest assessing for hypoglycemia amongst all individuals every visit (Yale, Paty, & Senior, 2018).

There are no recommendations or suggestions in the literature regarding individualized nutritional strategies. PCPs may consider co-management of an individualized dietary strategy with social work and dieticians. When individualizing a nutritional strategy, consideration should be taken in relation to the patient's food resources and also the individual's level of agency and self-efficacy. The CDG suggests self-management support (SMS) strategies as they focus directly on building a trusting and collaborative relationship, with consideration of the individual's abilities and capacity (Sherifali, Berard, Gucciardi, MacDonald, & MacNeill, 2018). It remains unclear, however, how SMS may be used for individuals with FI who experience a decreased capacity for self-management (Essien et al., 2016). Future studies should examine how PCPs may motivate and partner with individuals with FI who face difficulties with food consumption, self-management and self-efficacy.

Changes in mental health.

Studies found that rates of distress and depression are elevated by chronic FI (Essien et al., 2016; Ippolito et al., 2016) and influence the management of DM 2 (Essien et al., 2016; Montgomery et al., 2017; Walker et al., 2018). Stress directly interferes with an individual's ability to perform self-care behaviours such as healthy eating, exercising, self-monitoring of

[4] See discussion section on medication use

blood glucose and foot checks, subsequently resulting in worsening A1C levels (Ippolito et al., 2016). The results from the integrative review suggest a close relationship between FI, mental health and an individual's capacity to self-manage their diabetes, although the exact mechanism remains unclear.

Some studies highlighted that individuals with DM 2 and lower household income are especially vulnerable to increased rates of depression, in particular, because limited income impairs an individual's capacity to manage stress. Therefore, individuals experiencing income-associated FI (IAFI) may be additionally vulnerable to the effects of stress and depression. Identifying when finances are at the core of FI may be necessary to address additional barriers this population may be facing, such as the cost of rent, electricity, and clothing on top of food (Kollannoor-Samuel et al., 2011).

Strategies in addressing mental health amongst individuals with DM 2 experiencing FI is limited amongst the studies. Thomas et al. (2018) recommend assessing the mental health status of individuals experiencing FI and considering social work referrals, although the literature does not provide any specific strategies.

Recommendations for practice.

Identifying mental health concerns such as depression and distress amongst individuals with DM 2 is recommended by the CDG (Robinson et al., 2018). The CDG provide recommendations as outlined below.

Identifying diabetes distress and major depression.

The CDG recommends screening for mental health in individuals with diabetes throughout the lifespan (Robinson et al., 2018). There is no preferred screening tool in measuring depression or distress, although it is important to distinguish between them (Robinson et al.,

2018). All tools recommended by the CDG for measuring depression and distress are roughly equivocal in terms of sensitivity and specificity in the diabetic population (Robinson et al., 2018). In particular, the Diabetes Distress Scale (DDS) can be used to identify individuals with DM 2 at risk for, or experiencing, distress and a PHQ-9 can be used to identify individuals at risk of, or experiencing symptoms of, a major depressive disorder (Robinson et al., 2018). Both scales can assist in differentiating between distress and depression, as well as provide guidance in practice (Robinson et al., 2018). There are no recommendations for the frequency of screening in the literature review, nor are there recommendations in the guidelines. Future research should examine whether similar strategies for identifying depression and distress are equally as affective amongst individuals experiencing depression and distress secondary to FI.

Interventions for diabetes distress and major depression

The CDG recommends several non-pharmacological strategies that PCPs can incorporate into practice that have evidence for improved mental health and diabetes control (Robinson et al., 2018). This includes one-on-one individualized therapeutic strategies, cognitive behavioral therapy, motivational interviewing, family interventions, increasing self-management and coping skills, improving self-efficacy and stress management (Robinson et al., 2018). Further, there is some evidence for the use of pharmacotherapy in treating depression amongst individuals with DM 2, although caution must be weighed against the risk of glucose dysregulation. While evidence exists for mental health interventions amongst the general DM 2 population, the literature review found insufficient evidence promoting any specific therapeutic interventions to ameliorate depression and distress secondary to FI in the DM 2 population. Future studies should examine the efficacy of the interventions endorsed by the CDG in improving distress and depression amongst individuals who are FI.

Changes in medication use.

Changes in overall medication use and safety was described in the literature set. Studies noted medication underuse was significantly more likely to occur when FI was secondary to finances (Essien et al., 2016; Ippolito et al., 2016). However, there is evidence to support that all individuals with FI are significantly more likely not to fill their prescriptions, even when cost and all other variables are adjusted for (Ippolito et al., 2016). Stretching out medication prescriptions, delaying filling prescriptions or not using the medications at all have all been attributed to FI (Billimek & Sorkin, 2012). While cost is implicated in medication underuse in individuals with FIFC, the underlying mechanisms influencing all medication underuse behaviors remain unknown.

Medication safety issues may also arise if certain medication regimens remain the same, despite ongoing FI (Essien et al. 2016). FI is associated with a significantly increased risk of hypoglycemia secondary to medication-glycemia mismatch (Essien et al., 2016). These findings suggest that practitioners should be addressing medication use with all individuals who identify as food insecure, and that patterns of medication use may be complex and interfering with overall glycemic control.

Other unique patterns of medication use may arise when FI is secondary to financial constraints (FIFC): Ippolito et al. (2016) found that food-medicine-supply trade offs may occur when individuals cannot afford all three in order to manage their diabetes. As a result, dysglycemia may occur if food consumption is maintained at the expense of discontinuing medications. These findings highlight the importance of medicine reconciliation and addressing medication regimens and adherence in the presence of any individual identified as FI.

While not a trend, one longitudinal study demonstrated that individuals with FI use more insulin over time (Shalowitz et al., 2017). Insulin use is a predictor of poorly controlled diabetes and increasing A1C over time. As a result, insulin use among individuals with FI was seen as a consequence of poorly-controlled dysglycemia. These findings highlight the importance of FI identification in practice, as there are significant consequences to increasing insulin use amongst a population with inconsistent or insecure food consumption, or without understanding food consumption behaviors.

Assessing a client's medication regime, medication coverage, adherence to the regime, and individual risk for and occurrence of hypoglycemia, can lead to basic patient-centered pharmaco-education which may help guide diabetes pharmacotherapy (Thomas et al., 2018). By assessing for hypoglycemia that is conscious of coverage, providers can replace antihyperglycemics that pose the greatest risk of hypoglycemia with safer alternatives (Thomas et al., 2018). Further, by assessing an individual's medication regime, providers can encourage insulin regimens which are more flexible, safe and patient-centered (Thomas et al., 2018). Simple educational strategies can help promote safety, such as promoting medications with meals wherever appropriate and withholding certain medications when there is no food intake (Thomas et al., 2018). Lastly, it is prudent to consider less stringent glycemic targets that are safer and conscious of an individual's capacity to maintain glycemic control (Thomas et al., 2018).

PCPs, including NPs, are ideally situated to address pharmacological strategies amongst individuals with DM 2 experiencing FI. PCPs are primarily responsible for overseeing the medical management of their patients, are familiar with Pharmacare coverage, and can accommodate routine follow up and monitoring. While no recommendations specific to NPs

were retrieved from the literature set, NPs are specifically skilled at addressing difficult conversations such as medication adherence, and patient difficulties in adopting behavior change (Bartol, 2012).

Recommendations for Practice.

Medication reconciliation should ideally occur at every patient appointment as per CDG (Lipscombe et al., 2018). Care should be taken to consider the dates medications were prescribed via Pharmanet versus the amount of prescription remaining. Since the relationship of medication use amongst individuals with FI is complex and may accompany feelings of distress, depression and powerlessness, an open-ended, non-confrontational approach should be used to further understand the unique patterns of behavior related to medication use.

FI appears to be closely associated with financial constraints in the Canadian context (Tarasuk et al., 2016). With approximately 1 in 8 Canadians experiencing income-associated FI ([IAFI], Tarasuk et al., 2016), PCPs need to be cognizant of the interface between Pharmacare-covered medication reliance (Diabetes Canada, 201b), and safe prescribing practices in the context of FI. Specific pharmacotherapy strategies to prevent hypoglycemia are included below, are thoughtful of individual regimens, and are based on the recommendations from Thomas et al. (2018).

Adjusting sulfonylureas.

If an individual with FI is presently taking sulfonylureas, the following considerations are considered prudent: educate and reinforce that sulfonylureas work fairly rapidly and do not work in a glucose-dependent method (Lipscombe et al., 2018). As recommended by Thomas et al. (2018), if meals are skipped, encourage individuals to hold their sulfonylurea dose and to consume only with meals. If hypoglycemia has been identified on at least one occasion, the PCP

should consider one of three interventions: (1) if the individual is taking glyburide, the PCP should apply for Special Authority (SA) to substitute glyburide for an alternate sulfonylurea associated with less risk of hypoglycemia, such as gliclazide (Lipscombe et al., 2018); gliclazide is the preferred sulfonylurea due to its superior safety profile (Lipscombe et al., 2018); (2) consider the A1C and whether targets needs to be softened, as sulfonylureas may need to be discontinued, and whether increasing metformin to maximum tolerated doses is sufficient; (3) apply for SA-approved DPP4 inhibitors, linagliptin or saxagliptin, in place of sulfonylureas (Government of British Columbia, 2018b). Importantly, the SA for DPP4 inhibitors mandates that NPH must be tried and found either ineffective or inappropriate (Government of British Columbia, 2018e). Declaring NPH inappropriate on the application for DPP4 inhibitors is reasonable given the evidence surrounding FI and inconsistent food intake (Essien et al., 2016), a subsequent significant increased risk of hypoglycemia (Essien et al., 2016; Ippolito et al., 2016), significant harms associated with hypoglycemia (Yale et al., 2018), and the potential for nocturnal hypoglycemia with NPH (Lipscombe et al., 2018). This is supported by the Canadian Diabetes Guidelines (CDG), which recommends that medications with potential for hypoglycemia be avoided amongst individuals with high risk of hypoglycemia (Yale et al., 2018). Furthermore, the CDG supports the use of newer agents such as DPP4 inhibitors due to their safety profile and non-inferior A1C-lowering abilities (Lipscombe et al., 2018).

Changing insulin regimes.

If patients with FI are already taking insulins or require insulins, it would be prudent to consider one of the following options: (1) if the treatment of an individual with DM 2 has progressed in that they require exogenous intermediate acting insulin such as NPH, assess whether nocturnal hypoglycemia has been identified on at least one occasion within the last

month. SA for long-acting insulin Detemir should be considered as per SA criteria (Government of British Columbia, 2017f) for individuals experiencing hypoglycemia. As above, NPH presents challenges to the individual with DM 2 experiencing FI, but Detemir does not have a peak effect (Lipscombe et al., 2018); (2) if the treatment of an individual with DM 2 has progressed in that they require exogenous short acting insulin, consider if rapid acting insulin is both affordable and appropriate, as it poses less risk of postprandial hypoglycemia compared to short-acting insulins (Lipscombe et al., 2018). Other considerations in keeping with Thomas et al.'s (2018) findings include decreasing overall postprandial targets and insulin dosing, and educating on dose-holding when meals are skipped.

Other strategies that enhance pharmacotherapy.

Evidence is limited for increasing SMBG frequency beyond what is recommended by the CDG for each individual class of pharmacotherapy (Berard et al., 2018; Government of British Columbia, 2019). However, the CDG does endorse SMBG as a strategy to identify, monitor and prevent hypoglycemia, as well as promote the modification of healthy behaviors or adjust medications (Berard et al., 2018). Unfortunately, diabetes self-management behaviors are impaired as a result of FI (Essien et al., 2016; Ippolito et al., 2016; Walker et al., 2018). Therefore, it remains unclear whether increased SMBG may help prevent hypoglycemia in light of impaired capacity for self-management. If individuals are agreeable, willing and able to increase SMBG, an individualized strategy could be implemented which assists the individual in monitoring their glycemic levels where appropriate, in order to identify periods of hypoglycemia. In consideration of the cost of blood glucose strips, PCPs encouraging this strategy should apply for additional strips through Pharmacare as per criteria for additional test strips (Government of British Columbia, 2019).

Theme Two: Hierarchy of Need and Motivation

A hierarchy of need and motivation unique to individuals experiencing FI was noted throughout the literature. What is concerning amongst individuals with FI is that, unlike their food secure counterparts, individuals with FI do not necessarily derive benefit from access to comprehensive management by health care providers (Shalowitz et al., 2017). While the mechanism is not entirely clear, authors Shalowitz et al. (2017) suggest there are social determinants of diabetes control required for the successful management of individuals with FI (Shalowitz et al. 2017). Inadequate food, social support and self-efficacy appear to interfere with the individual's capacity to manage his or her diabetes. As a result, these determinants contribute to a hierarchy of need, each uniquely influencing an individual's motivation and ability to prioritize diabetes management.

When FI is present, eating patterns appear driven by physiological needs (Ippolito et al., 2016), availability, and accessibility (Essien et al., 2016), rather than a desire for diabetes control. These findings highlight the importance of understanding underlying motivators for food consumption in the presence of FI, and a hierarchy of eating patterns driven by the level of food security.

Importantly, stable access to food appears insufficient in supporting adequate self-management (Ippolito et al., 2016). Social support emerged as an important requisite to diabetes management amongst individuals with FI. Individuals with FI experience increased rates of depression and distress, but social support appears to act as a buffer against the detrimental effects of depression and distress on diabetes self-management (Walker et al., 2018). An individual's perception of consistent support from friends and family (Kollannoor-Samuel et al., 2011), as well as positive social interactions while engaging in enjoyable activities with others

(Walker et al., 2018), was sufficient in mitigating depression and distress symptoms. General recommendations for practitioners include assessing for, promoting, and fostering social support (Thomas et al., 2018; Walker et al., 2018).

Individuals with FI have an overall decreased self-efficacy leading to poorer diabetes self-management and A1C control (Gucciardi et al., 2009; Ippolito et al., 2016). The connection between FI and decreased self-efficacy remains unclear, however, it is speculated that repeated exposure to stress, distress, and depression arising from chronic FI promotes feelings of diminished control and self-efficacy (Essien et al., 2016).

Recommendations for Practice.

While practical recommendations for managing DM 2 amongst individuals who are food insecure were elicited from the literature, it remains unclear whether these recommendations may mitigate the hierarchical structure of needs present in individuals experiencing FI. Future research should focus on further understanding the relationship between food, social support and self-efficacy, and examine whether other needs or social determinants are necessary for effective diabetes management amongst individuals experiencing FI. The role of MTM as an underlying mechanism may provide further insight into these relationships and serves as a framework for understanding individual motivations and behaviors.

Theme Three: Food Insecurity Screening

Screening for FI can be successfully managed and implemented in the healthcare setting, and has been found to be both appropriate and acceptable by patients and care providers (De Marchis et al., 2019; Thomas et al. 2018). While evidence is limited to one pilot study, FI screening has been shown to assist in guiding care, providing support, and bringing meaning and understanding to patient self-management behaviors.

A specific and individualized approach for FI screening was preferred over any particular screening method (Jones et al., 2013). This individualized approach should include: selecting a clear definition of food insecurity useful to the specific purpose, identifying which attributes of FI subsequently need to be measured, and finally, selecting a corresponding tool that measures these elements (Jones et al., 2013).

Selecting a definition of food insecurity.

There was universal acknowledgement that FI results in interference of proper diabetes management and control (Bawadi et al., 2012; Billimek & Sorkin, 2012; Essien et al., 2016; Gucciardi et al., 2009; Ippolito et al., 2016; Kollannoor-Samuel et al., 2011; Montgomery et al., 2017; Shalowitz et al., 2017; Walker et al., 2018). However, few antecedents could be identified across various studies. Subsequently, it is unlikely that a universally acceptable definition of FI exists. Rather the literature suggests that selecting a definition of FI which corresponds with what is intended on being measured is preferred (Jones et al., 2013). For example, the Canadian government has operationalized FI screening nationwide, but defines FI as income associated (IAFI). They have operationalized this definition in order to identify a specific subpopulation experiencing poverty for whom policy changes could be developed to reduce IAFI (Tarasuk et al., 2016). How food insecurity is defined in a context sets the tone for how it will be measured and identified, what problems are elicited, and which solutions are appropriate. A significant limitation to this approach is that the majority of tools presently used measure IAFI, only thus validated to measure IAFI (Marques et al., 2015). No singular way to validate a screening tool- the process is varied depending on what the tool is trying to measure

Identifying the attributes.

Based on the literature review, there are no comprehensive tools that measure all attributes of FI (Ashby et al., 2016; Jones et al., 2013). This is likely in part to a lack of a universal definition of FI. Instead, the literature highlighted that successful FI screening requires the selection of target attributes intended on being examined (Jones et al., 2013). A focused attribute approach prevents the wrong attribute from being measured, confounding attributes from interfering with results, irrelevant information from being gathered that does not inform management, and identifying attributes of FI that cannot be managed in the healthcare setting (Jones et al., 2013). What is problematic with this approach is that the majority of tools are validated to measure access to food as a primary attribute for FI (Ashby et al., 2016; Jones et al., 2013). Future research should examine and develop new tools that measure other important attributes particularly important to DM 2 management, such as nutritionally adequate food.

Screening tool selection.

While an individual context-specific approach is favored, several of the most widely used tools such as the Household Food Security Scale are only validated to identify and measure IAFI and very few other attributes (Marques et al., 2015). Further, Marques et al., (2015) highlight that most FI screening tools have not been substantially analyzed or heavily validated (Marques et al., 2015). Several consequences may occur if a FI screening method is incorrectly selected: (1) the wrong determinant of FI is measured and the information gathered is not pertinent to the cause; (2) the tool is validated for the wrong level of data being gathered, i.e. a national FI screening tool is selected to identify individual FI; (3) repeat screening of FI is indicated but the screening tool selected cannot be used to re-measure FI; and (4) the FI screening tool selected

identifies issues beyond available resources for sufficient collection, analysis and intervention (Jones et al., 2013).

The literature review identified that one screening tool is unlikely to be able to address all domains of FI and that FI tools are not universally transferrable across circumstances (Ashby et al., 2016; Jones et al., 2013) Further, the majority of the tools have not been substantially analyzed (Marques et al., 2015), therefore, selecting a tool appropriate to a healthcare setting may be challenging. The recommended approach is to select a tool suited to a particular program's resources (Jones et al., 2013). For example, if practitioners agree to measure access and poverty as key attributes to FI, then resources must be in place to support practitioners and patients in increasing access to food, and diminishing financial burden.

Recommendations for Practice. [5]

Ideally, clinics should identify a definition of FI and corresponding attributes that resounds with their patient population and results in the provision of effective management strategies. Practitioner limitations and capacity in managing certain attributes of FI should be first identified before selecting certain FI tools. While it is important to select tools that are well matched to the patient population, ethical issues may arise in identifying aspects of FI that cannot be remedied. Additional research is needed to identify how clinics and primary care providers operationalize effective identification and screening of FI.

Limitations and Future Research

There were several limitations to the integrative literature review findings. They are discussed in the following sections: gaps in literature, and other limitations.

[5] For a list of all available screening tools and their properties, please see Appendix C

Gaps in the Literature

The majority of FI screening methods available and acceptable for use in the healthcare setting are only validated to identify FI secondary to financial constraints. For example, in a systematic review examining the validity and acceptability of food insecurity (FI) screening tools and their implementation in health care settings, De Marchis et al. (2019) found that all brief 1-3 question FI screening instruments examined, were all derived from and validated against the United States Department of Agriculture-Food Security Survey (USDA-FSS). The USDA-FSS, also known as the Household Food Security Survey (HFSS), is the most widely used, accepted and validated tool in the United States and other countries, but it is validated only to identify FI secondary to financial constraints (Marques et al., 2015). These findings are corroborated by Makelarski et al., (2017), who examined the diagnostic accuracy and validity of two other short-form FI tools used in healthcare; and Ashby et al. (2016) whose systematic review concluded all tools function to identify food access issues secondary to financial constraints. What is equally problematic is that it is challenging to validate other attributes in FI surveys, because they are so varied in what they measure (Jones et al., 2013). Therefore, the scope of these tools is significantly narrowed to identify a subpopulation of individuals experiencing FI, and the applicability of the tools in practice is significantly limited. Future research should identify or establish new screening strategies that identify multiple determinants of food insecurity within the healthcare setting.

Another limitation regarding the feasibility of implementing FI screening in primary care is that the majority of measures or tools have not been rigorously appraised. In a recent systematic review examining the psychometric properties of all available household FI measures, Marques et al., (2015) found that there was limited appraisal for most tools used. Half of the

tools searched had only been tested or appraised in the literature 1-2 times (Marques et al., 2015). Well-appraised tools were limited to identifying food insecurity secondary to financial constraints (Marques et al., 2015). Additional research should critically appraise existing screening tools available that have limited research.

The literature review supports the integration of FI screening in healthcare settings (De Marchis et al., 2019; Thomas et al., 2018). However, the evidence is limited to qualitative findings from one study (Thomas et al., 2018) and one systematic review (De Marchis et al., 2019). A significant limitation of this integrative review is that there is no available literature measuring the influence of FI screening on the management of DM 2 (Thomas et al., 2018) to support its implementation. While the majority of participating patients and healthcare providers supported screening implementation (De Marchis et al., 2019; Thomas et al., 2018), the benefits of screening for FI in primary care are inferred and are, at best, speculative in nature.

There is a dearth of literature available examining the effects of specific interventions on the management of DM 2 in individuals experiencing FI. The present practice recommendations are based on the discussion section of cross-sectional studies, one focused literature review, and one systematic review. The systematic review offered a limited discussion of the findings. Therefore, the strength of findings and recommendations are significantly limited and should, at present, be considered suggestions for practice. Several recommendations are based off of the Canadian Diabetes Guidelines. Therefore, many of the interventions suggested are based on general recommendations for the diabetic population. Future research should directly examine the impact of both pharmacological and non-pharmacological interventions on the management of DM 2 in individuals experiencing FI.

Other limitations in the literature identified by Jones et al. (2013) include discourse on how to establish accurate "cut-offs" for a positive FI screen, and how often to screen for FI (Jones et al., 2013). Since the definitions and causes for FI can be so diverse (Jones et al., 2013), it remains unclear how implemented tools can integrate accurate cut-offs for identifying FI and provide recommendations for repeat screening. Future research should focus on exploring these tenets so that PCPs can confidently implement FI screening methods into practice.

Other Limitations and Considerations

An A1C, or glycemic control, is a surrogate marker and its value does not translate into absolute risk. However, hard outcomes such as cardiovascular events, mortality and end-organ damage require longitudinal studies and extensive funding. As a result, most studies rely on AIC as a proxy measure for overall diabetes management. Previous studies caution estimating risk using the A1C (Yudkin, Lipska, & Montori, 2011). However, evidence suggests that lowering and controlling an A1C remains an important strategy in lowering the risk of micro and macrovascular complications (Gorst et al., 2015; Mitsios, Ekinci, Mitsios, Churilov, & Thijs, 2018; O'Sullivan & Dinneen, 2008; Roussel, Steg, Mohammedi, Marre, & Potier, 2018). To establish with certainty whether the current proposed strategies improve the management of DM 2 in individuals experiencing FI, future research is warranted that measures hard outcomes.

Time has been cited as a barrier to FI screening in healthcare by care providers. Short form questionnaires (SFQ) can be used readily as they require little time to complete in healthcare (De Marchis et al. 2019) and are among the few that have been rigorously analyzed. An important trade-off to consider with SFQ are simplicity and comparability over the comprehensive and contextual detail of longer questionnaires (Jones et al. 2013). Lastly, it is important to note that most SFQ are validated to measure almost exclusively FI secondary to

financial constraints (Ashby et al., 2016a; Makelarski et al., 2017; Marques et al., 2015). Future research should explore primary care providers' experiences of time constraints and establish acceptable time-appropriate strategies for identifying more diverse forms of FI.

Research is lacking into how PCPs can best use the hierarchy of needs and motivations identified in the literature to support and develop an individualized self-management plan cognizant of a patient's capacities and motivations for behavior. Future research should examine the perspectives and lived experiences of individuals with DM 2 and FI, which may help elicit further detail about underlying needs and motivations, and viable management strategies.

Conclusion

The relationship between FI and DM 2 is complex. FI has profound effects on the management of DM 2 but is difficult to identify, presenting a challenge for providers in managing DM 2 in individuals experiencing FI. The harmful effects of poorly managed diabetes secondary to FI emphasize the importance of identifying FI to enhance the management of, and to prevent complications associated with, DM 2.

This integrative review examined how NPs can use FI screening in primary care to enhance the management of individuals with DM 2 experiencing FI. A comprehensive literature search highlighted relevant articles. Fifteen articles in total were selected for final review. The selected articles were analyzed and the findings provided insight into how screening can be most effective in identifying FI, and which management strategies in primary care may be most effective for individuals with DM 2.

A synthesis of the findings from this review highlighted the importance of understanding the influence of FI on food behaviors, mental health, and medication use. Through the support of Maslow's Theory of Motivation (MTM), a better understanding was achieved with respect to

motivations for behavior and diabetes self-management amongst individuals with FI. Key findings from the literature review highlighted how FI reduces one's relationship to food to basic physiological need, superseding their capacity to use food for the dietary management of DM 2. As a result, compensatory food behaviors develop that are destructive to glycemic control. While efforts to supply stable food through low-cost alternatives or food banks are important, this strategy alone is not sufficient. Strategies to manage FI-mediated changes in food behaviors include individualized nutrition approaches cognizant of an individual's personal limitations, assessments for the risk and occurrence of hypoglycemia, and consideration of referrals to social work and dieticians for additional support.

Another key theme was the influence of FI on mental health and the subsequent challenges it presented in managing DM 2. The literature revealed that FI created a persistent level of stress, depression and distress, ultimately affecting an individual's capacity to engage in self-care behaviors such as healthy eating, exercising, and self-monitoring of blood glucose, which ultimately influenced the level of glycemic control. Furthermore, there was evidence that distress and depression resulted in an increase of some unhealthy behaviors such as smoking. This relationship appeared to be mitigated by social support. In particular, the presence of informal social support of friends and family in social contexts was particularly effective at mitigating depression. Strategies to manage the influence of mental health on the management of DM 2 include assessing an individual's level of social support, providing referrals or resources if necessary and creating a patient centered treatment strategy that acknowledges the individual's mental health and their capacity to self-manage their diabetes. Lastly, the findings also indicated that particular attention should be paid when financial constraints underlie FI, as this

subpopulation appears to suffer additional consequences and experience additional stressors hampering their ability to self-manage their diabetes.

FI screening in primary care is both feasible and acceptable. At present, there exists no comprehensive FI tools capturing all attributes of FI. Instead, the literature review suggests: (a) carefully examining the population of interest, available resources and feasible interventions; (b) selecting a definition and attributes of FI that reflect these key components; and (c) selecting a screening tool validated to capture these attributes. Challenges in this process were also identified. Several reviews indicated that, despite a diversity in FI conceptualization, the majority of tools were only validated to measure food access secondary to financial constraints, and that the majority of available tools also lacked rigorous appraisal.

Recommendations for future research were also identified in this integrative review. Additional research should establish validated strategies that identify multiple attributes of FI within the healthcare setting. Although the literature indicated that identifying FI in healthcare may be feasible and appropriate, FI identification methods are almost exclusively limited to identify FI secondary to financial constraints. Further, there is a dearth of literature examining whether FI screening improves the management of DM 2. Similarly, no studies to date have examined the benefit of specific interventions on the management of DM 2. Future research should examine how FI screening directly benefits the management of DM 2 in primary care and which interventions provide the most benefit. Additionally, few articles examined the perspectives of individuals with DM 2 experiencing FI.

While a hierarchy of needs and underlying motivations for behavior were identified in the literature, there is a lack of research into how PCPs can best use this knowledge to support individuals with DM 2 experiencing FI, and how to develop an individualized self-management

plan, cognoscente of a patient's capacities and motivations for behavior. These areas for future research which help support PCPs in how best to identify FI in the PC setting and to enhance the care they provide to individuals with DM 2 experiencing FI.

This integrative review highlighted how NPs as PCPs can play influential roles in screening for FI and managing DM 2 among individuals with FI. The literature findings highlight how PCPs can be key in identifying FI among their patients based on the trust and rapport that develops. Further, NPs are undertaking difficult conversations with patients surrounding the more vulnerable aspects of FI such as unhealthy food behaviors, stress, depression and medication adherence. NPs are also managing pharmacological and non-pharmacological aspects of care, considering the social determinants of health, including food insecurity, when providing care.

As the incidence and prevalence of DM 2 in Canada is projected to increase and FI remains pervasive in our Canadian population NPs must strive to identify the unique struggles of this subpopulation in primary care. The findings of this integrative literature review highlight how FI influences the management of DM 2. By screening for FI in primary care, the findings of this review can support NPs in identifying individuals with DM 2 experiencing FI. Ultimately, the findings assist NPs better managing DM 2 and glycemic control amongst individuals who are food insecure and contribute to the work in preventing diabetic complications.

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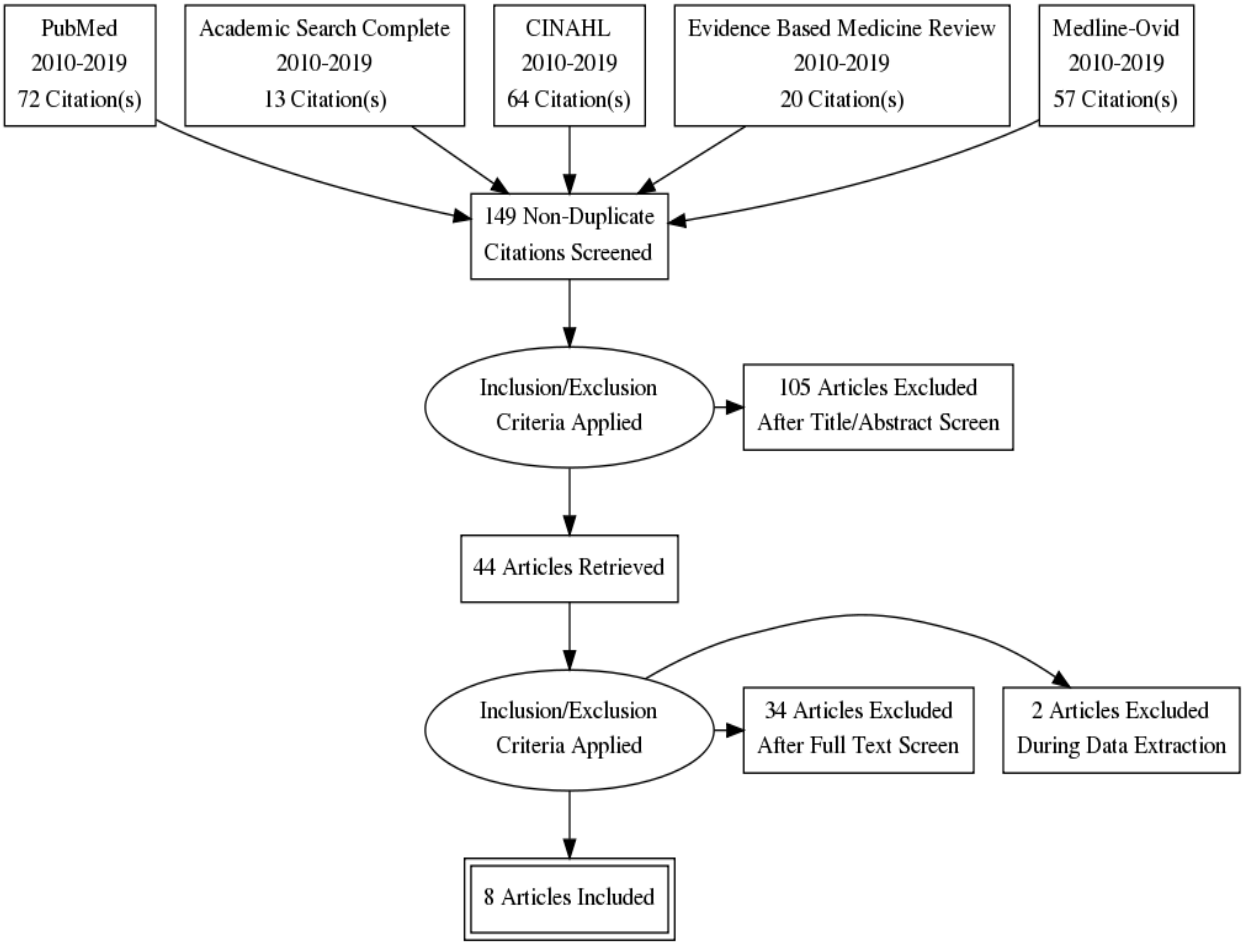
Yazıcı, D., & Sezer, H. (2017). Insulin Resistance, Obesity and Lipotoxicity. In A. B. Engin & A. Engin (Eds.), *Obesity and Lipotoxicity* (pp. 277–304). doi.10.1007/978-3-319-48382-5_12

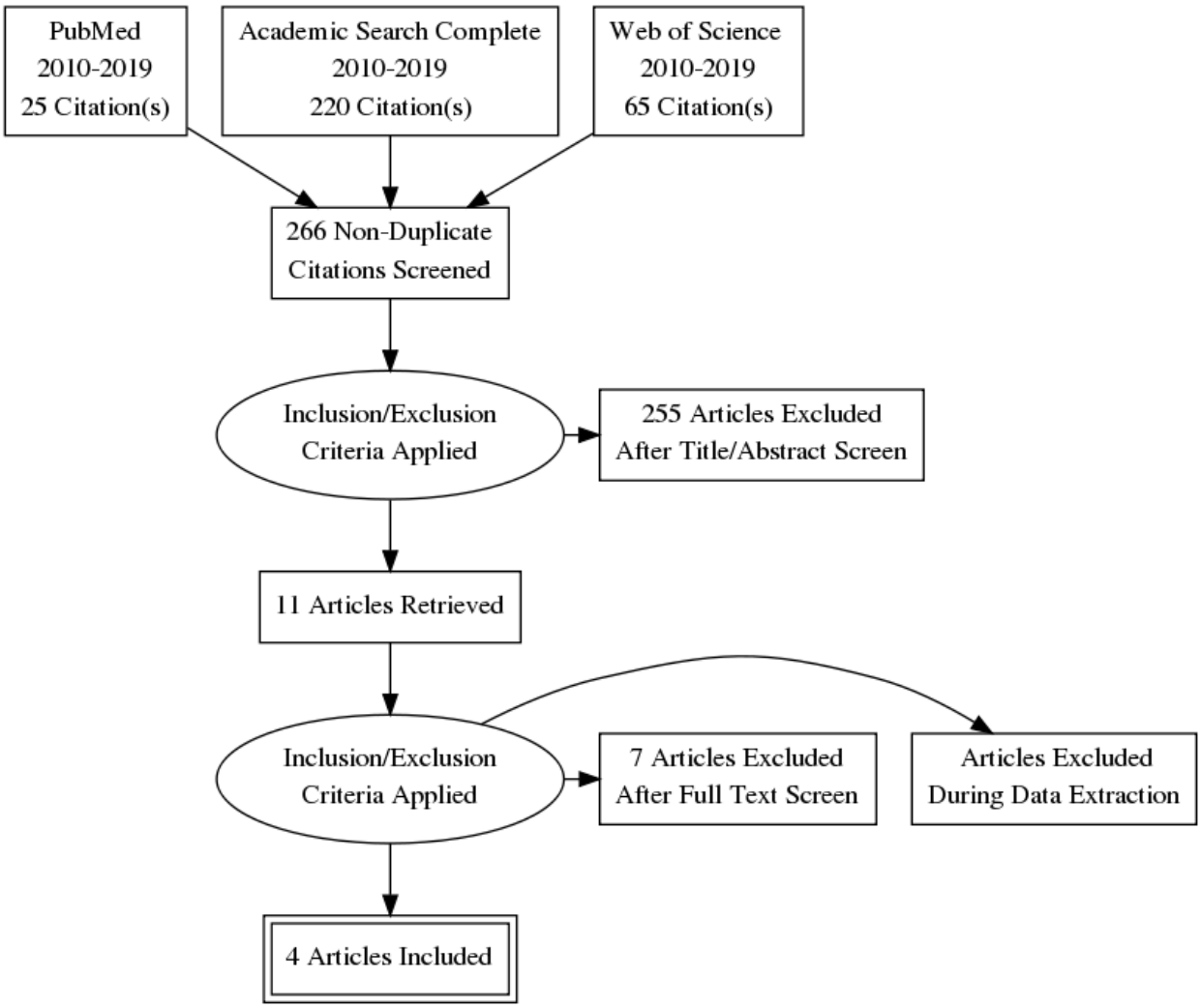
Appendix A

Search Strategy: Aim One and Two



Adapted from Prisma Flow Diagram Generator (2019)

Search Strategy: Aim 3



Adapted from Prisma Flow Diagram Generator (2019)

Appendix B

Literature Review Matrix

Authors, Date & Title	**Aim**	**Study Design & Location**	**Methods & Analysis**	**Key Findings:**	**Strengths & Limitations**
Essien, Shahid & Berkowitz (2016) *Food Insecurity and Diabetes in Developed Societies*	Examine evidence surrounding food insecurity and its connection to diabetes and determine what connections exist.	Focused literature review Unknown No limitations on location	Definition used: "Food insecurity refers to the uncertain or limited access to adequate and safe foods". Articles published on or later than January 1st, 2013 were included Cross-sectional, longitudinal, and interventional designs were included PubMed and Medical Subject Headings (MeSH) terms were used. Search strategy: diabetes mellitus OR prediabetic state OR abdominal obesity AND Food Insecurity OR Food Insufficiency OR Food Supply OR Hunger OR Poverty. Relevant studies from the reference section of	More likely to have poorly controlled diabetes due to: (1) Poor diet choices and compensatory changes in dietary habits: • Binge-fast eating depending on pay cycles or food availability/ affordability • Incentive to consume saturated fatty foods, simple carbohydrates, highly processed foods since they are cheaper and consumed more readily • Less consumption of fruits and vegetables • place individuals at risk for both hyper and hypoglycemia (2) When FI is secondary to finances, significantly increased likelihood of medication underuse due to costs (3) Significantly increased risk of hypoglycemic events when food becomes scarce and medication regimens remain unchanged (4) Other proposed mechanisms • Mental health (stress, depression and distress) from competing demands between food and managing disease with little income may	<u>Strengths</u> Based on references, covered a significant amount of relevant articles <u>Limitations</u> How FI is defined creates classification bias No description of inclusion/exclusion criteria, how many studies included or how many articles informed each conclusion Cross-sectional, longitudinal, and interventional designs reviewed only • Cross-sectional study designs not causational cannot help explain complex relationship between food insecurity, diabetes and other elements Difficult to generalize some results based on: • specific population sub-groups

			included articles included	decrease self-efficacy and self-management of diabetes: (a) Reduced mental capacity from the stress of managing diabetes in the face of FI (b) creates significant distress (due feelings of to powerlessness) Decreased likelihood of accessing healthcare	• healthcare coverage, insurance or circumstance in each state or country. Recall bias for studies suing questionnaires **CASP rating:** **Low**
Authors, Date & Title	**Aim**	**Study Design, Sample & Location**	**Methods & Analysis**	**Key Findings:**	**Strengths & Limitations**
Walker, Williams & Egede (2018) *Pathways between food insecurity and glycaemic control in individuals with type 2 diabetes*	recognize direct and indirect pathways that food insecurity influences diabetes self care behaviors and glycemic control in individuals with diabetes	Cross-sectional survey N= 615 English-speaking adults with type 2 diabetes (DM 2) Southeast USA	Definition of FI used: "Inability to or limitation in accessing nutritionally adequate foods, or dependence on emergency food supplies" Food insecurity measured using the US Household Food Security Survey Module short form scale The Perceived Stress Scale (PSS) was used to measure stress and is highly correlated with stress, depression and anxiety. Social support measured using Medical Outcomes Study (MOS) Social Support Survey	FI is directly related to increased HB A1C through: • increased stress • other mechanisms independent of stress FI indirectly related increased A1C through poorer self-care mediated by • increased stress • lower social support. Findings suggest that addressing stress and providing support for individuals with DM 2 experiencing FI may improve the individual's capacity to perform diabetes self-care behaviours. There are direct pathways independent of self-care by which FI impacts glycemic control. Results suggest	<u>Strengths</u> Calculated power based on specific model used N=615 appropriate sample size. All exposures (stress, support, FI clearly defined and measured using well-validated questionnaires Statistical significance between 0.05-0.0001 <u>Limitations</u> Cross sectional survey used-cannot draw causational results Recall and reporting bias for questionnaires Difficult to generalize from study population **CASP rating:** **High**

			Summary of Diabetes Self-Care Activities (SDSCA) scale measured self-management/self-care activities. Morisky Medication Adherence Scale (MMAS) measured medication adherence Glycemic control was measured using A1C Structural equation modelling (SEM) used to examine mechanisms through which food insecurity influences diabetes self-care behaviours and glycaemic control	• a multipronged approach to FI in individuals with DM2. • Addressing nutrition alone in individuals with DM 2 experiencing FI is insufficient • recommends additional pathways be targeted • social support acts as buffer in poor diabetes self-management	
Authors, Date & Title	**Aim**	**Study Design, Sample & Location**	**Methods & Analysis**	**Key Findings:**	**Strengths & Limitations**
Montgomery, Lu, Ratliff & Mezuk (2017) *Food Insecurity and Depression Among Adults with Diabetes: Results From*	(1) estimate prevalence of food insecurity (FI) among US adults with normoglycemia, prediabetes, and diabetes	Cross sectional design Adults ≥20 years old with diabetes or prediabetes: • as per fasting plasma glucose parameters in the American	Four years of data taken from 2011-2014 NHANES. (National Health and Nutrition Examination Survey). FI defined as "Food insecurity refers to the lack of a dependable	Approximately 1 in 3 adults with diabetes experiences food insecurity • 10.2% mild FI and 20.3% severe FI Dose-response relationship exists between FI and depression (1) mild food insecurity associated with 2.5-fold increase risk of depression	<u>Strengths</u> Validated questionnaires used C-statistic values used to determine predictive capability and study met baseline criteria Selection bias minimized based on selection strategy (using NHANES)

the National Health and Nutrition Examination Survey (NHANES)	(2) determine whether a difference existed in the prevalence of FI and major depression Across groups.	Diabetes Guidelines, or • self-report N=1724 for diabetes group N=2004 for prediabetes group Control: N=7713 depression among adults ≥20 with normoglycemia United States of America	means of obtaining safe, sufficient, and nutritious food" Depressive symptoms measured using PHQ-9 Global Physical Activity Questionnaire used to measure physical activity Smoking measured using self-reporting (never, previous, current) Multiple logistic regression models used to evaluate relationship between FI and depression. Covariates measured/controlled for by using multiple regression analysis • includes age, gender, race/ethnicity, educational attainment, household income, smoking, physical activity	(2) severe food insecurity associated with 3.5-fold increase in depression. Increased smoking rates and decreased physical activity only partly explains depression amongst adults with DM 2 experiencing FI	Recall bias attenuated by including subjective and objective measures. I.e. not 100% based on questionnaires and recall NHANES gathers data using mobile clinic-i.e. same measurement tools and personnel=minimize measurement bias Results clinically significant based on OR for depression amongst mild and severe FI P-value 0.001 <u>Limitations</u> Cross sectional survey used-cannot draw causational results Generalizability restricted by sample limitations • Certain ethnic groups excluded • Limited to the United States Pre-diabetes and diabetes groups were combined affecting validity of effect on DM2: Recall bias with PHQ- 9 questionnaires **CASP rating:** **High**

Authors, Date & Title	Aim	Study Design, Sample & Location	Methods & Analysis	Key Findings:	Strengths & Limitations
Bawadi, Ammari Abu-Jamous, Khader, Bataineh, Tayyeme, (2011) *Food insecurity is related to glycemic control deterioration in patients with type 2 diabetes*	Determine prevalence of food insecurity (FI)among type 2 diabetics (DM2) in a major Jordanian hospital and to investigate its relation to glycemic control.	Cross-sectional design 843 patients (327 male and 516 female) between 22-84 years old with confirmed diagnosis of type 2 diabetes who were patients in the endocrinology clinic at King Abdullah University Hospital (KAUH) in Al-Ramtha. Northern Jordan	Definition of FI used: "food insecurity is defined as limited or uncertain availability of nutritionally adequate and safe foods in socially acceptable ways" Interview-based questionnaire used to gather socioeconomic and health data Weight and height measured by a trained nutritionist. food frequency questionnaire (FFQ) used for dietary assessment. food processor software used to process dietary data. Short form of the U.S. food security survey used to identify FI Food insecurity categorized as moderately food insecure (MFIS) and severely food	(1) gender, age, education, and income are all related to food security status (2) Glycemic control worse in MFIS and SFIS (3) 70% of SFIS stated they often could not afford to eat a balanced meal. (4) 99% of the SFIS run out of food by the end of the month, and either meal skip, or cut meal size as a compensatory mechanism for running out of food. (5) SFIS associated with significantly higher average body mass index (2 BMI units) (6) No difference in overall intake of calories between all groups but SFIS consumed more sugar, on average, than MFIS and FS counterparts	<u>Strengths</u> Previous studies confirm that the US short-form questionnaire has been validated to be used in developing countries FFQ locally validated by asking 20 volunteer diabetic patients to review and with multiple day diaries. 200 Jordanian-specific items were added <u>Limitations</u> No power calculation Food frequency questionnaires are not 100% correlative with true diets Important covariates not controlled for: alcohol intake and smoking . Difficult to generalize based on Jordanian population, food costs, economical circumstances Self-report creates recall bias Cross-sectional surveys cannot determine causality The general questionnaire was

			insecure (SFIS) using standardized protocol Glycosylated hemoglobin (HbA1c) used to measure glycemic control Chi-square, and post-hoc analysis of variance was used as to analyze the data		not standardized or validated. It was developed by the research team Selection bias: • screening patients in hospital versus diabetics in general population seeking primary care **CASP Rating: Moderate/low**
Authors, Date & Title	**Aim**	**Study Design, Sample & Location**	**Methods & Analysis**	**Key Findings:**	**Strengths & Limitations**
Bilimek & Sorkin, (2012) *Food Insecurity, Processes of Care, and Self-Reported Medication Underuse in Patients with Type 2 Diabetes: Results from the California Health Interview Survey*	To establish whether there is an independent association of food insecurity to processes of care or delays in filling prescriptions	Cross sectional design N = 3,401 Adults selected from the 2007 Public Use File of the California Health Interview Survey (CHIS), (a randomized process) and (1) had a diagnosis of type 2 diabetes (2) saw a care provider over the last year (3) were presently taking diabetes medications California	Multivariable logistic regression analyses that adjusted for age, gender, education, race/ethnicity, factors related to access to care: insurance status, number of visits to the doctor in the previous year, and access to an automobile), duration of diabetes, general health condition, and psychological distress. Process of care defined by completing hemoglobin A1c, a dilated eye exam, and a foot exam over the last year	(1) Individuals with food insecurity are significantly more likely not to fill their prescriptions even when other variables are adjusted for (2) food insecurity may independently interfere with optimal diabetes management (3) Food insecurity does not interfere with process of care	<u>Strengths</u> Multivariable logistic regression analyses adjusted for several factors <u>Limitations</u> How FI is defined creates classification bias -Assumes below poverty line are the only people with food insecurity. Does not take into account other reasons for not being ale to afford medications. Does not address other medication behaviors connected with food insecurity such as medication underuse skipping doses, and discontinuing medications Does not measure power

			Timing of prescription pick up measured using: (1) the Medication Expenditures Panel Survey (Agency for Healthcare Research and Quality [AHRQ] 2004) and a questionnaire asking about the nature of delays in filling scripts Binary scoring used to determine the presence of food insecurity amongst individuals with household income less than 200 percent of the federal poverty level.		Possible selection bias only including individuals with diabetes who had sought healthcare in the last year. Generalizability limited due to population Recall bias possible in questionnaire. Observational studies don't provide robust enough evidence to recommend changes to clinical practice No power measure **CASP rating: Moderate quality**
Authors, Date & Title	**Aim**	**Study Design, Sample & Location**	**Methods & Analysis**	**Key Findings:**	**Strengths & Limitations**
Gucciardi, Vogt, Demelo, & Stewart (2009) *Exploration of the Relationship Between Household Food Insecurity and Diabetes in Canada*	(1) determine the prevalence of food insecurity amongst Canadians with diabetes (2) examine the relationship between food insecurity and diabetes management	Cross-sectional design N= 2,523 Ontarians to examine the relationship of FI to management, health status, and self-care (management) practices N= 6, 237 from throughout Canada to examine the	Definition of food insecurity: "exists when all people, at all times, have physical and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life" Data was analyzed from A Canadian-validated survey (2005 Canadian Community Health	(1) Process of care was the same in individuals with food insecurity and food security (2) Individuals with diabetes who are food insecure are more likely to be physically inactive, be overweight, eat less fruits and vegetables, twice as likely to be a smoker, twice as likely to report stress, report lower general health, mental health and perceived stress (3) No impact on accessing medical care.	<u>Strengths</u> OR=Results appear clinically significant HFSS and CCHS are Canadian validated surveys <u>Limitations</u> No p-values provided How FI is defined creates classification bias

		prevalence of food insecurity in individuals with type 2 diabetes versus the rest of Canada. Canada	Survey [CCHS]) was used to compare the prevalence of food insecurity in Canada compared to the prevalence of FI Canadians with diabetes. Ontario CCHS surveys contained both FI and diabetes modules and were used to examine the relationship between food insecurity self-care and management and health status. Used Canadian-validated Household Food Security Survey (HFSS) to identify income-associated food insecurity Process of care measured by completing hemoglobin A1c, a dilated eye exam, a urinalysis and a foot exam over the last year and taking ASA and cholesterol medication		Cross sectional analysis-difficult to draw causational relationships Only Ontario examined for the impact of FI on diabetes and some populations were excluded e.g. First Nations. i.e. Possibly not generalizable to all of the Canadian population, or may result in an information bias Cannot generalize that overall diabetes management is is similar for FI and food secure counterparts based on the study's specific identifiers. Ontario coverage may influence generalizability of results of SMBG and medication adherence Possible measurement bias: Surveys any missing information on diabetes or food insecurity were excluded Questionnaires are subject to recall bias Questionnaire not validated to identify difference between DM 1, DM 2 and gestational. No power calculation **CASP rating: Moderate-low**

Authors, Date & Title	**Aim**	**Study Design, Sample & Location**	**Methods & Analysis**	**Key Findings:**	**Strengths & Limitations**
Ippolito, Lyles, Prendergast, Marshall, Waxman5 & Seligman (2016) *Food insecurity and diabetes self-management among food pantry clients*	To observe the association between food security (FI) and diabetes self-management of patients accessing food pantries	Cross-sectional design Adults with diagnosed diabetes (via HbA1C or self-report) Using diabetes medications Speak English or Spanish accessing designated food pantries Sonoma County, Columbus, & Corpus Christi, USA	Food insecurity defined as "limited or uncertain access to adequate food at the level of the household related to affordability Baseline surveys for diabetes self-management intervention completed between March 2012 and March 2014. Food insecurity determined using short form of the US Department of Agriculture's Household Food Security Survey Module (HFSSM) which measured income-associated food insecurity. Three groups identified using questionnaire: food secure, low food secure, very low food secure 8 indicators of diabetes self-management examined:	Very low food secure participants had • inferior diabetes self-efficacy • more medication non-adherence • more frequent severe hypoglycaemic episodes Low food secure and very low food secure both had • Increased prevalence of depression and distress • Greater issues affording medication • More food- medicine-health supply trade-offs. No statistically significant difference in mean HbA1c (Table 1) or percentage of participants with HbA1c level above 8·5% Tobacco use was more than twice as frequent in the very low-food-secure compared with the food-secure group dose–response relationship between severity of food insecurity and barriers to diabetes self-management.	<u>Strengths</u> Demonstrates strong statistical significance OR indicates strong clinical significance Validated questionnaires used 83% response rate <u>Limitations</u> Categories used for Low food security and very low food security were decided by convention Cross sectional-cannot determine causality Control group significantly smaller than cases Recall bias with questionnaire Potential selection bias: • How FI is defined • by selecting participants accessing food pantry only • food secure controls are accessing food bank • not enough "controls" or food secure individuals comparatively speaking

			(1) HbA1c; (2) diabetes self-efficacy; (3) diabetes distress; (4) medication non-adherence; (5) severe hypoglycaemia; (6) depressive symptoms; (7) medication affordability; and (8) food–medicine purchasing trade-offs. HB A1C used to measure diabetes control Self-efficacy measured using 8-item questionnaire; diabetes distress measured using 2-item questionnaire; Medication adherence measures using a four-item Medication Adherence Questionnaire; Severe hypoglycemia assessed by asking "In the past 4 weeks, how many times have you had a severe low blood sugar reaction, such as passing out or needing help to treat the reaction?' Depressive symptoms assessed using patient Health Questionnaire-2;		Difficult to generalize some results from United States: • Medication and supply costs in California unique creating unique medicine-health supply-food trade offs • Medicine costs and coverage based on insurance affect affordability in a way unique to California and the individual Cannot control for all potential confounders, including medical co-morbidities Possible information bias: some interviews done in person and some over the phone **CASP rating:** **High**

			Inability to afford medicine was assessed by asking: 'In the last 12 months, how often did you take less medicine than you were supposed to because you could not afford to buy more?' Medicine-food trade offs were assessed using a 4-point questionnaire. Five covariates were measured and controlled for: age, gender, race/ethnicity, education and study site		
Authors, Date & Title	**Aim**	**Study Design, Sample & Location**	**Methods & Analysis**	**Key Findings:**	**Strengths & Limitations**
Kollannoor-Samuel, Wagner, Damio, Segura-Pe´rez, Chhabra, Vega-Lo´pez, & Pe´rez-Escamilla (2011) *Social Support Modifies the Association Between Household Food*	Identify risk factors for depression amongst individuals who are food insecure and establish if social support mediates this risk	Cross sectional 211 low income Latino adults with T2D Connecticut	Definition: "Limited availability, access and/or intake of nutritionally adequate foods" Baseline data form DIALBEST trial (longitudinal RCT) used. Participants were (1) 21 years old (2) living in Hartford County, CT, (3) HbA1c >7%, and (4) no medical conditions	At each level of food insecurity, greater social support led to lower depression rates support Results suggest Social support buffers depression risk in individuals experiencing food insecurity Increased depressive symptoms associated with: • lower household income, • increased perceived interference of DM2 on life	<u>Strengths</u> Validated tool for depression in DM2 Covariates known to be associated with depression were included in multivariate analysis <u>Limitations</u> Cross sectional analysis Cannot control for underlying genetic predisposition for depression or pre-existing traits

Insecurity and Depression Among Latinos with Uncontrolled Type 2 Diabetes			completely limiting physical activity. Depressive symptoms measured using the Center for Epidemiologic Studies (CES-D) Scale Food insecurity measured using Short form of the US household food security supplement module [US-HFSSM] Social support measured using an 11 item-questionnaire Multi Dimensional Diabetes Questionnaire Cultural, clinical, psychosocial variables measured using validated tools. Multivariate logistic regression model used Logistic regression used to determine social support-food insecurity-depression interaction	• Increased diabetes related clinical symptoms Our study suggests that depression risk is associated with the perception of how much diabetes interferes with work, income generation, relationship with partner, daily routine activities, and/or social activities Increasing social capital for patients with DM2 who are food insecure may mediate depressive symptoms-especially amongst individuals in low SES.	Limited generalizability: Puerto Rican & predominantly female participants Perceived social support limited by recall bias Post hoc- alpha Cronbach demonstrates internal consistency to support reliability of surveys used **CASP rating** **Low**
Authors, Date & Title	**Aim**	**Study Design, Sample & Location**	**Methods & Analysis**	**Key Findings:**	**Strengths & Limitations**
Shalowitz, Eng, McKinney,	Determine if food insecurity	longitudinal observational study	comprehensive care, including complete	Insulin use and A1C increase with increasing food insecurity.	<u>Strengths</u> Longitudinal study

Krohn, Lapin, Wang & Nodine (2017) *Food security is related to adult type 2 diabetes control over time in a United States safety net primary care clinic population*	(FI) is associated longitudinally with poor glucose control- even when barriers to comprehensive management are minimized.	336 patients from a multi-site federally qualified health centre (FQHC) servicing individuals with DM2 Illinois	medication management is provided to Individuals with DM2: • Medication and testing supply assistance • Diabetes self-management • Education • One-on-one and group support • Retinal screenings • Fitness • programmes. Data collected using • baseline assessment of patients' FI using the short form US Household Food Security Module follow up screening FI annually and after study completion A1C levels recorded throughout 24- month study period (between 2-6 times depending on participant) and once during follow up. longitudinal mixed-effects models using • maximum likelihood estimating method	level of FI only slightly related to BMI low food security directly impacts glucose control Unlike individuals who are FS, individuals with FI do not derive benefit from access to comprehensive management (comprehensive care included quarterly visits with A1C testing, medication and testing supply assistance, diabetes self-management education, one-on-one and group support, retinal screenings, and fitness programmes). Directly supports the significance of the social determinants of diabetes control Near independent effect of FI on diabetes control, confirmed with multivariable model	Validated tool used for FI <u>Limitations</u> Generalizability limited: • Results based on one facility. • Culturally limited to African Americans, Hispanic, and Caucasian No power calculation **CASP rating** **Moderate**

			• unstructured covariance controlling • covariate analysis		
Authors, Date & Title	**Aim**	**Study Design, Sample & Location**	**Methods & Analysis**	**Key Findings:**	**Strengths & Limitations**
De Marchis; Torres; Fichtenberg; & Gottlieb (2019) *Identifying Food Insecurity in Health Care Settings: A Systematic Scoping Review of the Evidence*	Examine the validity and acceptability of food insecurity (FI) screening tools, and their implementation in health care settings.	Systematic review 25 articles United States	PubMed and Ovid MEDLINE were searched using keywords from 3 domains: (1) FI; (2) screening; and (3) health care settings Between June 30th, 2000- July 27, 2017. Articles excluded if evidence for validity, acceptability, or feasibility of FI screening not included What was examined: study design and setting; FI screening tools; barriers to uptake; patient vs clinician factors, FI appropriateness, acceptability, or feasibility Studies were assigned quality ratings using the Grading Recommendations Assessment Development and	Majority of articles conducted in pediatric setting Brief FI screening instruments were all derived from and validated against the United States Department of Agriculture-Food Security Survey (USDA-FSS) Brief (1- and 2-item) FI screening tools are validated for use in US healthcare settings, mostly among caregivers in pediatric population • 1-item hunger screening question • SEEK (safe environment for every kid) • 2-item Hunger Vital Sign no difference in screening mode of administration (based on one RCT) 66% -88% found it appropriate to be asked about FI in healthcare setting (based on 6 observational studies of low quality of caregivers for pediatric patients and young adults) between 80-89% of clinicians found it acceptable to screen for FI in healthcare visits (based on 2	<u>Strengths</u> Covers several aspects regarding the implementation of FI screening Each article was assigned a quality rating Each finding listed the number of articles and level of quality it was based on. <u>Limitations</u> Validated against USDA Food security scale • Limited generalizability • USDA-FSS is limited to financially associated food insecurity. Limited mostly to pediatric, young adult population Some conclusions were derived from only 3-4 studies. 19 of 25 studies examined were rated low-very low quality. **CASP grade** **Moderate**

			Evaluation approach (GRADE) Standardized mean differences were calculated using 2-by-2 frequency tables of outcome frequencies	qualitative articles of very low quality) time required for FI screening was varied (30 seconds to 10 minutes) 4 out of 10 studies reported time as a barrier to FI screening in practice while 6 out of 10 reported time created minimal barriers to implementation (all observational studies) 6 articles found that educating on the importance of FI screening and impact of SDOH on patient health improved FI screening competence and uptake Not everyone who screens positive for food insecurity wants help from care providers	
Authors, Date & Title	**Aim**	**Study Design, Sample & Location**	**Methods & Analysis**	**Key Findings:**	**Strengths & Limitations**
Jones, Ngure, Pelto & Young (2013) *What Are We Assessing When We Measure Food Security? A Compendium and Review of Current Metrics*	1) examine food security (FS) as a concept, the different methods used to measure FS along with their purpose and concepts of FS used 2) Identify challenges to FS	Review 17 different FS measures Total sample unknown, 17 articles pulled as part of screening for validation in its use for FS No restrictions on location	PubMed, CABI, Elsevier, Google Scholar, and Web of Science as well as the Web sites of several international organizations Included Screening tools, metrics (proxy measures) or any method historically correlated with FS.	Concept of food security: having consistent and stable, physical and financial access and availability of nutritionally adequate food and the ability to utilize, acquire and consume food in socially and culturally acceptable ways Access needs to be further broken down and understood as 3 different aspects: access, acquisition, and consumption Food measures are not always clear about what concepts of FS they are	<u>Strengths</u> Assessed the individual quality and strength/limitations of each FS measure Examine 17 different food security measures <u>Limitations</u> CI and p-values provided for validation measures only

	measurement and future directions needed			measuring, nor do they all have the same purpose Challenges to measuring food insecurity 1) accurately measuring dietary sufficiency 2) Determining which concepts of FS the measurement aims to address 3) discerning between various components of food access 3) accurate cutoff for food insecurity 4) controlling for Response and recall bias 6) validating measures when they are so diverse in what they measure One is not necessarily superior: rather it is important to choose A screening tool that is informed by the concept that one intends to measure. Data across measures collected at differing levels (national, regional, household, and/or individual Levels) Acquiring foods in socially acceptable/unacceptable ways is not measured Safety of food acquired is not measured Nutritionally adequate diet/diet quality not measured	Individual articles are not assessed for their quality Unclear how information or findings were grouped as based on what level of evidence. **CASP rating** **Low**

				Difficult to identify chronic, vs transitory vs seasonal food insecurity Important trade-off to consider with selecting food security screening tools: exchanging comprehensibility and contextual detail for simplicity and comparability No singular way to validate a screening tool-the process is varied depending on what the tool is trying to measure. One metric is unlikely to be able to address all domains of FS. Consider selecting FS measures that identify aspects that can be addressed or is suited to a particular program's resources Household consumption and expenditure surveys or dietary diversity surveys may be best in identifying household level behaviors, however there is a lot of room for error.	
Authors, Date & Title	**Aim**	**Study Design, Sample & Location**	**Methods & Analysis**	**Key Findings:**	**Strengths & Limitations**
Ashby, Kleve, McKechnie, & Palermo (2016) *Measurement of the*	Identify and review all multi-item tools measuring food insecurity (FI) available in	Systematic Review 13 articles All developed countries	CENTRAL, CINAHL plus, EMBASE, MEDLINE, TRIP were searched	8 tools were identified in total All tools assessed food access as a dimension and it is addressed adequately in each tool.	<u>Strengths</u> quality of the study and risk of bias for every study is assessed

dimensions of food insecurity in developed countries: a systematic literature review	developed countries and explore the dimensions of FI they address.		English studies since 1999. USDA Food Security Survey Module excluded due to the known reliability/validity established in earlier (Marques et al. (2014) systematic reviews. Data were summarized against the dimensions of food insecurity quality of the study and risk of bias as assessed using the American Dietetic Association Evidence Analysis Manual	Most tools only assessed food access as a dimension • physical and economic resources to access food Tools do not explore other components of FI. Radimer/Cornell tool enquired about anxiety around eating a good meal due to assistance required with preparing food, and food utilization Kuyper tool attempted to measure stability over time Only one tool measures both household food insecurity, and individual food insecurity All studies used Cronbach's alpha (coefficient of internal consistency) to measure reliability and scored moderate to high. All tools are self-report	Discussed each measurement's reliability and validity <u>Limitations</u> None **CASP rating** **High**
Authors, Date & Title	**Aim**	**Study Design, Sample & Location**	**Methods & Analysis**	**Key Findings:**	**Strengths & Limitations**
Marques, Reichenheim, de Moraes, Antunes, & Salles-Costa (2014)	Identify & describe household food security scales available in peer reviewed literature and examine, plus	Systematic review 24 different tools from 184 articles written either in English, Spanish or Portuguese	Databases used: MEDLINE, LILACS and SciELO databases, Terms used: ('food insecurity' OR 'food security') AND	Instruments use different terms to describe same concept of household food insecurity All instruments or tools were developed using the same underlying concept of food insecurity (FI): poor access to food	<u>Strengths</u> Minimized publication bias by examining the reference sections of all the articles to ensure articles weren't missed using the algorithm-based search method

Household food insecurity: a systematic review of the measuring instruments used in epidemiological studies	synthesize their psychometric properties.	Tools developed in United States Canada, Venezuela, Colombia, Costa Rica, Burkina Faso, Kenya, Iran, Bangladesh and Indonesia	('questionnaires' OR 'scales' OR 'validity' OR 'reliability') No time period limit applied Use household food insecurity (HFI), not individual food insecurity Article review carried out by independent reviewers Reliability was classified by using intra-observer reliability, inter-observer reliability and internal consistency Validity: examined for (i) face or content validity (ii) structural (dimensional) Validity (iii) criterion or concurrent validity (iv) construct Validity Tools were only included if they contained 3 or items.	secondary to financial constraints. Other underlying aspects of FI unexplored For most tools there is very limited appraisal Core Food Security Measurement/Household Food Security Survey Module (CFSM/HFSSM) has been significantly analyzed in literature, while SPHFSS and HFSSM-6SF have been moderately analyzed in the literature. Half of the tools had only been tested or studied in the literature 1-2 times. CFSM/HFSSM and HFSSM-6SF studied/validated in many countries worldwide Cronbach's α coefficients demonstrates good internal consistency for CFSM/HFSSMand HFSSM-6SF & SPHFSS with α varying from 0·82 to 0·94. Few studies measured other Dimensions of reliability e.g. test–retest reliability All 3 had studies that measured construct validity, structural validity, convergent validity Most tools examined only reliability and validity Future studies should aim to examine other	<u>Limitations</u> Tools with less than 3 items were not included Language bias Selection bias: FI tools not previously part of a peer reviewed study not included **Casp Rating** **High**

				psychometric properties not yet explored HFSSM-6SF has demonstrated acceptable screening capability in 2 validity studies Choosing an appropriate instrument for use requires significant in-depth analysis, but to date has not been done in the majority of the tools measuring FI	
Authors, Date & Title	**Aim**	**Study Design, Sample & Location**	**Methods & Analysis**	**Key Findings:**	**Strengths & Limitations**
Makelarski, Abramsohn, Benjamin, Du, & Lindau (2017) *Diagnostic Accuracy of Two Food Insecurity Screeners Recommended for Use in Health Care Settings*	To test the diagnostic accuracy of the American Academy of Pediatrics (AAP) and Hunger Vital Sign (HVS) against gold standard Household Food Security Screen short form (HFSS-sf)	Case control N= 342 patients, parents, caregivers, family members, and friends of patients >18 years of age Emergencies Chicago Illinois between July-Nov 2016	Definition used: "limited or uncertain availability of nutritionally adequate and safe foods" A self-administered survey was given which included all 3 tools. Approximately half the participants completed based on a 30-day recall and the other half with a 12-month recall. Sensitivity specificity, positive likelihood ratios, negative likelihood ratios and 95% confidence intervals (CIs) were calculated	Compared to gold standard (HFSS), the AAP lacks sensitivity: Nearly 25% of individuals who positively identified with FI through HFSS, were negative with the AAP. AAP tool slightly more sensitive amongst households with children compared to without children HVS was highly sensitive in detecting FI compared to HFSS-sf, but has lower specificity than AAP. HVS viable alternative to HFSS-sf, however AAP is lacking sensitivity Yes or no i.e. dichotomous surveys for FI might be prone to more measurement error than surveys with more response options. Stigmatization may play a role in answers and survey accuracy-	<u>Strengths</u> No priming effect noted based on the order screening tools were employed. High response level Valid results <u>Limitations</u> Statistically significant results had wide confidence intervals, lack precision. Small sample size. Lacks power to identify small differences Selection bias-people who were unwell were excluded Recall bias with self questionnaires

				answering "yes" is more stigmatizing than "sometimes true"	Measurement bias-some surveys had missing data Generalizability- 76% African American respondents from one hospital in Chicago Using HFSS-sf as gold standard. It is not absolute in detecting all forms of FI. Possible social desirability bias- easier to say "sometimes true" than to answer "yes" to FI. Some mention of, but no adjustment for confounding factors **CASP rating** **Low**
Authors, Date & Title	**Aim**	**Study Design, Sample & Location**	**Methods & Analysis**	**Key Findings:**	**Strengths & Limitations**
Thomas, Fitzpatrick, Sidani, & Gucciardi (2018) *Developing and Implementing a Food Insecurity Screening Initiative for Adult Patients Living With Type 2 Diabetes*	Examine acceptability & feasibility of a food insecurity (FI) screening initiative that will help health providers modify diabetes management strategies	Systematic literature reviews, qualitative interviews & 4 diabetes care sites in Toronto were used	Definition: inadequate or insecure access to food because of financial constraints Part 1: Choosing and piloting FI questionnaires with population of interest, including qualitative interviews with 10 patients and 15 care providers Single- and 2-item versions of HFSS were	39% found to be food insecure 71% patients were willing and comfortable to discuss their experiences with food insecurity with their healthcare provider Was found both relevant and non-intrusive to discuss in healthcare setting. No embarrassment or negative reactions reported Perceived time barriers of the provider and discomfort with discussing financial hardship may	<u>Strengths</u> Care algorithm based on systematic review of evidence Recruitment strategy well described and validated by participants <u>Limitations</u> Screen only for income-associated FI as per HFSS Assumes poverty is root cause of FI

			used to assess food consumption over last 3 months Part 2: A systematic literature review to develop a FI algorithm and guidelines for managing individuals with DM 2 who are food insecure. Part 3: registered nurses& registered dietitians working in diabetes consented to the FI screening initiative to determining acceptability and feasibility of Part 2 by (a) employing initiative with 33 patients & 5 care providers (b) Interviewing 7 patients and 5 care providers to discuss acceptability and feasibility. Recruitment occurred by handing out flyers during diabetes classes or appointments and by using posters Participants were > 18 years and were	be barriers in patients choosing to disclose their FI status Strong rapport with a provider, perceiving the questions as important to their diabetes management and overall literacy increased the likelihood of answering the FI questions Screening elicited how patients cope with FI and how it affects diabetes self-management. Information provided was helpful to providers in guiding care and support for patients. Systematic review that informed FI algorithm encouraged the following assessment & management plan for individuals identified with FI: Assess • Medical history • Diabetes knowledge • Diabetes self-management skills • Mental health • Literacy level • Physical limitations • Housing • Financial support • Social support • Access to food • Cultural influences • Smoking habits Assess risk of hypoglycemia:	Results limited to the experience of dieticians one RN screening, not PCPs Unclear how comfortable PCP feel discussing FI Unclear how often screening should occur, especially if temporarily food insecure Unsure if saturation of data reached vs screening was completed during a given/specific period of time **CASP rating** **Moderate**

			diagnosed with diabetes Inductive qualitative approach used Interviewed audio-recorded and coded in NVivo Thematic analysis used to recognize developing themes Consensus among researchers was used to recap final set of themes	• Review how to treat hypoglycemia • Replace glucose lowering medications that cause hypoglycemia • Schedule medications with meals • Consider a more flexible insulin regimen • Consider adjusting glycemic target upwards Management • Develop collaborative & realistic treatment plan • Encourage inclusion of family members in education • Consider client's medication coverage Consider referrals: • Dietitian • Nurse • Social worker • Respiratory Therapist for smoking cessation • Local community food resources (food banks, community kitchens, low cost grocery stores) • Food skills classes • Assess if eligible for Special Diet Allowance funding Dietary management • Individualize nutrition recommendations based on the client's budget, food skills, and	

				available food storage and cooking equipment • Provide information on low cost community foods recourses and meals • Provide low cost ideas for treating hypoglycemia Assessing for FI can assist health-care providers in supporting diabetes self-management. Further evaluation needed to establish how FI screening may improve a diabetes self-management and outcomes. Important to acknowledge when screening may not be necessary or important. May bring meaning and understanding to providers why patients might not follow diabetes management recommendations. FI can be best addressed through income-based interventions.	

Appendix C

Food Insecurity Tools

Screening Tool	Purpose/ Intent	Dimension measured	Food Insecurity Level	No. of Questions	Sensitivity/ Specificity[6]	Validated in Healthcare Setting?	Comments
Hager two-item screen	Identifies income associated food insecurity	Economic Access[7]	Household	2	97% / 83%	No	
Girard four-point tool	Identifies income associated food insecurity	Economic Access	Household Individual	4	n/a	No	
Household Food Insecurity Access Scale (HFIAS)	Measures access and Anxiety or uncertainty surrounding food supply Access to quality and variety of food Insufficient food intake and its physical consequences	Economic Access	Individual	9	n/a	No	
Townsend Food Behaviour Checklist	Identifies income associated food insecurity	Economic Access	Individual	2	n/a	No	
Radimer/Cornell	Identifies income associated food insecurity	Economic Access Utilization	Individual	8	n/a	No	Well analyzed in peer-reviewed literature
Modified Radimer/Cornell	Identifies income associated food insecurity	Economic Access Utilization	Individual	10	n/a	No	Well analyzed in peer-reviewed literature
One-Item Hunger Screening Question	Detect income-associated food insecurity	Economic Access	Household	1	83% / 80%	Yes	

[6] Diagnostic accuracy in capturing the specific dimension of food insecurity listed in each study. Note: studies have near exclusively determined this value by validating the tool against the HFSSM
[7] "Economic access" to food refers to access to food income-associated food insecurity

Two-Item Hunger [8]Vital Sign (HVS)	Detect income-associated food insecurity and hunger for the purpose of linking screened individuals to resources	Economic Access	Household	2	89-97% / 74-84%	Yes	
Household Dietary Diversity Score (HDDS)	Measures dietary diversity as a proxy for food security. Measures 12 different food groups Can be used to measure food security changes over time	Food quality	National Regional Household	12		No	
Household Food Insecurity Access Scale (HFIAS)	Used to measure FS at regional or household levels Used to monitor impact of interventions	Anxiety Food Preferences Economic access Food quantity	Regional Household	9		No	
Household Hunger Scale (HHS)	Measures hunger as a proxy for food security Can be repeated to measure the impact of interventions on hunger	Economic Access Food quantity	Regional Household	3		No	
Core Food Security Measurement /Household Food Security Survey Module (CFSM/HFSSM)	Measures 4 areas of IAFI: 1) anxiety about household food supplies 2) perceptions of accessibility to food quality or quantity	Economic Access Anxiety	Household	18		Yes	Well analyzed in peer reviewed literature Gold standard

[8] Note: Two-question short-form from HFSS tool

	3) any reductions in food intake 4) children's reduced food intake						
Household Food Security Survey Module SF (HFSSM-sf)	Validated short form of HFSSM to capture IAFI	Economic Access	Household	6	98%/ 92%	Yes	Well analyzed in peer reviewed literature
American Academy of Pediatrics (AAP) Tool[9]	Detect income-associated food insecurity and hunger for the purpose of linking screened individuals to resources	Economic Access	Household	2	71%-82% / 96%[10]	Yes	Comparative studies demonstrate AAP missed a quarter of food insecure individuals compared to HVS
3-item Food Security tool[11]	Adapted from the HFSSM to identify food insecurity amongst a diabetic population	Economic Access	Household	3	n/a	No	Not validated. Used for one pilot study Validated using 3 food secure and 3 food insecure individuals with DM 2
Food Insecurity by Elders (FIE)	Elderly augmented HFSSM	Economic Access Physical Access Utilization	Individual-	14[12]	89%/69%	No	Extra questions created based on one study's findings

[9] Validated against HVS, and does not specifically measure pediatric population
[10] Values reflect families without children
[11] Adapted using 3 questions from validated HFSSM. Not validated to identify food insecurity and no sensitivity/specificity testing.
[12] In addition to the HFSSM