An Evaluation of Diabetes-Related Foot Ulcer Screening Implementation Initiatives and the Application of Guideline-Recommended Prevention Recommendations by New Zealand Podiatrists

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Abstract

Introduction

The rise of non-communicable diseases such as diabetes is one of the New Zealand (NZ) health system's greatest challenges. In NZ, diabetes rates are forecasted to grow 70-90% by 2040, with an associated cost of care increase of 63% to NZD$3.5 billion. Arguably, the most serious complication of diabetes is the development of diabetes-related foot ulcers. Much of the foot ulcer research has been on ulcer healing; however, there have been increasing calls for more focus on prevention. There are suggestions that up to 75% of foot ulcers can be prevented by applying guideline-recommended care. However, the extent to which these guideline recommendations are implemented into clinical practice in relation to the prevention of diabetes-related foot ulcers remains unknown.

Aim

This thesis intends to determine how guideline recommendations relating to the prevention of diabetes-related foot ulcers are implemented within clinical practice. This was undertaken through two aims. Firstly, to review studies that have evaluated interventions designed to increase guideline-recommended foot screening rates within health systems and to determine whether these interventions have resulted in a change in foot screenings. Secondly, to assess the alignment of assessment and management used in the prevention of diabetes-related foot disease by NZ podiatrists to the international prevention guideline recommendations.

Methods

This thesis involved two central studies. Firstly, a scoping review was undertaken to review existing literature, evaluating the implementation of guideline recommendations relating to foot screening to prevent diabetes-related foot ulcers. This review primarily aimed to determine whether these implementation interventions resulted in changes in foot screening rates in clinical practice. Secondly, a survey of NZ podiatrists was undertaken to assess the level of self-reported adherence in clinical practice to international guideline recommendations relating to the prevention of diabetes-related foot ulcers and what barriers and enablers they considered existed to implement those recommendations in clinical practice.

Results

The scoping review screened 2900 studies, of which forty-nine studies were included in the review. The primary population targeted were doctors (n=23, 47%), health centres (n=12, 24%), allied health professionals (n=7, 14%), patients (n=4, 8%) and nurses (n=3, 6%). Most studies (82%) used between one and three intervention modalities, with clinician education and training used most frequently, followed by provision of clinical resources, feedback reports and

infrastructure. In total, 83% (n=41) of the studies identified an improvement in foot screening rates, with 10% (n=5) identifying no change and 2% (n=1) identifying a decrease in foot screening rates.

The survey of NZ podiatrists had seventy-seven responses (16.3% of the NZ podiatry workforce) which were received, of which 52 completed >50% of items and were included. Of those 52 podiatrists, 73% were from the private sector. Public sector podiatrists reported higher weekly caseloads of patients with diabetes (p=0.03) and foot ulcers (p<0.001). The NZ Society for the Study of Diabetes (NZSSD) risk stratification pathway and IWGDF guidelines were the two most frequently utilised guidance documents. Participants reported median scores of at least “often” (<2) for all items in the assessment and management, inspection, screening, and education provision domains for people with a high-risk foot. More than 50% of respondents reported screening more frequently than guideline recommendations for people with a very low to moderate risk foot. A structured education program was only used by 4 (5%) participants. Public sector podiatrists reported greater provision of custom-made footwear (p=0.04) and multi-disciplinary team care (p=0.03).

Conclusions

The scoping review identified that doctors continue to remain the population most often targeted for foot screening initiatives and that a range of interventions can result in an improvement of foot screening rates if their selection is guided by the needs of the population. The survey identified that NZ podiatrists generally follow international guidelines for the prevention of diabetes-related foot ulceration; however, there may be an over-screening of people with very low to medium risk in clinical practice. Podiatrists are less adherent to more complex recommendations, such as structured education and integrated care, which may require resourcing. Future directions include an increasing emphasis on the personalisation of preventative care strategies with the development of a conceptual framework, the need for investigation into the state of play and application of integrative care systems to support the care of the person with diabetes, and the potential need for locally adapted guidelines to support the provision of diabetic foot care within NZ.

Contents Page

List of Figures

List of Tables

Attestation of Authorship

I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person (except where explicitly defined in the acknowledgements), nor used artificial intelligence tools or generative artificial intelligence tools (unless it is clearly stated, and referenced, along with the purpose of use), nor material which to a substantial extent has been submitted for the award of any other degree or diploma of a university or other institution of higher learning.

Signature:

Hannah Jepson

Date: 24/05/2024

List of Common Abbreviations

AGREE	Appraisal of Guidelines for Research and Evaluation
AUTEC	Auckland University of Technology Ethics Committee
CPG	Clinical Practice Guidelines
DALY	Disability Adjusted Life Years
DFD	Diabetes-related foot disease
DFU	Diabetes-related foot ulcer
GP	General practitioner
GRADE	Grading of Recommendations Assessment, Development and Evaluation
HRFS	High-Risk Foot Service
IWGDF	International Working Group of diabetes-related foot ulceration
LEA	Lower Extremity Amputation
NZ	Aotearoa New Zealand
NZSSD	New Zealand Society for the Study of Diabetes

Co-authored Works Arising from the Thesis

Chapter 2 of this thesis is presented in preparation for submission to the Journal of Foot and Ankle Research. Chapter 3 is published in the Journal of Foot and Ankle Research and made available under the CC BY-NC-ND 4.0. deed.

Candidate contribution to co-authored publications	
Chapter 2 Jepson, H., Lazzarini, P. A., Garrett, M., & Carroll, M. R. (2023). Strategies Employed to Increase the Rate of Guideline-Recommended Foot Screening in People with Diabetes: A Scoping Review. [to be submitted to Journal of Foot and Ankle Research]	
HJ, PL, MG, and MC were responsible for the conception and design of the research. HJ and MC were responsible for data analysis. HJ and MC were responsible for data interpretation. HJ, PL, MG, and MC were responsible for the preparation of the manuscript. HJ, PL, MG, and MC read and approved the final manuscript prior to submission for peer review.	Jepson, H (80%) Carroll, M (10%) Lazzarini, P (5%) Garrett, M (5%)

Candidate contribution to co-authored publications	
Chapter 3 Jepson, H., Lazzarini, P. A., Garrett, M., & Carroll, M. R. (2023). How does the clinical practice of Aotearoa New Zealand podiatrists align with international guidelines for the prevention of diabetes-related foot disease? A cross-sectional survey. Journal of Foot and Ankle Research, 16(1), 53.	
HJ, PL, MG, and MC were responsible for the conception and design of the research. HJ and MC were responsible for data analysis. HJ and MC were responsible for data interpretation. HJ, PL, MG, and MC were responsible for the preparation of the manuscript. HJ, PL, MG, and MC read and approved the final manuscript prior to submission for peer review.	Jepson, H (80%) Carroll, M (10%) Lazzarini, P (5%) Garrett, M (5%)

We, the undersigned, hereby agree to the percentages of participation identified in the chapters above.

Matthew Carroll	
Peter Lazzarini	
Michele Garrett	

Ethical Approval

Auckland University of Technology Ethics Committee (AUTEC) granted ethical approval for research conducted and disseminated in chapters three and four. All relevant documentation described below is included in the appendices.

Chapter 3

Ethics approval (22/129, expiry date 6th July 2025) – Appendix 1

Participant information sheet – Appendix 2

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Chapter 1: Thesis Overview

Purpose of the Research

This thesis aimed to determine how guideline recommendations for preventing diabetes-related foot ulcers (DFU) are implemented within clinical practice. Firstly, it aimed to review studies that have evaluated interventions designed to increase guideline-recommended foot screening rates within health systems and to determine whether these interventions have resulted in increased foot screenings. Secondly, it aimed to review the application of guideline-recommended preventative care within clinical practice locally by NZ podiatrists, with a survey on the application of assessment and management prevention practices for DFU.

Background

Diabetes

Diabetes is a condition related to the body's ability to regulate blood sugar levels. It is defined by the degree of hyperglycaemia, with fasting plasma glucose ≥7.0mmol/l considered diagnostic of the condition (1). An individuals pathway to developing diabetes can be considered as a complex combination of risk factors, some of which are not able to be modified, such as ethnicity, family history and genetic predisposition, and others which are more modifiable, such as obesity, physical activity levels, and dietary choices (2). Additionally, the development of a chronic disease such as diabetes is often influenced by social determinants of health outside of an individual's control, such as education, income, social cohesion, equity, access, geographical isolation, and deprivation (3, 4). Diabetes can result in reduced life expectancy, significant morbidity, and diminished quality of life, with the increasing burden of diabetes accompanied by greater health expenditures (5, 6). It is currently estimated that diabetes affects 537 million people worldwide, with future projections suggesting that by 2045 this figure will have increased by 46% (6). Between 2000 and 2016, there was a 5% increase in premature mortality from diabetes, which is contrasted with the probability of dying from any one of the four main noncommunicable diseases, which decreased by 18% globally over the same time period (7). In relation to disability-adjusted life years (DALY), a measure of the equivalent of one year of full health lost to disease, diabetes is increasing in burden throughout the world, moving from number 20 in 1990 to number 8 in 2019 for all ages (8). Diabetes increases the demand on all levels of health care, and when combined with other comorbidities, the total healthcare utilisation significantly increases (9). The 2019 estimated global direct health expenditure for diabetes is US$760 billion, which is expected to grow to US$825 billion by 2030 and US$845 billion by 2045 (10).

Diabetes lower extremity complications

The effects of hyperglycaemia can impact almost every system of the body. Adults with diabetes have a two-fold excess risk for a range of vascular diseases, with the condition particularly affecting both the macrovascular supply (leading to the development of myocardial infarction, cerebral vascular aneurysm, and/or peripheral vascular disease) and microvascular supply (leading to the development of nephropathy, retinopathy, and/or neuropathy) (11, 12, 13, 14). One of the more serious complications of diabetes is the development of a diabetes-related foot ulcer (DFU), which is a foot ulcer in a person with current or previously diagnosed diabetes mellitus, and usually accompanied by peripheral neuropathy and/or peripheral artery disease in the lower extremity (15). An individual with a DFU is associated with a wide range of treatment costs, with studies demonstrating that this can amount to tens of thousands of dollars per year, irrespective of the study and the implicated healthcare system (16). However, determining the true cost of DFU can be challenging, as the costs are often restricted to the healthcare payer's perspective and can, therefore, underestimate the true societal costs of DFU (17). For example, if the complications of diabetes are considered independently in terms of their impact on DALY, estimates have placed diabetes-related foot disease (DFD) within the top ten causes of the global disability burden (18). The combined cost of DFU on the healthcare systems, therefore, can be considered significant, with Kerr et al. (2019) estimating that diabetic foot care accounted for a substantial proportion of healthcare expenditure in England, estimated at between £837 million and £962 million pounds between the years 2014-2015 (19). In response to this significant burden of DFD, there have been calls for an increased focus on preventative strategies to reduce the burden of foot disease and for efforts to be centred on maximising ulcer-free days (13, 19, 20, 21). There is evidence that this focus on the prevention and rehabilitation of DFU can improve health outcomes. In studies evaluating the implementation of guideline recommendations for preventing DFU, a reduction in LEA frequency has been identified in association with the provision of structured diabetic foot care (22) and implementation of a multidisciplinary care team approach (23). In studies on outcomes following the diagnosis of DFU, the implementation of guideline-recommended care has resulted in a progressive reduction of hospitalisation and amputee rates for major LEAs (24, 25); and significant decreases in rates of diabetes-related LEA (26).

Diabetes in New Zealand

The NZ health system faces many competing demands, which are placing considerable strain on its current and future capacity. New Zealanders are living longer and are reporting more time in poor health, with the main cause of death being non-communicable diseases (27). In NZ, diabetes rates are forecasted to grow 70-90% by 2040, with an associated cost of care increase of 63% to NZD$3.5 billion (28). The development of lower-extremity complications in people with diabetes, therefore, constitutes a considerable burden for the healthcare system (13). Currently,

the complication costs of people with diabetes are estimated to be 109-275% higher than in people without diabetes, with the estimated first-year costs of LEA AU$63,575, ulceration/gangrene AU$29,803, and neuropathy AU$15,637, with second-year costs ranging from 16% to 74% of first-year costs (28, 29). In NZ, it has been identified that 58% of amputations were performed on people with diabetes (30). The impact of diabetes throughout NZ is not equal, with those living in the most deprived areas having rates 2.7 times higher than those living in the least deprived areas (31). Additionally, the prevalence and impact in those populations which are geographically remote and/or with lower access to specialised care (26) and in ethnic groups that face systemic inequities which drive disparities significantly higher (30). Although the NZ Pacific population had the highest estimated rates of diabetes at 122.7 per 1000, followed by the Indian population at 103.1; the Māori population at 71.2 appear to be disproportionally affected by the complications of diabetes and are 65% more likely to undergo a major LEA (31, 32). This evidence of a widening disease burden gap occurring within NZ between Māori and non-Māori, with Māori developing morbidities at a substantially younger age than other ethnic groups, results in an associated increase in the downstream impacts and costs for Māori whānau and the health and disability system (3, 33). This increase in diabetes and the high cost of complications have resulted in calls for a change in the NZ diabetes model of care (28). New Zealand currently has no public health strategy for the prevention, treatment, and care of diabetes (28), however there are national documents supporting the treatment and care pathways within the primary care health systems although these are not consistently applied throughout regions of NZ (34). The process of screening is to test for the presence or absence of diabetes-related foot disease, and its level of detail is limited compared to that of a foot examination (15). It is important however to note that the process of screening aims to determine the presence or absence of a disease or condition, and that in order for it to result in improved health outcome it should be implemented within an organised screening program that includes not only the identification of target populations but also considers treatment, monitoring, and evaluation (35). It has been suggested that a NZ government investment in a foot screening and protection program for people with diabetes could have a significantly positive impact on the NZ economy and society, with 390 major and 211 minor LEA potentially avoided each year (28).

Guidelines on the prevention of diabetes-related foot ulceration

There has been an increased emphasis on a wider range of evidence for the basis of clinical decision-making in relation to clinical care provision (36, 37) and a rapid increase in the volume of evidence produced (38, 39). Additionally, the active involvement of patients in healthcare decisions is increasingly driving consideration of the full range of outcomes that patients experience and consider critical in deciding what to do (40). Combined, this creates a considerable challenge for the healthcare practitioner. Decisions made in isolation from other

decisions in healthcare on the same topic can cause misleading, unnecessary, or conflicted inputs on the health system (36). In response to these pressures, new approaches for disseminating research have been developed, with an emphasis on practice-based evidence and external validity (41). By developing high-quality, evidence-based clinical practice guidelines, clinicians can practice evidence-based medicine without critically appraising individual studies. Guidelines offer a way of bridging the gap between policy, best practice, local contexts, and patient choice (42, 43). Guidelines are systematically developed statements (44), and guideline-driven care can effectively change the process and outcome of care provided (45). However, the potential benefits of guidelines are only as good as their quality, with guidelines often developed with different methodologies, evidence grading, topics and professionals involved (46).

The evidence around the adoption of guidelines remains variable, with guidelines more likely to be adopted when there is strong professional support, the professionals involved are not isolated, where there is a stable and convincing evidence base and no increased or unfunded costs, and where there are systems for tracking implementation (47). The development, evaluation, dissemination, and implementation strategies of guidelines are central to their success and ability to promote evidence-based clinical practice and create change in clinical care to support improvement in healthcare outcomes (48, 49). It has been identified that applying prevention guidelines for DFU can reduce the disease burden (50). These recommendations around foot ulcer healing and prevention are developed through a structured evaluation process and synthesis of the available evidence base. This understanding and application of evidence-based practice (EBP) has emphasised a wider range of evidence to be considered when undertaking healthcare-related decisions, along with an increased awareness of the production of quality research (51, 52, 53).

The International Working Group on the Diabetic Foot (IWGDF) aimed to develop guidance to support clinicians in increasing awareness of the complexity of the diabetic foot and rapidly increasing production of research literature (54). Since 2007, it has been informed by a systematic review of the literature, and since 2015, it has been formulated through grading recommendations, assessment, development, and evaluations (GRADE) (55). The IWGDF guidelines are currently considered the best quality international guidelines for foot care in people with diabetes (54). The vision of the IWGDF is to (1) develop evidence-based guidelines with recommendations that aim to be applicable in daily practice and that reflect the level of (un)certainty of the knowledge obtained and (2) to reduce the high burden of disease that societies and people with diabetic foot disease experience (56). With the worldwide diabetes epidemic, it can be considered that this vision is imperative more than ever to ensure access to quality care for all people with diabetes, regardless of their age, geographic location, economic or social status. The current best practice approach for diabetic foot ulcer healing within the IWGDF

guidelines focuses on identifying and treating foot infection and ischaemia, applying pressure offloading, and providing local ulcer care (57). Adjunct therapies for foot ulcer healing are only recommended in cases where the best standard of care alone has failed to heal foot ulceration (58). The International Working Group on the Diabetic Foot guideline recommendations for the prevention of foot ulceration focus on the identification of a person at risk, the regular inspection and screening of the person at risk, the provision of structured education, and the treatment of relevant risk factors for foot ulcer development (57).

Podiatrists' role in the prevention of diabetes-related foot ulceration

Few diseases globally require treatment from so many different disciplines as diabetes-related foot disease, with a team-based approach has been shown to result in improved outcomes (23). Supported by international guidelines such as the IWGDF, the development of a shared vocabulary, treatment goals, and recommendations can continue to act to bring the number of different disciplines together to support the person with diabetes-related foot disease (59). Additionally, research indicates that there is a need for Indigenous and general health model inclusion, alongside the provision of evidence-based, trauma-informed, and culturally safe approaches for those patients from Indigenous, rural and low-income backgrounds, which can support improved diabetic foot outcomes (60, 61, 62, 63). This is likely to be achievable, particularly within the profession of podiatry. Podiatrists have developed into key healthcare professionals in managing DFU, with the contribution of podiatrists in both the prevention and the management of diabetic foot complications having long been acknowledged (64). However, podiatrists alone are not able to manage the complexity of DFD, with the ageing population along with the associated burden of chronic disease giving rise to the need for a health workforce reform agenda (65). The care of DFD requires a high level of multidisciplinary involvement (59) and there have been increasing calls for integrated care as an approach to reducing this burden, with links between community and hospital services providing a pathway of care with the implementation of interdisciplinary foot care services (66, 67, 68)However, as a key member of the community prevention strategy, secondary care services, and tertiary diabetic foot interdisciplinary team, podiatrists play a key role in a larger diabetic foot prevention strategy.

In NZ, the peak body for diabetes care is the New Zealand Society for the Study of Diabetes (NZZSD), which aims to make best-practice diabetes foot-related education, screening, and treatment equitable and accessible to all people with diabetes in NZ (69). New Zealand currently has available a foot screening and referral pathway alongside the development of regional community health pathways (34) to support the provision of care. However, with the disbanding of the NZ Guidelines Group in 2012, clinical practice for DFU is not supported by locally adapted comprehensive guidelines (70). In a workforce study in NZ, 21% of podiatrists identified that their main work was 'diabetes podiatry', similar to that of the UK and Australia (71). However, the

extent to which guidelines are employed within clinical practice to prevent diabetic foot complications remains unknown. This thesis, therefore, aims to determine how guideline recommendations relating to the prevention of diabetic foot complications are implemented within clinical practice.

Thesis Aims and Outline

Research Aims

1. To review studies that have evaluated interventions designed to increase guideline-recommended foot screening rates within health systems and to determine whether these interventions have resulted in a change in foot screenings undertaken.
2. To determine the alignment of assessment and management used in the prevention of diabetes-related foot disease by NZ podiatrists to the international prevention guideline recommendations.

Thesis Outline

The thesis comprises four chapters. Table 1 presents an overview of the chapters aligned with the research objectives and questions.

Table 1. Overview of thesis chapters

Chapter 2 Strategies Employed to Increase the Rate of Guideline-Recommended Foot Screening in People with Diabetes: A Scoping Review	**Research Aim 1**: To review studies that have evaluated interventions designed to increase guideline-recommended foot screening rates within health systems and to determine whether these interventions have resulted in an increase in foot screenings undertaken.
Chapter 3 How Does the Clinical Practice of Aotearoa New Zealand Podiatrists Align with International Guidelines for the Prevention of Diabetes-Related Foot Disease? A Cross-Sectional Survey	**Research Aim 2**: To determine the alignment of assessment and management used in the prevention of diabetes-related foot disease by NZ podiatrists to the international prevention guideline recommendations.
Chapter 4 This includes the thesis discussion, an overview of the main findings, future directions, clinical implications, the strengths and limitations of the thesis, and the thesis conclusion.	

Chapter One References

1. World Health Organization. Definition and Diagnosis of Diabetes Mellitus and Intermediate Hyperglycemia. Report of a WHO/IDF Consultation [Internet]. Geneva: World Health Organization; 2006. 9241594934 Available from: https://www.who.int/publications/i/item/definition-and-diagnosis-of-diabetes-mellitus-and-intermediate-hyperglycaemia
2. Schellenberg ESD, M; D, Vandermeer B, Ha C, Korownyk C. Lifestyle Interventions for Patients With and At Risk for Type 2 Diabetes. Ann Intern Med. 2013;159(8):543-51.
3. Gurney J, Stanley J, Sarfati D. The Inequity of Morbidity: Disparities in the Prevalence of Morbidity Between Ethnic Groups in New Zealand. J Comorb. 2020;10:2235042x20971168.
4. Yu D, Osuagwu UL, Pickering K, Baker J, Cutfield R, Wang Z, et al. Adverse Clinical Outcomes Attributable to Socioeconomic and Ethnic Disparities Among People with Type 2 Diabetes in New Zealand Between 1994–2018: A Multiple Linked Cohort Study. Clin Epidemiol. 2023;Volume 15:511-23.
5. World Health Organization. Diabetes Fact Sheet [Internet]. 2022 [Available from: https://www.who.int/news-room/fact-sheets/detail/diabetes.
6. Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, Duncan BB, et al. IDF Diabetes Atlas: Global, Regional and Country-Level Diabetes Prevalence Estimates for 2021 and Projections for 2045. Diabetes Res Clin Pract. 2022;183:109119.
7. Mikkelsen B. Surveillance of Noncommunicable Diseases "About Us" [Internet]. World Health Organization; 2020 [Available from: https://www.who.int/teams/surveillance-of-noncommunicable-diseases/about/ncds.
8. Vos T, Lim SS, Abbafati C, Abbas KM, Abbasi M, Abbasifard M, et al. Global Burden of 369 Diseases and Injuries in 204 Countries and Territories, 1990–2019: A Systematic Analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396(10258):1204-22.
9. Struijs JN, Baan CA, Schellevis FG, Westert GP, Van Den Bos GA. Comorbidity in Patients with Diabetes Mellitus: Impact on Medical Health Care Utilization. BMC Health Serv Res. 2006;6(1):1-9.
10. Williams R, Karuranga S, Malanda B, Saeedi P, Basit A, Besançon S, et al. Global and Regional Estimates and Projections of Diabetes-Related Health Expenditure: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. Diabetes Res Clin Pract. 2020;162:108072.
11. The Emerging Risk Factors Collaboration. Diabetes Mellitus, Fasting Blood Glucose Concentration, and Risk of Vascular Disease: A Collaborative Meta-Analysis of 102 Prospective Studies. Lancet. 2010;375(9733):2215-22.
12. United States Renal Data System. 2018 USRDS Annual Data Report: Epidemiology of Kidney Disease in the United States. [Internet]. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2018. Available from: https://www.niddk.nih.gov/about-niddk/strategic-plans-reports/usrds/prior-data-reports/2018
13. Armstrong DG, Boulton AJM, Bus SA. Diabetic Foot Ulcers and their Recurrence. N Engl J Med. 2017;376(24):2367-75.
14. Steinmetz JD, Bourne RR, Briant PS, Flaxman SR, Taylor HR, Jonas JB, et al. Causes of Blindness and Vision Impairment in 2020 and Trends over 30 Years, and Prevalence of Avoidable Blindness in Relation to VISION 2020: the Right to Sight: an analysis for the Global Burden of Disease Study. Lancet Glob Health. 2021;9(2):e144-e60.
15. van Netten JJ, Bus SA, Apelqvist J, Chen P, Chuter V, Fitridge R, et al. Definitions and Criteria for Diabetes-Related Foot Disease (IWGDF 2023 update). Diabetes Metab Res Rev. 2023.
16. Petrakis I, Kyriopoulos IJ, Ginis A, Athanasakis K. Losing a Foot Versus Losing a Dollar; A Systematic Review of Cost Studies in Diabetic Foot Complications. Expert Rev Pharmacoecon Outcomes Res. 2017;17(2):165-80.
17. Mairghani M, Jassim G, Elmusharaf K, Patton D, Eltahir O, Moore Z, et al. Methodological Approaches for Assessing the Cost of Diabetic Foot Ulcers: A Systematic Literature Review. J Wound Care. 2019;28(5):261-6.

18. Lazzarini PA, Pacella RE, Armstrong DG, Van Netten JJ. Diabetes-Related Lower-Extremity Complications are a Leading Cause of the Global Burden of Disability. Diabet Med. 2018;35(9):1297-9.
19. Kerr M, Barron E, Chadwick P, Evans T, Kong WM, Rayman G, et al. The Cost of Diabetic Foot Ulcers and Amputations to the National Health Service in England. Diabet Med. 2019;36(8):995-1002.
20. Lazzarini PA, Hurn SE, Kuys SS, Kamp MC, Ng V, Thomas C, et al. The Silent Overall Burden of Foot Disease in a Representative Hospitalised Population. Int Wound J. 2017;14(4):716-28.
21. Pena G, Cowled P, Dawson J, Johnson B, Fitridge R. Diabetic Foot and Lower Limb Amputations: Underestimated Problem with a Cost to Health System and to the Patient. ANZ J Surg. 2018;88(7-8):666-7.
22. Monteiro-Soares M, Vale-Lima J, Martiniano J, Pinheiro-Torres S, Dias V, Boyko EJ. A Systematic Review with Meta-Analysis of the Impact of Access and Quality of Diabetic Foot Care Delivery in Preventing Lower Extremity Amputation. J Diabetes Complications. 2021;35(4):107837.
23. Albright RH, Manohar NB, Murillo JF, Kengne LAM, Delgado-Hurtado JJ, Diamond ML, et al. Effectiveness of Multidisciplinary Care Teams in Reducing Major Amputation Rate in Adults with Diabetes: A Systematic Review & Meta-Analysis. Diabetes Res Clin Pract. 2020;161:107996.
24. Lombardo FL, Maggini M, De Bellis A, Seghieri G, Anichini R. Lower Extremity Amputations in Persons with and without Diabetes in Italy: 2001–2010. PLoS One. 2014;9(1):e86405.
25. Krishnan S, Nash F, Baker N, Fowler D, Rayman G. Reduction in Diabetic Amputations Over 11 Years in a Defined U.K. Population. Diabetes Care. 2008;31(1):99-101.
26. Zhang Y, Van Netten JJ, Baba M, Cheng Q, Pacella R, McPhail SM, et al. Diabetes-Related Foot Disease in Australia: A Systematic Review of the Prevalence and Incidence of Risk Factors, Disease and Amputation in Australian Populations. J Foot Ankle Res. 2021;14(1):1-16.
27. Cumming J. New Zealand Health System Review. [[Internet]]. New Delhi: World Health Organization Regional Office for South-East Asia; 2022. Report No.: 9789290210122 Available from: https://apo.who.int/publications/i/item/new-zealand-health-system-review
28. Shepard-Wipiiti T, Brennan L. The Economic and Social Cost of Type 2 Diabetes. [Internet]. Ministry of Health; 2021. Available from: https://healthierlives.co.nz/report-on-the-economic-and-social-cost-of-type-2-diabetes/
29. Dinh NTT, De Graaff B, Campbell JA, Jose MD, John B, Saunder T, et al. Costs of Major Complications in People With and Without Diabetes in Tasmania, Australia. Aust Health Rev. 2022;46(6):667-78.
30. Gurney JK, Stanley J, York S, Sarfati D. Lower-Limb Amputation in New Zealand: Temporal Changes and the Role of Diabetes Mellitus. NZ Med J. 2018;131(1484):71-3.
31. Health New Zealand [Te Whatu Ora]. Virtual Diabetes Register and Web Tool: New Zealand Government; 2022 [Available from: https://www.tewhatuora.govt.nz/for-health-professionals/data-and-statistics/virtual-diabetes-tool/#:~:text=In%202022%2C%20about%20307%2C400%20people,CI%3A%2043.0%2C%2043.3).
32. Robinson TE, Kenealy T, Garrett M, Bramley D, Drury PL, Elley CR. Ethnicity and Risk of Lower Limb Amputation in People with Type 2 Diabetes: A Prospective Cohort Study. Diabet Med. 2016;33(1):55-61.
33. Ministry of Health. Whakamaua: Māori Health Action Plan 2020-2025. [Internet]. Wellington: Ministry of Health 2020. Report No.: 7429 Available from: https://www.health.govt.nz/publication/whakamaua-maori-health-action-plan-2020-2025
34. Stokes T, Tumilty E, Doolan-Noble F, Gauld R. HealthPathways Implementation in a New Zealand Health Region: Qualitative Study Using the Consolidated Framework for Implementation Research. BMJ Open. 2018;8(12):e025094.
35. Sagan A, McDaid D, Rajan S, Farrington J, McKee M. Screening: When Is It Appropriate and How Can We Get it Right? [Internet]. Copenhagen (Denmark): World Health Organization 2020; 2020. Available from: https://pubmed.ncbi.nlm.nih.gov/32716617/

36. Schünemann HJ, Reinap M, Piggott T, Laidmäe E, Köhler K, Põld M, et al. The Ecosystem of Health Decision Making: From Fragmentation to Synergy. Lancet Public Health. 2022;7(4):e378-e90.
37. Parkhurst JO, Abeysinghe S. What Constitutes "Good" Evidence for Public Health and Social Policy-making? From Hierarchies to Appropriateness. Soc Epistemol. 2016;30(5-6):665-79.
38. Howick J, Koletsi D, Ioannidis JPA, Madigan C, Pandis N, Loef M, et al. Most Healthcare Interventions Tested in Cochrane Reviews are not Effective According to High Quality Evidence: A Systematic Review and Meta-Analysis. J Clin Epidemiol. 2022;148:160-9.
39. Zha M-L, Cai J-Y, Chen H-L. A Bibliometric Analysis of Global Research Production Pertaining to Diabetic Foot Ulcers in the Past Ten Years. J Foot Ankle Surg. 2019;58(2):253-9.
40. Montori VM, Brito JP, Murad MH. The Optimal Practice of Evidence-Based Medicine. JAMA. 2013;310(23):2503.
41. Brownson RC, Fielding JE, Green LW. Building Capacity for Evidence-Based Public Health: Reconciling the Pulls of Practice and the Push of Research. Annu Rev Public Health. 2018;39(1):27-53.
42. Albarqouni L, Hoffmann T, Straus S, Olsen NR, Young T, Ilic D, et al. Core Competencies in Evidence-Based Practice for Health Professionals. JAMA Network Open. 2018;1(2):e180281.
43. Kredo T, Bernhardsson S, Machingaidze S, Young T, Louw Q, Ochodo E, et al. Guide to Clinical Practice Guidelines: The Current State of Play. Int J Qual Health Care. 2016;28(1):122-8.
44. Brouwers MC, Spithoff K, Kerkvliet K, Alonso-Coello P, Burgers J, Cluzeau F, et al. Development and Validation of a Tool to Assess the Quality of Clinical Practice Guideline Recommendations. JAMA Network Open. 2020;3(5):e205535.
45. Thomas L, Cullum N, McColl E, Rousseau N, Soutter J, Steen N. Guidelines in Professions Allied to Medicine. Cochrane Database Syst Rev. 2000(2):Cd000349.
46. Tan MKH, Goodall R, Hughes W, Langridge B, Shalhoub J, Davies AH. A Methodological Assessment of Diabetic Foot Syndrome Clinical Practice Guidelines. Eur J Vasc Endovasc Surg. 2020;60(2):274-81.
47. Sheldon TA, Cullum N, Dawson D, Lankshear A, Lowson K, Watt I, et al. What's the Evidence that NICE Guidance has been Implemented? Results From a National Evaluation Using Time Series Analysis, Audit of Patients' Notes, and Interviews. BMJ. 2004;329(7473):999.
48. Fischer F, Lange K, Klose K, Greiner W, Kraemer A. Barriers and Strategies in Guideline Implementation—A Scoping Review. Healthcare. 2016;4(3):36.
49. Grimshaw J, Thomas R, Maclennan G, Fraser C, Ramsay C, Vale L, et al. Effectiveness and Efficiency of Guideline Dissemination and Implementation Strategies. Health Technol Assess. 2004;8(6):1-72.
50. Bus SA, van Netten JJ. A Shift in Priority in Diabetic Foot Care and Research: 75% of Foot Ulcers are Preventable. Diabetes Metab Res Rev. 2016;32:195-200.
51. Baker M. 1,500 Scientists Lift the Lid on Reproducibility. Nature. 2016;533(7604):452-4.
52. Munafò MR, Chambers C, Collins A, Fortunato L, Macleod M. The Reproducibility Debate is an Opportunity, Not a Crisis. BMC Res Notes. 2022;15(1).
53. Eshre Capri Workshop Group. Protect Us from Poor-Quality Medical Research. Hum Reprod. 2018;33(5):770-6.
54. van Netten JJ, Apelqvist J, Bus SA, Fitridge R, Game F, Monteiro-Soares M, et al. The International Working Group on the Diabetic Foot: Stories and Numbers Behind Three Decades of Evidence-Based Guidelines for the Management of Diabetes-Related Foot Disease. Diabetes Ther. 2023;15:19-31.
55. Bus SA, van Netten JJ, Hinchliffe RJ, Apelqvist J, Lipsky BA, Schaper NC, et al. Standards for the Development and Methodology of the 2019 International Working Group on the Diabetic Foot Guidelines. Diabetes Metab Res Rev. 2020;36:e3267.
56. International Working Group of the Diabetic Foot. About IWGDF Guidelines [Internet]. 2023 [cited 2023 May 8]. Available from: https://iwgdfguidelines.org/about-iwgdf-guidelines/.
57. Schaper NC, Van Netten JJ, Apelqvist J, Bus SA, Fitridge R, Game F, et al. Practical Guidelines on the Prevention and Management of Diabetes-Related Foot Disease (IWGDF 2023 update). Diabetes Metab Res Rev. 2023.

58. Chen P, Vilorio NC, Dhatariya K, Jeffcoate W, Lobmann R, McIntosh C, et al. Guidelines on Interventions to Enhance Healing of Foot Ulcers in People with Diabetes (IWGDF 2023 update). Diabetes Metab Res Rev. 2024;40(3):e3644.
59. van Netten JJ, Apelqvist J, Bus SA, Fitridge R, Game F, Monteiro-Soares M, et al. The Unique Multidisciplinarity of Diabetes-Related Foot Disease. Diabetes Metab Res Rev. 2024;40(4):e3804.
60. van Netten J, Lazzarini P, Fitridge R, Kinnear E, Griffiths I, Malone M, et al. Australian Diabetes-Related Foot Disease Strategy 2018-2022: The First Step Towards Ending Avoidable Amputations Within a Generation. [Internet]. Brisbane: Diabetic Foot Australia, Wound Management CRC; 2017. Available from: https://www.diabetesfeetaustralia.org/australian-diabetes-related-foot-disease-strategy-2018-2022/
61. Blanchette V, Patry J, Brousseau-Foley M, Todkar S, Libier S, Leclerc A-M, et al. Diabetic Foot Complications Among Indigenous Peoples in Canada: A Scoping Review Through the PROGRESS-PLUS Equity Lens. Front Endocrinol. 2023;14.
62. Asiniwasis R, Stonechild AB, Queen D, Sibbald RG. Indigenous Diabetic Foot-Related Lower Extremity Amputations: Integrating Traditional Indigenous and Western Health Models for Improved Outcomes. Adv Skin Wound Care. 2023;36(2):63.
63. Bonevski B, Randell M, Paul C, Chapman K, Twyman L, Bryant J, et al. Reaching the Hard-to-Reach: a Systematic Review of Strategies for Improving Health and Medical Research with Socially Disadvantaged Groups. BMC Med Res Methodol. 2014;14(1):42.
64. Bacon D, Borthwick AM. Charismatic Authority in Modern Healthcare: The Case of the 'Diabetes Specialist Podiatrist'. Sociol Health Illn. 2013;35(7):1080-94.
65. Davies A, Bennett P, Nancarrow S, Cuesta-Vargas A. Specialisation Versus Special Interest - the Australian Podiatry Experience. J Foot Ankle Res. 2015;8(1).
66. Boulton AJM, Vileikyte L, Ragnarson-Tennvall G, Apelqvist J. The global burden of diabetic foot disease. Lancet. 2005;366(9498):1719-24.
67. Zhang Y, Lazzarini PA, McPhail SM, van Netten JJ, Armstrong DG, Pacella RE. Global Disability Burdens of Diabetes-Related Lower-Extremity Complications in 1990 and 2016. Diabetes Care. 2020;43(5):964-74.
68. Pallin JA, Buckley-O'Farrell K, Riordan F, McGrath N, O'Neill K, Macloughlin D, et al. Implementing an Integrated Diabetic Foot Care Programme in Ireland: Podiatrists' Experience. BMC Health Serv Res. 2023;23(1).
69. New Zealand Society for the Study of Diabetes. Diabetic Foot Special Interest Group [Internet]. NZSSD; 2022 [16th March 2024]. Available from: https://www.nzssd.org.nz/special-interest-groups/group/3/diabetic-foot-special-interest-group.
70. Formosa C, Gatt A, Chockalingam N. A Critical Evaluation of Existing Diabetic Foot Screening Guidelines. Rev Diabet Stud. 2016;13(2-3):158-86.
71. Carroll M, Jepson H, Molyneux P, Brenton-Rule A. The New Zealand Podiatry Profession – A Workforce in Crisis? J Foot Ankle Res. 2020;13(1):1-7.

Chapter 2: Strategies Employed to Increase the Rate of Guideline-Recommended Foot Screening in People with Diabetes: A Scoping Review

Preamble

The introduction highlighted both the size and extent of the diabetes epidemic worldwide, along with the need for an emphasis on lower limb prevention (50). It also highlighted the need in NZ for increased healthcare focus and government investment in the prevention of DFU and support of the care of the lower limb in people with diabetes (28). Best practice guidelines were identified as a mechanism for supporting clinical practice and assisting in knowledge translation, ensuring the best use of healthcare resources (72).

There is a high level of agreement within prevention guidelines on the identification of the person with the at-risk foot through routine screening (73, 74). The identification of a person at risk is ideally undertaken through population screening within an organised screening program, which includes the identification of the target population through treatment, monitoring, and evaluation (35) as without this organised approach, the short-term fall in incidences due to the identification of early diabetes-related foot changes through screening will be followed by a rise in step with the global epidemic (75). However, screening programs are not simple undertakings and require many changes to the behaviour at both a clinician and system level (35).

This scoping review aimed to determine what initiatives were used to increase guideline-recommended foot screening rates within health systems, the population they were targeted at, and what effect the foot screening initiative had on foot screening rates.

Abstract

Background

With the diabetes-related foot disease burden escalating, the implementation of targeted and effective risk screening in primary healthcare becomes urgent. This scoping review evaluates interventions designed to increase guideline-recommended foot screening rates within health systems. The goal is to determine whether these interventions have resulted in a change in foot screenings, underscoring the critical need for early detection of foot disease.

Methods

The scoping review was conducted per the JBI methodology for scoping reviews (83) and was reported in alignment with the Preferred Reporting Items for Systematic Reviews and Meta–Analysis–Scoping Review (PRISMA-ScR) checklist. A systematic search of the Medline and CINAHL databases was conducted to identify all studies relating to interventions designed to increase foot screening rates within health systems. To be included, studies had to apply an intervention to a health system while collecting pre-and post-test data; studies were excluded if the duration was less than 12 months, the study only included a single site, or if the study protocol was not based on national or international guidelines. Studies were then categorised by population (e.g., doctors, health practitioners, health centres, patients, nurses), intervention (e.g., education, clinical resources, feedback), country of origin, and whether there was a change in foot screening rates.

Results

Of the 2900 studies screened, forty-nine studies were included in the review. The primary population targeted were doctors (n=23, 47%), health centres (n=12, 24%), allied health professionals (n=7, 14%), patients (n=4, 8%) and nurses (n=3, 6%). Most studies (82%) used between one and three intervention modalities, with clinician education and training used most frequently, followed by provision of clinical resources, feedback reports and infrastructure. In total, 83% (n=41) of the studies identified an improvement in foot screening rates, with 10% (n=5) identifying no change and 2% (n=1) identifying a decrease in foot screening rates.

Conclusions

This study has several important findings. Firstly, most studies within this scoping review reported an increase in foot screening rates irrespective of who the target clinician was, what the intervention modality/modalities were, or what system it was applied to. Secondly, clinician education and training, followed by clinical resources, feedback reports, and investment into infrastructure, were the most common intervention modalities. Lastly, it was found that doctors were the most common target for initiatives designed to increase foot screening rates, which may indicate that the responsibility of preventative diabetes care continues to remain with the primary

doctor. Given the work around implementation science, it may be that changes in clinical practice can occur with a range of interventions as long as they are suitable for the environment they are applied into (acceptability, fidelity, feasibility). There is scope for further integration of implementation science methodologies into clinical research.

Background

Diabetes mellitus is estimated to affect 10.5% (536.6 million) of the adult population (20-79 years), with this figure projected to increase to 783.2 million by 2045 (6). Diabetes is a chronic condition which is characterised by hyperglycaemia, which, if not managed, can lead to serious complications, such as heart, eye, kidney, and foot disease (76). A diabetes-related foot ulcer (DFU) is defined as a foot ulcer in a person with current or previously diagnosed diabetes mellitus, usually accompanied by peripheral neuropathy and/or peripheral artery disease in the lower extremities. (15). Diabetes-related foot ulceration is common, complex, and costly, with its impact DFU comparable to many cancers (77), and is now a leading cause of global hospitalisations, amputations, mortality, and overall disease burdens (78, 79). Studies have reported that the provision of structured DFU care has been associated with a reduction in amputation rates (22), but few studies have investigated the prevention of DFU.

Due to the increasing prevalence, burden, and cost of DFU, there have been calls for a research emphasis on prevention (50). However, research in the prevention of DFU is challenging and is complicated by poor data availability on ulcer incidence, the need for a large patient population, the lack of interdisciplinary teams for ulcer prevention, and difficulties with industry and research engagement (80). Because of this, within research, there continues to be bias in the published literature towards studies that look at healing (50, 80). Foot screening of people with diabetes can offer a valuable solution for identifying those at risk of diabetes-related foot disease (DFD) early to allow for the application of interventions to prevent future common, complex and costly outcomes (16). The most recent international guidelines on the prevention of DFU strongly recommend annual foot screening of all people with diabetes (73, 80). It is recommended that population screening should be undertaken within an organised screening programme for identified target populations (35). Foot screening is recommended to be performed on all people with diabetes at least annually to identify signs and symptoms of peripheral neuropathy and peripheral arterial disease to determine the risk of DFU (81). Whilst many guidelines have strongly recommended routine foot screening of people with diabetes, it is still not clear whether this screening translates into the prevention of DFU (82). The undertaking of a screening program is a complex task and requires an organised program that includes the identification of target populations through treatment, monitoring, and evaluation (35). Therefore, this difficulty in

establishing a direct translation of foot screening to DFU prevention in part can be explained by the complexity of the people, populations, and health systems in which screening is undertaken.

The impact of implementation of guideline recommendations into practice for DFU has been explored, with research in Australia identifying that guideline-based care for patients with DFU found to be likely cheaper and more effective than usual clinical practice (72). The translation of guidelines into clinical practice can be challenging, with guideline dissemination and implementation strategies finding mixed adoption in healthcare environments, particularly those in resource-low settings (83, 84). Limited research is performed on the degree to which guideline recommendations are applied in practice to prevent DFU. In research on podiatrists, one Australian survey identified that podiatrists are generally implementing best practice guidelines (85), however, in a Belgium survey, it was identified that only 66% of podiatrists were reporting using a guideline for diabetes-related foot assessment (86). Research amongst other healthcare professionals suggests that diabetes-related foot assessment remains a low-priority (87). Concerning the treatment of patients with a DFU, the proportion who are receiving guideline-recommended care has been estimated at 30% (72).

Thus, the aim of this scoping review was to review studies that have evaluated interventions designed to increase guideline-recommended foot screening rates within health systems and to determine whether these interventions have resulted in a change in foot screenings undertaken. The review investigated the following:

1) Which populations have been used, and which has successfully improved foot screening rates in people with diabetes?
2) What interventions have been employed, and which have successfully improved foot screening rates in people with diabetes?
3) What are the gaps surrounding the utilisation of interventions to improve foot screening rates for people with diabetes?

Methods

Rationale

As the breadth of the literature on this topic was considered complex, with studies likely to contain a high degree of heterogeneity, including differences in the methodological approach, clinical environment, population evaluated, and nature of the interventions applied, a scoping review was considered to be more suited in comparison to a traditional systematic review. Scoping reviews are designed to address broad clinical questions and provide an overview of the state of the literature (88). Consistent with a scoping review, a critical appraisal via quality or risk of bias assessments of included studies was not undertaken, with the primary purpose of this

review to map a body of literature in terms of characteristics and factors relating to the clinical question (89). This lack of critical appraisal means that the studies included were not evaluated in terms of their study design, use of statistics, or whether the study outcome was clinically significant (90).

Protocol

The scoping review was conducted in accordance with the Joanna Briggs Institute (JBI) methodology for scoping reviews (91) and reported in alignment with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis – Scoping Review (PRISMA-ScR) checklist [Appendix 3] (92).

Inclusion Criteria

Studies were required to meet the following inclusion criteria (Figure 1).

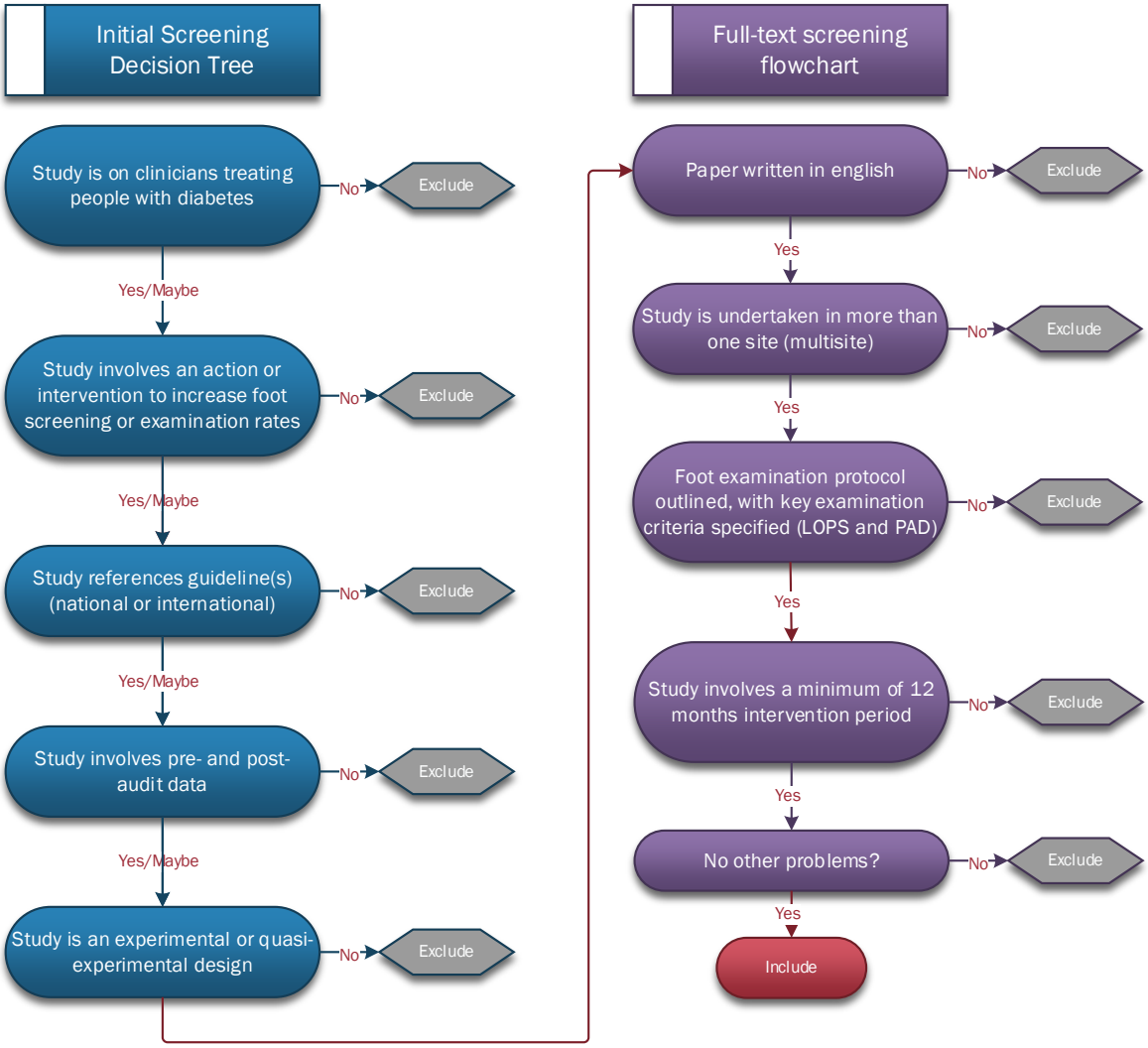
i. Be an experimental or quasi-experimental study design, evaluating the impact of an intervention.
ii. Include a foot screening intervention in people with diabetes based on national or international guideline recommendations. Case studies and case reports were excluded.
iii. Include an outcome measure of foot screening rates in people with diabetes.
iv. Be written in the English language.
v. Have a study duration of more than 12 months to increase the clinical relevance and evaluate the medium-long-term sustainability of the intervention/s.
vi. Be conducted in more than one intervention site to increase the generalisability of findings.

Search and Screening Strategy

This scoping review followed the JBI-recommended search strategy, which consisted of three steps: first, a limited search of at least two appropriate online databases relevant to the topic; Secondly, a search using all identified keywords and index terms was undertaken across all included databases; and finally, the searching of all identified reports and studies within the reference list for additional sources (91). A pilot search of MEDLINE and CINAHL was undertaken using the words in the titles and abstracts and the index terms used to describe the studies to develop a full search strategy for CINAHL Complete and Medline (Appendix 4). The final search included studies published from the databases' inception up to 7th November 2023. The search strategy, including all identified keywords and index terms, was adapted for each included database with the reference list of all included sources of evidence screened for additional studies. Title and abstract screening were performed independently by Prue Molyneux

(P.M.) and Hannah Jepson (H.J.) to determine relevance according to the inclusion criteria. Any differences in options about the selection of articles were resolved by a third party, Matthew Carroll (M.C.). Full-text screening was performed by one reviewer (H.J.).

Figure 1. Screening inclusion criteria



Data Extraction

An evidence table was prepared in Microsoft Word with data extracted from studies included in the scoping review by the primary researcher using a pre-specified form developed by H.J. and M.C. This was used as a prompt to record any relevant findings from each piece of literature with the data extracted including specific details about the participants, concept, context, study methods, and key findings relevant to the scoping review objective.

A map of interventions was developed as part of the objectives of the scoping review to gain an overall understanding of the types of initiatives employed. The data was summarised in tables that included the following information:

I. Study identification
II. Guidelines referenced
III. Aim
IV. Patient population characteristics
V. Number and type of clinical setting
VI. Number and type of clinicians
VII. Intervention categories
VIII. Study duration
IX. Number of patients in the final evaluation
X. Primary findings
XI. Whether there was an improvement in foot screenings identified

Data charting

Studies were categorised in relation to their population and intervention. The population was the primary categorisation and was identified as either (1) doctor, (2) allied health practitioner, (3) health centre or clinic (incorporating multiple health professionals), (4) nurse, or (5) patient. If there was more than one target involved within the healthcare improvement initiative, the primary target (often the clinician undertaking the foot examination) was selected. The interventions applied to improve foot screening rates were then categorised into broad intervention modalities, outlined in Table 2 and mapped in Appendix 5. Finally, in those studies that stated and/or showed in their data that at the end of the study, there was a greater proportion of people with diabetes undertaking foot examinations compared to before the intervention was applied, and a ‘yes’ count was made. Those who did not identify an improvement were divided into those who identified a decrease in foot screening rates and those who identified no change (stable). An ‘unclear' statement was applied in studies that could not determine whether an improvement was identified or whose results were inconclusive.

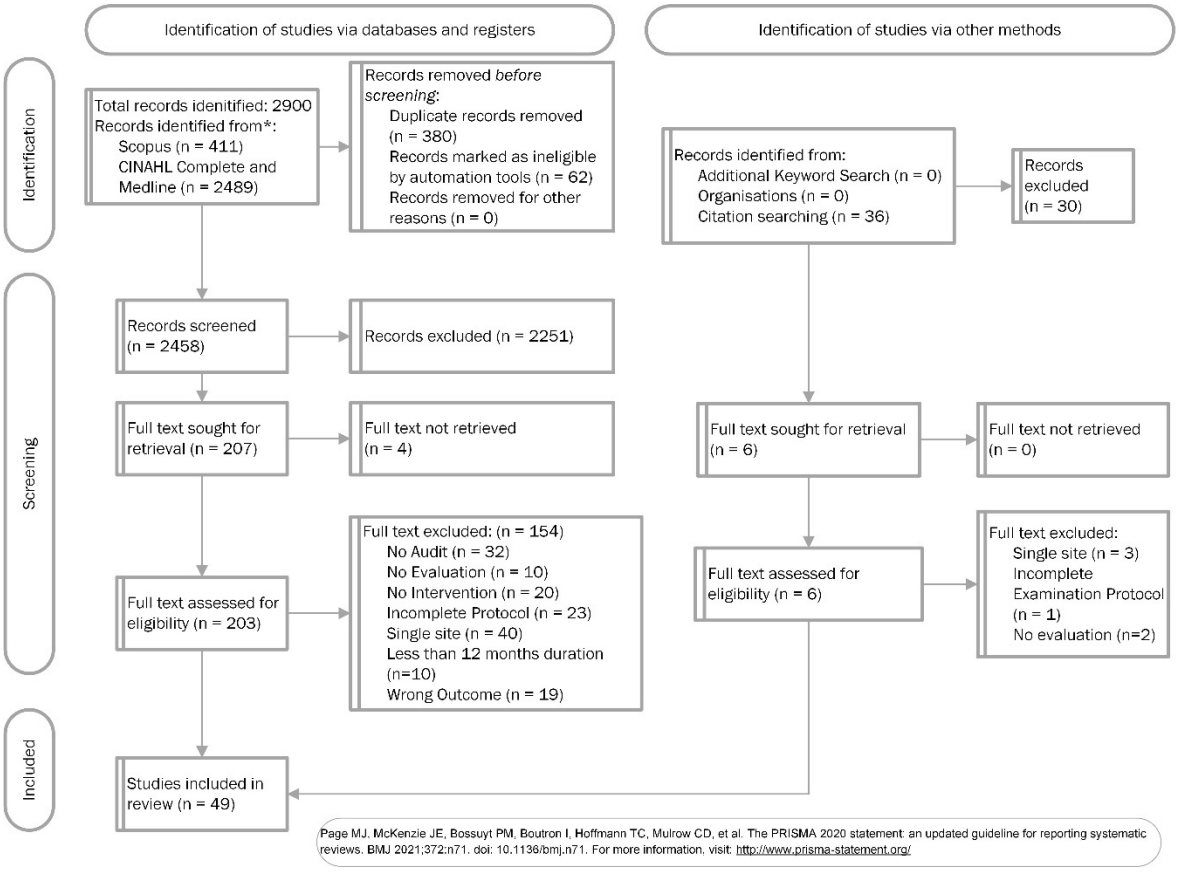
Table 2. Intervention modality employed to improve foot screening rates and examples.

Intervention Modality	Examples from included studies
Clinician education and training	**Content Delivery** (Seminars, Online Education Content, Handouts/Resources, Posters, Videos, Syllabus) **Interactive Learning** (Workshops, Demonstrations, Clinical Discussions, Multi-day Learning Sessions, Behaviour Change Sessions, Summative Congress) **Educational Programs** (Targeted Education Program, Linked Doctor/Patient Education Sessions, Education Program, Training Program, Training Module/s, Integrated Training) **Resources and Materials** (Toolkits, Materials, Educational Updates, Published Guideline Dissemination) **Evaluation** (Assessment)
Feedback reports	**Individual Feedback** (Individual Chart Audit Reports, Performance Reports on Quality and Outcome Measures) **Group Feedback** (Group Reports, Practice Audit with Feedback to Providers, Site-Level Feedback Reports) **Periodic Feedback** (Monthly Reporting Measures) **Feedback on Performance Indicators** (Clinical Performance Indicators, Quality of Diabetes Care Score, Benchmarks)
Infrastructure (new)	**Health Record Systems** (Integrated Electronic Health Record System, Diabetes Electronic Management System, Electronic Diabetes Registry) **Workflow and Process Systems** (Workflow Process, Electronic Processes, Electronic Documentation System) **Support and Service Systems** (Diabetes Support Service, Telehealth) **Information and Data Systems** (Clinical Information System, Diabetes Information System, Computer Systems)
Forms/Templates	**Decision Support** (Decision Support Tool, Management Algorithms, Clinical Pathways) **Management and Referral** (Management Forms, Referral Forms, Chronic Disease Management Flowsheets) **Monitoring and Evaluation** (Flowsheets, Monitoring Form, Custom Audit Form) **Information and Education** (Information Cards) **Assessment and Documentation** (New Assessment Tool, New Chart Documents, Diabetic Foot Form)
Reminder systems (practitioner)	**Visual Reminders** (Stickers, Chart Flow Sheets, Newsletter) **Electronic Reminders** (Computerised Alert/Reminder Systems, Alert System, Diabetes Recall System, Individualised Patient-Management Prompts) **Personal Reminders** (Phone Calls from the Project Officer) **Support and Guidance** (Logistic Support, Decision Support, Structured Recall)
Resources (clinical, practitioner)	**Incentives and Rewards** (Financial and Professional Incentives (i.e., pay-for-performance)) **Additional Staff and Support** (Additional Clinician/s (i.e., diabetes resource nurse, nurse facilitator, Specially Trained Nurse), Specialised Clinical Support, Quality Improvement Coaches, Onsite Diabetes Education Teams) **Expertise and Knowledge** (Experts (i.e., content, behaviour change experts)) **Time and Space** (i.e., Protected Time, Dedicated Ambulatory Setting)
Resources (new funding, new equipment)	**Practitioner focussed** (Government funding package, government funding for staff, incentives for providers, reimbursement for practitioners, allocation of financial resources) **Patient focussed** (free passes at the local gym, incentives for patients, waived co-payments, access to blood glucose monitoring supplies and medications)
Clinical/Administrative Leadership	**Motivational Leadership** (Incentive Plan) **Supportive Leadership** (Management Support, Commitment of Senior Level Management Support)
Peer Network Support	**Telephone-Based** (Telephone Conference Calls, Teleconferences) **Web-Based** (Virtual Office, Collaborative Users' Group)
Patient education and training	**Information and Material-based Education** (Patient Take-Home Materials, Information Support, Printed Materials and Videos) **Interactive and Personalised Education** (Education Sessions, personalised coach assigned, Calls to Patients to Discuss Individual Needs, Phone Calls for Lifestyle Advice, Report Card) **Structured and Focused Education** (Structured Clinical Visits that Focused on Knowledge, Skills, and Performance)
Reminder systems (patient)	**Reminder System** (Phone reminders) **Personalised Reminders and Support** (pre-visit phone calls, 'care calls')

Results

Figure 2 displays the PRISMA flow diagram, in which 2900 records were identified from searches of CINAHL Complete and Medline (combined search) along with Scopus. This search included 380 duplicates, which were removed. Thus, 2520 unique records were screened. Of these, 209 full-text articles were assessed for eligibility. A full-text screening was completed on 207 articles, as four could not be retrieved from the university library. Citation searching was completed on forty-nine studies, identifying six additional studies that did not meet the inclusion criteria. Forty-nine studies were included in the final scoping review. The most common reason for exclusion was the involvement of only a single intervention site, followed by a lack of pre- and post-audit data.

Figure 2. PRISMA flow diagram for the scoping review process.



Study Characteristics

Of the 49 studies included, 23 (47%) involved doctors, 12 (24%) involved health centres, 7 (14%) involved allied health professionals, 4 (8%) involved patients and 3 (6%) involved nurses [Table 2]. Studies were conducted in 12 countries, with America (n=21, 43%), Canada (n=8, 16%) and the United Kingdom (n=5, 10%) producing the largest number by count. A majority of studies had less than three interventions, with n=14 (29%) having one intervention, n=11 (22%) having two

interventions and n=15 (31%) having three interventions. Most studies were conducted for less than 24 months (n=33, 67%). More than half (n=28, 57%) of the studies had between 101-1000 patients, with n=17 (35%) studies containing more than 2000 patients. Table 3 shows that of the studies included, the American Diabetes Association was the most commonly referenced by 37% (n=18) of studies, followed by National guidelines (n=16, 33%). See Appendix 6 for the complete data collection table.

Table 3. Diabetes guidelines referenced within included studies.

Guidelines referenced within the study	Number n (%)
American Diabetes Association	18 (37)
National guidelines	16 (33)
Canadian Practice Guidelines	6 (12)
Local guidelines	4 (8)
Unclear	2 (4)
National Institute for Health and Care Excellence (NICE)	1 (2)
Japan Diabetes Society	1 (2)
IWGDF	1 (2)
Total	**49**

Number of Intervention Modalities per Study

Table 4 displays the number of intervention modalities per study. Of these studies, n=14 (29%) had only one intervention, of which n=2 (14%) reported no change in foot screening rates, and n=2 (14%) reported a decrease in foot screening rates. Two interventions were applied by n=11 (22%) studies, of which n=1 (9%) reported no change. There were three interventions applied within n=15 (31%), which was the most common number of intervention modalities within all the studies, and in which n=1 (7%) reported no change and n=1 (7%) reported a decrease in foot screening rates by the end of the study period. Less than (n=9, 18%) applied more than four intervention modalities, of which n=1 (11%) reported no change at the end of the study period.

Table 4. Number of intervention modalities per study.

Number of intervention modalities applied within each study	Doctors	Health Centres	Allied Health Professionals	Patients	Nurses	Total
One n (%)	9 (18)	2 (4)	1 (2)	2 (4)	-	**14**
Two n (%)	6 (12)	2 (4)	3 (6)	-	-	**11**
Three n (%)	5 (10)	4 (8)	3 (6)	2 (4)	1 (2)	**15**
Four n (%)	1 (2)	1 (2)	-	-	1 (2)	**3**
Five n (%)	1 (2)	1 (2)	-	-	-	**2**
Six or more n (%)	1 (2)	2 (4)	-	-	1 (2)	**4**
Total	**23**	**12**	**7**	**4**	**2**	**49**

Improvements in Foot Screening

Table 5 displays the target groups for interventions and whether an improvement in foot screening rates was identified. Twenty-three (47%) of the studies investigated interventions designed to increase foot screening rates by doctors, with the highest proportion of studies originating in America (n=11, 48%). In total, 83% (n=41) of the studies identified an improvement in foot screening rates, with 10% (n=5) identifying no change and 2% (n=1) identifying a decrease in foot screening rates.

Table 5. Improvement in foot screening rates identified within the included studies by intervention target.

Improvement in foot screening rates identified?	Doctors	Health Centres	Allied Health Professionals	Patients	Nurses	Total
Yes n (%)	20 (87)	8 (67)	7 (100)	3 (75)	3 (100)	**41 (83)**
Decreased n (%)	1 (4)	1 (8)	0 (0)	0 (0)	0 (0)	**2 (4)**
Stable n (%)	2 (9)	2 (17)	0 (0)	1 (25)	0 (0)	**5 (10)**
Unclear n (%)	0 (0)	1 (8)	0 (0)	0 (0)	0 (0)	**1 (2)**
Number and percentage of total studies	**23 (47)**	**12 (24)**	**7 (14)**	**4 (8)**	**3 (6)**	**49**

Intervention Target: Doctors

Table 6 shows the most commonly applied intervention for doctors was feedback reports (n=12, 52%), clinician education and training (n=9, 39%), forms/templates (n=8, 35%) and reminder systems (n=3, 13%). Twelve (n=12, 52%) studies which involved audit and feedback identified an improvement in foot screening rates, nine (n=9, 39%) involved clinician education and training, and eight (n=8, 35%) involved forms and templates. Those studies implementing practitioner reminder systems produced mixed results, with two studies not identifying an improvement and one identifying an improvement in foot screening rates.

Table 6. Intervention type by intervention target: note that many included studies applied more than one intervention.

Intervention modality	Doctors	Health Centres	Allied Health Professionals	Patients	Nurses	Total interventions
Clinician education and training n (%)	9 (39)	6 (50)	5 (71)	0 (0)	3 (100)	**23**
Resources (clinical, practitioner) n (%)	7 (30)	8 (66)	0 (0)	1 (25)	2 (66)	**18**
Feedback reports n (%)	12 (52)	1 (8)	2 (29)	1 (25)	0 (0)	**16**
Infrastructure (new) n (%)	5 (28)	6 (50)	3 (43)	1 (25)	1 (33)	**16**
Forms/Templates n (%)	8 (35)	2 (17)	1 (14)	0 (0)	3 (100)	**14**
Patient education n (%)	5 (22)	1 (8)	1 (14)	2 (50)	1 (33)	**10**
Resources (new funding, new equipment) n (%)	3 (13)	3 (25)	2 (29)	0 (0)	1 (33)	**9**
Reminder systems (practitioner) n (%)	3 (13)	1 (8)	3 (43)	0 (0)	0 (0)	**7**
Clinical/Administrative Leadership n (%)	1 (4)	4 (33)	0 (0)	0 (0)	2 (66)	**7**
Peer Network Support n (%)	3 (13)	3 (25)	0 (0)	0 (0)	0 (0)	**6**
Reminder systems (patient) n (%)	0 (0)	0 (0)	0 (0)	3 (75)	0 (0)	**3**
Total studies	**23**	**12**	**7**	**4**	**3**	**0**

Intervention Target: Health centres

Table 6 shows the most commonly applied interventions for health centres, with the resources (clinical, practitioner) n=8 (66%), infrastructure n=7 (50%), and clinician education and training n=6 (50%) being the interventions most often applied. Four studies n=4 (33%) did not produce an increase in foot screening rates after the intervention, with one study (n=1, 8%) identifying a decrease, two studies (n=2, 17%) identifying no change, and one study n=1 (8%) which was unclear. This study was by Johnson et al. (93) which was a quality improvement project involving the implementation of computer systems along with specialised clinical and leadership support, which found significant improvements in foot screenings at one site and a decrease in foot screenings at another (93).

Intervention Target: Allied Health Professionals

Table 6 shows the most commonly applied interventions for allied health professionals. The most commonly employed interventions were clinician education and training (n=5, 71%), implementation of infrastructure and practitioner reminder systems (n =3, 38%), and feedback reports and resources (n=2, 29%). All interventions applied within this population increased the rates of foot screenings undertaken.

Intervention Target: Patients

Four studies (8%) targeted interventions at patients to improve foot screening rates, of which one (n=1, 25%) identified no change in foot screening rates and three (n=3, 75%) identified improvement at the end of the study period. The most common intervention was patient education (n=2, 50%), followed by provision of clinical resources, patient feedback reports, and implementation of new infrastructure (n=1, 25%). The one study which did not identify improvement in foot screening rates involved the application of a telehealth intervention and compared this with face-to-face clinical care, which identified no change after two years (94).

Intervention Target: Nurses

Three (n=3, 6%) studies targeted nurses, all of which identified an improvement in foot screening rates by the end of the study period (n=3, 100%). The most common interventions within this population were clinician education and training and forms/templates (n=3, 100%), followed by clinical resources and leadership (n=2, 66%).

Interventions type by improvement to foot screening rates

Table 7 shows the intervention type applied and how the intervention impacted the number of foot screenings undertaken. Of the top four interventions, the application of infrastructure had the only decrease identified in foot screening rates by the end of the study period, with 2% of studies identifying a decrease, 4% reporting stable rates, and 2% reporting unclear results. The provision

of resources also identified the least number of changes with the intervention, with 8% reporting stable foot screening rates by the end of the study period.

Table 7. Intervention type by improvement to foot screening rates

Intervention type	Yes	Decreased	Stable	Unclear	Total
Clinician education and training n (%)	20 (41)	0 (0)	3 (6)	0 (0)	**23**
Resources (clinical, practitioner) n (%)	13 (27)	0 (0)	4 (8)	1 (2)	**18**
Feedback reports n (%)	15 (31)	0 (0)	1 (2)	0 (0)	**16**
Infrastructure n (%)	12 (24)	1 (2)	2 (4)	1 (2)	**16**
Forms/Templates n (%)	13 (27)	0 (0)	1 (2)	0 (0)	**14**
Patient education n (%)	10 (20)	0 (0)	0 (0)	0 (0)	**10**
Resources (new funding, new equipment) n (%)	8 (16)	0 (0)	1 (2)	0 (0)	**9**
Reminder systems (practitioner) n (%)	5 (10)	0 (0)	2 (4)	0 (0)	**7**
Clinical/Administrative Leadership n (%)	5 (10)	0 (0)	1 (2)	1 (2)	**7**
Peer Network Support n (%)	4 (8)	0 (0)	2 (4)	0 (0)	**6**
Reminder systems (patient) n (%)	3 (6)	0 (0)	0 (0)	0 (0)	**3**

Discussion

This study has several important findings. Firstly, most studies included in this review reported improved foot screening rates regardless of the intervention target or modality. Secondly, doctors were the most common target for initiatives. Thirdly, clinician education and training, followed by clinical resources, feedback reports, and investment into infrastructure, were the most common intervention modalities. Lastly, it appeared that those studies that implemented less than three intervention modalities and applied interventions relating to the provision of infrastructure, clinical resources, or clinical education and training were more likely to result in no change or a decrease in foot screening rates. This was also more likely found in studies lacking clinician engagement.

The finding that doctors were the most common target for initiatives designed to increase foot screening rates may indicate that the responsibility of preventative diabetes care continues to remain with the primary doctor. The interventions identified that were more likely to increase the foot screening rates were feedback reports, professional incentives, and forms/templates. This finding should be considered because a majority of the studies included within this review originated in America (n=21, 43%), with America a country with a complex healthcare system which has many components which make it difficult to translate research, including a lack of a universal healthcare model, high degree of socio-cultural and economic diversity, and a large

geographic size (95). It has been proposed that doctors may not always be the most appropriate target for foot screening initiatives depending on individual country, population, and system constraints (96).

It has been found that within large health systems, multiple approaches have been employed to encourage guideline adherence by clinicians (97). This review identified that clinician education and training was the most commonly investigated modality, with education delivered in many different formats, including lecture-based content delivery, interactive learning and provision of materials and resources. Education has been found to play an important role in potentially changing practice. However, the application of education alone has been challenged within the broader literature, with findings that lecture-based education alone does not lead to improvements in critical appraisal skills, attitudes toward evidence-based medicine, or clinical practice (98, 99). The studies within this scoping review support this finding, with some of the largest studies by population identifying no evidence of its effectiveness (100). The reason for this may be due to the number of system constraints that make facilitating change to clinical behaviour difficult, given the number of competing demands within clinical practice on clinician time and energy (101). The provision of clinical resources was the second most common intervention modality, with this finding consistent with previous research on addressing common barriers to implementation success, such as environmental barriers at the system level, staff commitment, and attitudes toward the intervention (102). Many of the resources were implemented at the system level, where the workplace environment facilitated the quality improvement project through incentives, additional staff, expert support and/or protected time, which all may have resulted in increased clinical engagement with the change process. Despite over half of the studies targeting doctors involving audit and feedback as an intervention modality, and with almost all the studies identifying an improvement in foot screening rate, within the literature, the understanding of how and why this intervention is effective is not as well understood (103). It has been suggested that there is a need for further development of the scientific basis for audit and feedback, informed by behavioural and system theory within large-scale and rigorous evaluation studies (104). Lastly, within the studies, most of the infrastructure interventions primarily were the application of electronic medical record processes, registries, or computer systems, all of which are components of an implementation process strategy which focuses on investment into delivery systems (105). Data management, digital health and other technological systems have also been proposed to enable healthcare improvement better and are often used as quality improvement methods for simplifying processes, creating reminder systems, and supplying data for evaluation (106). As healthcare moves into the era of big data, technology will increasingly play an important role in the modern-day healthcare environment (107).

This scoping review identified several different intervention targets, modalities, and healthcare systems worldwide through which practice change was attempted. Most studies reported increased foot screening rates irrespective of who the target clinician was, the intervention modality/modalities, or what system it was applied to. Given the work around implementation science, it may be that changes in clinical practice can occur with a range of interventions as long as they are suitable for the environment that they are applied into (acceptability, fidelity, feasibility) with scope for further integration of implementation science methodologies into clinical research (108, 109).

Limitations

These research findings should be interpreted with respect to their limitations. Firstly, although two authors independently performed title and abstract screening, only one author completed full-text screening and data extraction. Therefore, this may have resulted in missed or incorrectly interpreted studies within the full-text analysis component of the scoping review. Secondly, this scoping review excluded studies that were less than 12 months, which may have excluded relevant studies; however, this aimed to increase the clinical relevance and evaluate the medium-long-term sustainability of the interventions. Thirdly, those studies that involved the implementation of interventions within a single site were excluded, and the scoping review was focused on multi-site evaluative studies. This was performed to increase the generalisability of the interventions and be more reflective of the complexity of health systems. Fourthly, the intervention target and modalities were grouped as to the primary intervention target and the intervention theme to allow for analysis. However, this categorisation process in many studies may have represented an oversimplification of interventions and change facilitation within complex adaptive systems. This review included research involving several study designs, including cohort and controlled studies. However, the simple before-and-after study was by far the most common study design identified within this review and is inherently susceptible to bias (i.e., such as regression to the mean or secular trends unrelated to the intervention), making the ability to draw conclusions on the scalability or sustainability of the healthcare intervention challenging (110). Finally, most of the studies included within this scoping review were not focussed on the health impact or clinical outcome of diabetes foot screening but rather on the uptake of diabetes foot screening into clinical practice. This raises the question of whether the screening initiatives implemented were part of an integrated healthcare approach, for example, if they were linked to prevention initiatives and patient support and information services, or whether they were isolated implementation studies focussing on a single task or outcome measure of foot screening, which often employs mechanistic, linear reductionist methods more suited to physical systems than complex adaptive human systems (111). Additionally, the undertaking of screening alone cannot prevent diabetic foot complications, as for a screening programme to be

appropriate, it requires integration with effective treatment to prevent progression, mitigate effects, manage risk factors, or ideally, cure the condition for those diagnosed (35).

Recommendations for future research

Research relating to initiatives designed to change behaviour within healthcare systems would benefit from studies which conduct complexity-informed primary care research (111). Firstly, as healthcare is considered to be a complex adaptive system (111), focusing on a single outcome, such as the recording of foot screening rates, may be an oversimplification of what occurs within clinical practice. Prevention is considered 'best achieved within a multi-speciality group of providers that have a common objective', and future research needs to not only evaluate changes to foot screening rates but also look to how foot screening changes translate to meaningful outcomes for people at risk of DFU (112, 113). Secondly, this scoping review identified that health centres, nurses, and allied health professionals were successful targets for foot screening initiatives. Future directions in research focussing on preventive care with the aim of ensuring the appropriate and effective use of healthcare resources in the preventative setting, such as supporting a movement away from the doctor-centric model, may help to maximise limited healthcare resources (96).

Conclusion

This scoping review aimed to map the available published evidence relating to interventions applied within health systems designed to increase guideline-recommended foot screening rates and to determine whether these interventions have resulted in a change in foot screenings. This study has several important findings. Firstly, most studies within this scoping review reported increased foot screening rates irrespective of who the target clinician was, the intervention modality/modalities, or what system it was applied to. Secondly, clinician education and training, followed by clinical resources, feedback reports, and investment into infrastructure, were the most common intervention modalities. Lastly, it was found that doctors were the most common target for initiatives designed to increase foot screening rates, which may indicate that the responsibility of preventative diabetes care continues to remain with the primary doctor. Given the work around implementation science, it may be that changes in clinical practice can occur with a range of interventions as long as they are suitable for the environment that they are applied into (acceptability, fidelity, feasibility) with scope for further integration of implementation science methodologies into clinical research.

Chapter 2 References

6. Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, Duncan BB, et al. IDF Diabetes Atlas: Global, Regional and Country-Level Diabetes Prevalence Estimates for 2021 and Projections for 2045. Diabetes Res Clin Pract. 2022;183:109119.
15. van Netten JJ, Bus SA, Apelqvist J, Chen P, Chuter V, Fitridge R, et al. Definitions and Criteria for Diabetes-Related Foot Disease (IWGDF 2023 update). Diabetes Metab Res Rev. 2023.
16. Petrakis I, Kyriopoulos IJ, Ginis A, Athanasakis K. Losing a Foot Versus Losing a Dollar; A Systematic Review of Cost Studies in Diabetic Foot Complications. Expert Rev Pharmacoecon Outcomes Res. 2017;17(2):165-80.
22. Monteiro-Soares M, Vale-Lima J, Martiniano J, Pinheiro-Torres S, Dias V, Boyko EJ. A Systematic Review with Meta-Analysis of the Impact of Access and Quality of Diabetic Foot Care Delivery in Preventing Lower Extremity Amputation. J Diabetes Complications. 2021;35(4):107837.
28. Shepard-Wipiiti T, Brennan L. The Economic and Social Cost of Type 2 Diabetes. [Internet]. Ministry of Health; 2021. Available from: https://healthierlives.co.nz/report-on-the-economic-and-social-cost-of-type-2-diabetes/
35. Sagan A, McDaid D, Rajan S, Farrington J, McKee M. Screening: When Is It Appropriate and How Can We Get it Right? [Internet]. Copenhagen (Denmark): World Health Organization 2020; 2020. Available from: https://pubmed.ncbi.nlm.nih.gov/32716617/
50. Bus SA, van Netten JJ. A Shift in Priority in Diabetic Foot Care and Research: 75% of Foot Ulcers are Preventable. Diabetes Metab Res Rev. 2016;32:195-200.
72. Zhang Y, Carter HE, Lazzarini PA, Cramb S, Pacella R, van Netten JJ, et al. Cost-Effectiveness of Guideline-Based Care Provision for Patients with Diabetes-Related Foot Ulcers: A Modelled Analysis Using Discrete Event Simulation. Diabet Med. 2023;40(1):1-11.
73. Schaper NC, van Netten JJ, Apelqvist J, Bus SA, Fitridge R, Game F, et al. Guidelines on the Prevention of Foot Ulcers in Persons with Diabetes. Diabetes Metab Res Rev. 2023;36(57):1-14.
74. Parker CN, Van Netten JJ, Parker TJ, Jia L, Corcoran H, Garrett M, et al. Differences Between National and International Guidelines for the Management of Diabetic Foot Disease. Diabetes Metab Res Rev. 2019;35(2):e3101.
75. Jeffcoate W, Young B. Reducing Amputation in Diabetes: Work from the West Country Provides both Evidence and a Tool-kit. Diabet Med. 2018;35(1):8-9.
76. Galicia-Garcia U, Benito-Vicente A, Jebari S, Larrea-Sebal A, Siddiqi H, Uribe KB, et al. Pathophysiology of Type 2 Diabetes Mellitus. Int J Mol Sci. 2020;21(17):6275.
77. Armstrong DG, Swerdlow MA, Armstrong AA, Conte MS, Padula WV, Bus SA. Five Year Mortality and Direct Costs of Care for People with Diabetic Foot Complications are Comparable to Cancer. J Foot Ankle Res. 2020;13(1).
78. Armstrong DG, Tan T-W, Boulton AJM, Bus SA. Diabetic Foot Ulcers. JAMA. 2023;330(1):62-75.
79. Martins-Mendes D, Monteiro-Soares M, Boyko EJ, Ribeiro M, Barata P, Lima J, et al. The Independent Contribution of Diabetic Foot Ulcer on Lower Extremity Amputation and Mortality Risk. J Diabetes Complications. 2014;28(5):632-8.
80. van Netten JJ, Woodburn J, Bus SA. The Future for Diabetic Foot Ulcer Prevention: A Paradigm Shift From Stratified Healthcare Towards Personalized Medicine. Diabetes Metab Res Rev. 2020;36(S1):1-7.
81. Chappell FM, Crawford F, Horne M, Leese GP, Martin A, Weller D, et al. Development and Validation of a Clinical Prediction Rule for Development of Diabetic Foot Ulceration: An Analysis of Data From Five Cohort Studies. BMJ Open Diabetes Res Care. 2021;9(1):e002150.
82. Kaminski MR, Golledge J, Lasschuit JWJ, Schott K-H, Charles J, Cheney J, et al. Australian Guideline on Prevention of Foot Ulceration: Part of the 2021 Australian Evidence-Based Guidelines for Diabetes-Related Foot Disease. J Foot Ankle Res. 2022;15(1):1-33.

83. Fischer F, Lange K, Klose K, Greiner W, Kraemer A. Barriers and Strategies in Guideline Implementation; A Scoping Review. Healthcare. 2016;4(3):36.
84. Maaløe N, Ørtved AMR, Sørensen JB, Sequeira Dmello B, Van Den Akker T, Kujabi ML, et al. The Injustice of Unfit Clinical Practice Guidelines in Low-Resource Realities. Lancet Glob Health. 2021;9(6):e875-e9.
85. Quinton TR, Lazzarini PA, Boyle FM, Russell AW, Armstrong DG. How do Australian Podiatrists Manage Patients with Diabetes? The Australian Diabetic Foot Management Survey. J Foot Ankle Res. 2015;8(1):1-8.
86. Vansteenland I, Forss R. What are the Current Diabetic Foot Assessment Methods in Private Podiatry Practices in Flanders, Belgium: an Exploratory Mixed Method Study. J Foot Ankle Res. 2022;16(17).
87. Mullan L, Wynter K, Driscoll A, Rasmussen B. Prioritisation of Diabetes-Related Footcare Amongst Primary Care Healthcare Professionals. J Clin Nurs. 2020;29(23-24):4653-73.
88. Munn Z, Peters MDJ, Stern C, Tufanaru C, McArthur A, Aromataris E. Systematic Review or Scoping Review? Guidance for Authors When Choosing Between a Aystematic or Scoping Review Approach. BMC Med Res Methodol. 2018;18(1):1-7.
89. Peters MDJ, Godfrey C, McInerney P, Khalil H, Larsen P, Marnie C, et al. Best Practice Guidance and Reporting Items for the Development of Scoping Review Protocols. JBI Evidence Synthesis. 2022;20(4):953-68.
90. Page P. Beyond Statistical Significance: Clinical Interpretation of Rehabilitation Research Literature. Int J Sports Phys Ther. 2014;9(5):726-36.
91. Aromataris E, Munn Z. JBI Manual for Evidence Synthesis [Internet]. Joanna Briggs Institute; 2020 [16th March 2024]. Available from: https://doi.org/10.46658/JBIMES-20-01.
92. Tricco A, Lillie, E, Zarin, W, O'Brien, KK, Colquhoun, H, Levac, D, Moher, D, Peters, MD, Horsley, T, Weeks, L, Hempel, S et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann Intern Med. 2018;169(7):467-73.
93. Johnson E, Webb W, McDowall J, Chasson L, Oser C, R J, et al. A Field-Based Approach to Support Improved Diabetes Care in Rural States. Prev Chronic Dis. 2005;2(4):A08.
94. Ciemins E, Coon P, Peck R, Holloway B, Min S-J. Using Telehealth to Provide Diabetes Care to Patients in Rural Montana: Findings From the Promoting Realistic Individual Self-Management Program. Telemed J E Health. 2011;17(8):596-602.
95. Zieff G, Kerr ZY, Moore JB, Stoner L. Universal Healthcare in the United States of America: A Healthy Debate. Medicina. 2020;56(11):580.
96. Chan J, Lim L-L, Wareham NJ, Shaw JE, Orchard TJ, Zhang P, et al. The Lancet Commission on Diabetes: Using Data to Transform Diabetes Care and Patient Lives. Lancet. 2020;396(10267):2019-82.
97. Doherty JA, Crelia SJ, Smith MW, Rosenblum SF, Rumsey EM, Mabry-Hernandez IR, et al. Large Health Systems' Prevention Guideline Implementation: a Qualitative Study. Am J Prev Med. 2018;54(1):S88-S94.
98. Gupta DM, Boland RJ, Aron DC. The physician's experience of changing clinical practice: a struggle to unlearn. Implement Sci. 2017;12(1).
99. Herman DD, Weiss CH, Thomson CC. Educational Strategies for Training in Quality Improvement and Implementation Medicine. ATS Sch. 2020;1(1):20-32.
100. Presseau J, Mackintosh J, Hawthorne G, Francis JJ, Johnston M, Grimshaw JM, et al. Cluster Randomised Controlled Trial of a Theory-Based Multiple Behaviour Change Intervention Aimed at Healthcare Professionals to Improve Their Management of Type 2 Diabetes in Primary Care. Implement Sci. 2018;13(1):1-10.
101. Braithwaite J. Changing How We Think About Healthcare Improvement. BMJ. 2018(361):1-5.
102. Geerligs L, Rankin NM, Shepherd HL, Butow P. Hospital-based interventions: a systematic review of staff-reported barriers and facilitators to implementation processes. Implement Sci. 2018;13(1).
103. Ivers NM, Grimshaw JM, Jamtvedt G, Flottorp S, O'Brien MA, French SD, et al. Growing Literature, Stagnant Science? Systematic Review, Meta-Regression and Cumulative Analysis of Audit and Feedback Interventions in Health Care. J Gen Intern Med. 2014;29(11):1534-41.

104. Grimshaw J, Ivers N, Linklater S, Foy R, Francis JJ, Gude WT, et al. Reinvigorating Stagnant Science: Implementation Laboratories and a Meta-Laboratory to Efficiently Advance the Science of Audit and Feedback. BMJ Qual Saf. 2019;28(5):416-23.
105. Leeman J, Birken SA, Powell BJ, Rohweder C, Shea CM. Beyond "Implementation Strategies": Classifying the Full Range of Strategies Used in Implementation Science and Practice. Implement Sci. 2017;12(1).
106. Glasziou P, Ogrinc G, Goodman S. Can Evidence-Based Medicine and Clinical Quality Improvement Learn From Each Other? BMJ Qual Saf. 2011;20(Suppl 1):i13-i7.
107. Luo J, Wu M, Gopukumar D, Zhao Y. Big Data Application in Biomedical Research and Health Care: a Literature Review. Biomed Inform Insights. 2016;8:1-10.
108. Klaic M, Kapp S, Hudson P, Chapman W, Denehy L, Story D, et al. Implementability of healthcare interventions: an overview of reviews and development of a conceptual framework. Implement Sci. 2022;17(1):1-20.
109. Bauer MS, Kirchner J. Implementation Science: What Is It and Why Should I Care? Psychiatry Res. 2020;283:112376.
110. Clarke GM, Conti S, Wolters AT, Steventon A. Evaluating the Impact of Healthcare Interventions Using Routine Data. BMJ. 2019;365(12239):1-7.
111. Carroll Á, Collins C, McKenzie J, Stokes D, Darley A. Application of Complexity Theory in Health and Social Care Research: A Scoping Review. BMJ Open. 2023;13(3):e069180.
112. Siegel KR, Ali MK, Zhou X, Ng BP, Jawanda S, Proia K, et al. Cost-effectiveness of interventions to manage diabetes: has the evidence changed since 2008? Diabetes Care. 2020;43(7):1557-92.
113. Lavery LA, La Fontaine J, Kim PJ. Preventing the First or Recurrent Ulcers. Med Clin North Am. 2013;97(5):807-20.

Chapter 3: How does the Clinical Practice of Aotearoa New Zealand Podiatrists Align with International Guidelines for the Prevention of Diabetes-Related Foot Disease? A Cross-Sectional Survey

Citation

Jepson, H., Lazzarini, P. A., Garrett, M., & Carroll, M. R. (2023). How does the clinical practice of Aotearoa New Zealand podiatrists align with international guidelines for the prevention of diabetes-related foot disease? A cross-sectional survey. *Journal of Foot and Ankle Research*, 16(1), 53.

Preamble

The routine screening of the foot for diabetes has the intention of identifying those at risk for them to receive preventative care interventions (114). The scoping review identified that foot screening occurs primarily in primary healthcare and, in many cases, in the care of individual providers (115). It identified that screening initiatives largely focussed on doctors and that a range of implementation strategies could potentially increase screening rates. However, screening is only one component of prevention (35). The early identification of the foot at risk needs to be supported by the application of prevention strategies, which is a key component of reducing costs, both to the patient, health system, and society (16). Podiatrists are key healthcare practitioners in the care of the lower limb of people with diabetes and work in many healthcare environments, providing care for the prevention of diabetes-related foot ulceration (DFU). However, OECD and Commonwealth fund data suggest that New Zealand falls behind in terms of primary health care - critical for keeping people out of hospital - with challenges relating to the overuse and misapplication of resources (27, 116) resulting in inequities and missed opportunities for effective provision of healthcare and access to services (27). One of the primary components of guidelines influencing practice is the dissemination and uptake of guidelines at the clinical level, with barriers to guideline implementation able to be differentiated into personal factors, guideline-related factors, and external factors (83). Therefore, this survey aimed to look at the uptake and implementation of guidelines by podiatrists in the prevention of DFU and the alignment this had with international prevention guideline recommendations.

Abstract

Background

Given the importance of preventive care for the lower limb in people with diabetes, and the absence of local guidelines in Aotearoa New Zealand (NZ), the aim of this study was to determine the alignment of assessment and management used in the prevention of diabetes-related foot disease (DFD) by NZ podiatrists to the international prevention guideline recommendations.

Methods

A 37-item web-based survey was developed using a 5-point Likert scale (0 = always; 5 = never) based on the International Working Group of the Diabetic foot (IWGDF) 2019 prevention guidelines and included domains on participant demographics, sector, caseloads, guidelines, screening, management, education, and referral. The survey was distributed to NZ podiatrists through the NZ podiatry association and social media. Participants completing >50% of items were included. The Mann-Whitney U test was used to examine differences between sector subgroups.

Results

Seventy-seven responses (16.3% of the NZ podiatry workforce) were received, of which 52 completed >50% of items and were included. Of those 52 podiatrists, 73% were from the private sector. Public sector podiatrists reported higher weekly caseloads of patients with diabetes ($p=0.03$) and foot ulcers ($p<0.001$). The New Zealand Society for the Study of Diabetes (NZSSD) risk stratification pathway and IWGDF guidelines were the two most frequently utilised guidance documents. Participants reported median scores of at least “often” (<2) for all items in the assessment and management, inspection, screening, and education provision domains for people with a high-risk foot. More than 50% of respondents reported screening more frequently than guideline recommendations for people with a very low to moderate risk foot. Structured education program was only used by 4 (5%) participants. Public sector podiatrists reported greater provision of custom-made footwear ($p=0.04$) and multi-disciplinary team care ($p=0.03$).

Conclusion

NZ podiatrists generally follow international guideline recommendations with respect to screening, self-care education, appropriate footwear, and treatment of risk factors for people at-risk of DFD. However, there may be over-screening of people with very low to medium risk occurring in clinical practice. Increasing access to integrated healthcare, custom-made footwear

and structured educational programmes appear to be areas of practice that could be developed in future to help prevent DFD in NZ.

Background

Diabetes is a leading and rapidly growing cause of the global disease burden and affects approximately 10.5% of the adult population worldwide (6). In Aotearoa New Zealand (NZ), type 2 diabetes is on a trajectory to reach epidemic proportions within the next 20 years with the cost to the health system estimated to increase by 63% to $NZ 3.5 billion (28). Diabetes-related foot ulceration (DFU) is a leading cause of the hospitalisation, amputation, and disability burdens of people with diabetes (8, 67). DFU has an estimated lifetime incidence of between 19% and 34% (13). Prevention of DFU, particularly ulceration and amputation, have the potential to generate significant economic and social benefits for the international community (117). In response, healthcare and research organisations worldwide have called for increasing investment along with the development of international best practice guidelines for the prevention of DFU (80, 118, 119). The International Working Group of the Diabetic Foot (IWGDF) guidelines are recognised as the DFU guidelines of highest quality and have been adopted and used in many countries of the world (56). Implementation of IWGDF guideline recommendations is associated with a decrease in the frequency of lower limb amputations (118). However, despite the intention of guidelines to improve the quality of care and promote patient safety, it has been recognised that the publication of guidelines alone does not automatically lead to their application in practice (83). In NZ, there are no official national DFU guidelines, except for a 2013 national risk stratification and referral pathway (New Zealand Society for the Study of Diabetes (NZSSD) risk stratification pathway) adapted from the Scottish Foot Action Group (120).

International guidelines recognise that foot care provided by podiatrists is central to the prevention and management of DFU (121). In NZ, approximately 21% of podiatrists report they work with people with diabetes, including 80% of those working primarily in private practice and approximately 8% in public diabetes-related foot services with the remainder in research or higher education settings (71). Foot services for people with diabetes is frequently split between preventative care for people at increased risk of DFD and specialist services for management of people with DFU. Given the importance of preventive care for the lower limb in people with diabetes, and the lack of NZ specific guidelines, the aim of this study was to determine the degree of alignment between the assessment and management strategies used by NZ podiatrists in the prevention of DFU and the 2019 IWGDF prevention guideline recommendations.

Methods

Study Design and Settings

This study was a cross-sectional observational designed study using an anonymous web-based survey. The study was approved by the Auckland University of Technology Ethics Committee (AUTEC 22/129) and the web-based survey was conducted between November 2 and December 14, 2022, using the Qualtrics XM, software package Provo, UT.

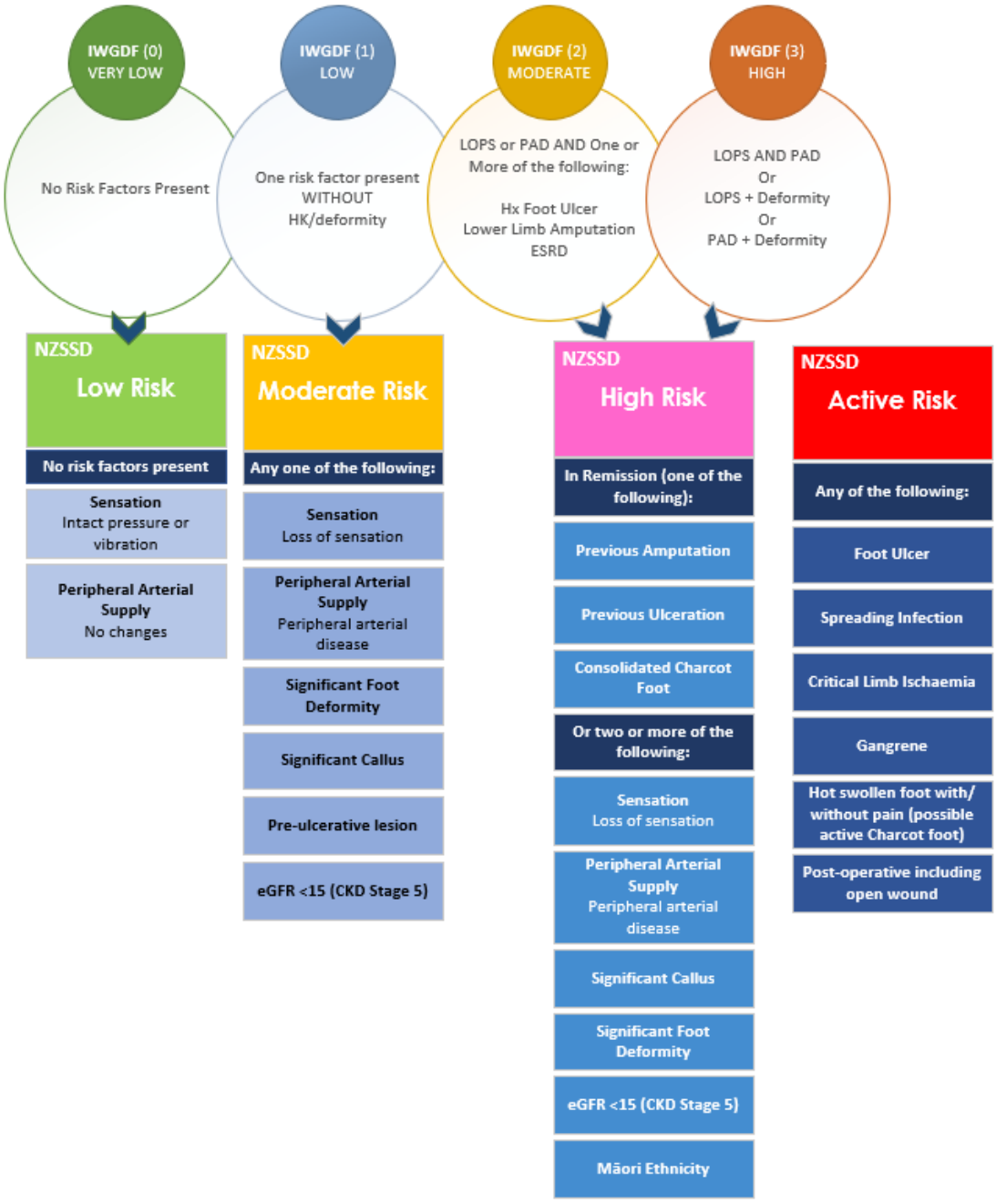
Participants

All NZ registered podiatrists with a current annual practising certificate were eligible to participate. At the time of the survey closing, there were 470 registered podiatrists in NZ (Registrar, Podiatrist's Board of NZ, email on podiatrists with registration, 2023 Feb 18).

Survey Development/items Collected

The design of the survey was adapted (with permission) based on a similar Australian-based survey (85), with the questions developed to align with the 2019 IWGDF prevention guidelines, which were the most recent international guidelines at the time (118). As it was considered that NZ podiatrists would be most familiar with the NZSSD risk stratification pathway, mapping was conducted to align the 2019 IWGDF prevention guideline recommendations and the NZSSD risk stratification pathway to improve the face validity of the survey (Figure 3). In this process, the prevention recommendations were used to develop survey questions incorporating elements of the NZSSD and IWGDF risk classification systems. A draft survey was piloted with four podiatrists, three from NZ and one from Australia. Pilot group respondents had diverse clinical backgrounds and experience in caring for people with DFD in public and private practice. The draft survey was distributed through the Qualtrics platform via an anonymous survey link, and all members of the pilot group completed the online survey and provided written feedback. Based on the feedback, questions and wording in the online survey were refined to create the final survey and aligned with the IWGDF recommendations (Appendix 7). The final survey comprised 31 items covering the domains of participant characteristics (Q1-8), foot screening (Q9-11), identifying the at-risk foot (Q11-12), regularly inspecting and examining the at-risk foot (Q12), instructions on foot self-care (Q13), providing structured education about foot self-care (Q14), instructions about foot self-management (Q14), ensuring routine wearing of appropriate footwear (Q15), treatment of risk factors or pre-ulcerative signs on the foot (Q16-17), surgical interventions (Q25-27), foot-related exercises and weight-bearing activity (Q18-21), and integrated foot care (Q22).

Figure 3. Alignment table between NZSSD and IWGDF



New Zealand utilises the New Zealand Society for the Study of Diabetes (NZSSD) risk stratification system which is adapted with permission from the Scottish Intercollegiate Guidelines Network (SIGN) 2016 Diabetic Foot Risk Stratification and Triage System. An alignment table between IWGDF 2019 recommendations and NZSSD risk stratification was developed, and the recommendations were written to ensure that there was reasonable consistency between the two risk stratification systems. Both systems had a similar criterion for IWGDF Very Low Risk (IWGDF 0) and NZSSD Low Risk, however for the NZSSD Moderate Risk, the alignment of this fell between IWGDF Low risk and Moderate Risk (IWGDF 1-2) and for NZSSD High Risk, alignment of this fell between IWGDF Moderate Risk and IWGDF High Risk (IWGDF 2-3).

Procedure

An invitation to participate was distributed through professional podiatry networks in NZ, including Facebook podiatry groups, the podiatry association, and email networks. Respondents followed an anonymous URL link and were directed to the participant information sheet, which detailed the purpose of the study, the duration of the survey, how the data would be stored, details of how anonymity was ensured, and the investigators' contact details. Consent for participation was implicit with the submission of the survey. Anonymous responses were enabled in Qualtrics security settings to ensure respondents' IP addresses, location data, and contact information were not recorded. Survey question back-tracking was enabled to allow respondents to review and change their answers, however, respondents were unable to make multiple survey submissions. A number of questions relating to clinical practice allowed for multiple selections. No survey question had a forced response requirement. A prize of one of five $100 coupons was also offered as an incentive to participate in the survey. Those participants responding to more than 50% of the survey questions/items were included in the final analysis.

Data Analysis

Descriptive statistics displayed variable data using numbers and proportions for categorical data and median and interquartile range for ordinal data. The Mann Whitney U test was used to examine differences between subgroups. All analyses were undertaken in XLSTAT® software (version 2022.5.1) with a p value of <0.05 considered significant. Survey data was reported in accordance with the Checklist for Reporting Results of Internet E-Surveys (Appendix 8) (122).

Results

There were 77 responses (16.3% of all NZ podiatrists with annual practising certificates). Fifty participants completed the survey, with 4 participants completing between 50-95% of the survey. Of these, 2 participants did not submit any responses despite progressing through the survey and were excluded from the final analysis. Twenty-one participants (27%) completed less than 50% of the survey and were excluded from the final data analysis. The total included responses analysed was 52 (67.5% of total participant responses). Table 8 displays the characteristics of the 52 included participants, including 73% from private practice, 50% based in Auckland and 49% identified as NZ European.

Table 8. Survey Participant characteristics

		Total	Private	Public	P value
Work duration, n (%)	0-2 years	10 (19)	10 (25)	0 (0)	**<0.001**
	3-5 years	7 (14)	5 (12)	2 (18)	0.62
	6-10 years	4 (8)	2 (5)	2 (18)	0.25
	11-15 years	9 (17)	7 (17)	2 (18)	0.81
	16-20 years	2 (4)	1 (2)	1 (9)	0.42
	21-25 years	10 (19)	7 (17)	3 (27)	0.49
	>26 years	10 (19)	9 (22)	1 (9)	0.56
Ethnicity, n (%)	NZ European/Pākehā	28 (49)	24 (52)	4 (37)	0.53
	Indian	7 (12)	7 (15)	0 (0)	0.07
	European	5 (9)	2 (4)	3 (27)	0.21
	Chinese	3 (5)	1 (2)	2 (18)	0.38
	Other Asian	4 (7)	4 (9)	0 (0)	0.46
	Other Ethnicity	3 (5)	3 (7)	0 (0)	0.80
	Southeast Asian	3 (5)	3 (7)	0 (0)	0.80
	Māori	2 (4)	2 (4)	0 (0)	0.21
	Latin American/Hispanic	1 (2)	0 (0)	1 (9)	0.69
	Middle eastern	1 (2)	0 (0)	1 (9)	0.69
Geographical region, n (%)	Auckland	26 (50)	21 (52)	5 (46)	0.91
	Canterbury	5 (9)	5 (12)	0 (0)	0.21
	Bay of Plenty	4 (8)	2 (5)	2 (18)	0.26
	Taranaki	4 (8)	4 (10)	0 (0)	0.23
	Waikato	4 (8)	3 (7)	1 (9)	0.78
	Wellington	5 (9)	3 (7)	2 (18)	0.36
	Manawatū-Whanganui	2 (4)	2 (5)	0 (0)	0.27
	Hawkes Bay	1 (2)	0 (0)	1 (9)	0.21
	Otago	1 (2)	1 (2)	0 (0)	0.30
Work type, n (%)	Private practice	38 (73)			
	High-Risk Foot Service	11 (21)			
	Education	1 (2)			
	Research	1 (2)			
	Other	1 (2)			

Table 9 displays participant caseloads, with respondents reporting treating a median of 21-30 patients with diabetes per week, including a median of 1–5-foot ulcers. Public podiatrists treated more people with foot ulcers per week (21-30) than private podiatrists (1-5) ($p < 0.001$).

Table 9. Reported diabetes caseload

	Total	Private	Public	P value
People with diabetes treated/week, median (IQR)	11-20 (1-5 - 21-30)	11-20 (1-5 - 21-30)	31-40 (21-30 - >51)	**0.03**
People with diabetic foot ulcers treated/week, median (IQR)	1-5 (0 - 6-10)	1-5 (0 - 1-5)	21-30 (11-20 - 31-40)	**< 0.001**

Table 10 shows the guidelines most commonly used to inform practice were the NZSSD risk stratification pathway (n=32, 62%) and the IWGDF guidelines (n=24, 46%).

Table 10. Guidelines utilised in practice

		Total n (%)	Private n (%)	Public n (%)	P value
Information sources used to guide assessment and management of people with diabetes[#]	NZSSD	32 (62)	24 (30)	8 (15)	0.06
	IWGDF	24 (46)	14 (18)	10 (19)	0.91
	Health Navigator NZ	9 (17)	5 (6)	4 (7)	0.81
	DFA	9 (17)	2 (3)	7 (13)	0.06
	NICE	9 (17)	3 (4)	6 (11)	0.16
	bpac	8 (15)	4 (5)	4 (7)	0.61
	SIGN	8 (15)	4 (5)	4 (7)	0.61
	Goodfellow Unit	8 (15)	5 (6)	3 (6)	0.92
	IDF	5 (10)	1 (1)	4 (7)	0.13
	ADA	5 (10)	2 (3)	3 (6)	0.47
	Other	5 (10)	4 (5)	1 (2)	0.49
	None of the above	11 (21)	11 (14)	0 (0)	**0.01**

IWGDF, International Working Group for diabetes-related foot ulceration; NZSSD, New Zealand Society for the Study of Diabetes; DFA, Diabetes Feet Australia; NICE, National Institute for Health and Care Excellence; bpac, Best Practice Advocacy Centre New Zealand; SIGN, Scottish Intercollegiate Guidelines Network; IDF, International Diabetes Federation; ADA, American Diabetes Association

[#]Participants were able to select multiple answers for this question

Table 11 shows the screening frequency and diagnostic tests that were utilised. The frequency of screening of the very low-risk foot (IWGDF 0) was performed annually as recommended by the IWGDF guidelines by 44% of respondents, with the remainder indicating that they screen more frequently (29%) or only at initial consult (27%). The screening frequency of the low-risk foot (IWGDF 1) was performed every 6-12 months as recommended by the IWGDF guidelines by 18% of respondents, with the screening of the moderate-high risk foot (IWGDF 2-3) between 1-6 months by 78% of respondents. Of the screening diagnostic tests used, private podiatrists used Doppler examination without waveform analysis more often when assessing peripheral artery disease ($p = 0.01$), and public podiatrists used the Ipswich touch test more frequently when assessing peripheral neurological supply ($p = 0.02$).

Table 11. Screening frequency and diagnostic tests utilised

			Total	Private	Public	P value
Screening frequency of the very low, moderate, and high-risk foot*	**Screening of the very low risk (IWGDF 0) foot n (%)**	Initial consult only	14 (27)	12 (32)	1 (9)	0.14
		Every 1-3 Months	0 (0)	0 (0)	0 (0)	1.00
		Every 3-6 Months	4 (8)	2 (5)	2 (18)	0.56
		Every 6-12 Months	8 (15)	5 (13)	1 (9)	1.00
		Annually	23 (44)	18 (47)	6 (54)	0.94
		Never	3 (6)	1 (3)	1 (9)	0.95
	Screening of the low risk foot (IWGDF 1) n (%)	Initial consult only	2 (4)	2 (5)	0 (0)	0.25
		Every 1-3 Months	7 (14)	3 (8)	4 (36)	0.06
		Every 3-6 Months	21 (43)	17 (45)	4 (36)	0.85
		Every 6-12 Months	9 (18)	7 (18)	2 (18)	0.86
		Annually	10 (20)	9 (24)	1 (9)	0.43
		Never	0 (0)	0 (0)	0 (0)	1.00
	Screening of the moderate-high risk foot (IWGDF 2-3) n (%)	Initial consult only	0 (0)	0 (0)	0 (0)	1.00
		Every 1-3 Months	24 (49)	16 (42)	8 (73)	0.11
		Every 3-6 Months	14 (29)	13 (34)	1 (9)	0.10
		Every 6-12 Months	5 (10)	3 (8)	2 (18)	0.39
		Annually	6 (12)	6 (16)	0 (0)	0.09
		Never	0 (0)	0 (0)	0 (0)	1.00
Diagnostic tests utilised in practice (peripheral vascular supply)#		Manual palpation of pulses	52 (100)	37 (100)	11 (100)	0.96
		Capillary refill time/SVPFT	44 (85)	22 (59)	9 (82)	0.98
		Temperature gradient	35 (67)	32 (86)	9 (82)	0.56
		Doppler examination (with waveform)	27 (52)	16 (43)	10 (91)	0.14
		Doppler examination (without waveform)	20 (38)	18 (49)	1 (9)	**0.01**
		Toe systolic pressure (absolute toe pressure)	14 (27)	5 (14)	6 (55)	0.20
		Ankle brachial index	12 (23)	3 (8)	5 (45)	0.29
		Toe brachial index	9 (17)	7 (19)	5 (45)	0.14
		Ankle systolic pressure	5 (10)	1 (3)	3 (27)	0.10
		Other	5 (10)	1 (3)	3 (27)	0.10
Diagnostic tests utilised in practice (peripheral neurological supply)#		10g Monofilament	52 (100)	37 (100)	11 (100)	0.78
		Sharp/Blunt	31 (60)	21 (57)	7 (64)	0.72
		Hot/Cold	26 (50)	18 (49)	7 (64)	0.85
		128Hz Tuning fork	25 (48)	17 (46)	5 (45)	0.79
		Light Touch	25 (48)	16 (43)	6 (55)	0.86
		Joint Position Test	25 (48)	16 (43)	5 (45)	0.84
		Reflexes (Achilles/patella)	21 (40)	15 (41)	4 (36)	0.83
		Diabetic Neuropathy Symptom Score	14 (27)	8 (22)	4 36)	0.62
		Biosthesiometer	11 (21)	6 (16)	3 (27)	0.72
		Ipswich Touch Test	10 (19)	4 (11)	6 (55)	**0.02**
		Two Point Discrimination	5 (10)	4 (11)	0 (0)	0.70
		Other:	2 (4)	1 (3)	0 (0)	0.26

*low risk foot (IWGDF 1) incorporated into the moderate risk foot (IWGDF 2) category in order to align the IWGDF risk stratification system with the NZSSD risk stratification system widely utilised within New Zealand. #Participants were able to select multiple answers

Table 12 displays the median (interquartile range) results for assessment and management of the low, moderate, and high-risk foot. Participants registered median scores of at least “often” (<2) for all items in the frequency of assessment and management, inspection and examination of the high-risk foot, and frequency of education provision domains. High-risk foot Service (HRFS) podiatrists reported more prescribing of custom-made footwear for moderate to high-risk feet (p = 0.04) and more care as part of a multidisciplinary foot team more often than private podiatrists (p = 0.03). Participants indicated that they sometimes provide foot and mobility-related exercises and often encourage daily walking; however, when prompted to answer an open-ended question about what resources or guidance they used to help guide this provision, no responses were received.

Table 12. Assessment and management of a person with diabetes

			Total	Private	Public	P value
Frequency that assessment guided by evidence-based guidelines			2 (1-2)	2 (1-2)	1 (1-2)	0.30
Frequency that management guided by evidence-based guidelines			1 (1-2)	2 (1-2)	1 (1-2)	0.41
Frequency of inspection & examination of the at-risk foot	History of foot ulceration		1 (1-1)	1 (1-2)	1 (1-1)	0.27
	History of lower extremity amputation		1 (1-1)	1 (1-1)	1 (1-1)	0.68
	Diagnosis of end-stage renal disease		1 (1-2)	1 (1-3)	1 (1-2)	0.06
	Presence or progression of foot deformity		1 (1-1)	1 (1-2)	1 (1-1)	0.17
	Limited joint mobility		1 (1-2)	1 (1-2)	2 (1-2)	0.30
	Significant callus		1 (1-1)	1 (1-1)	1 (1-1)	0.84
	Pre-ulcerative signs		1 (1-1)	1 (1-1)	1 (1-1)	0.60
Frequency of education provision relating to the prevention of DFD	Foot care	Medium risk	1 (1-1)	1 (1-1)	1 (1-1)	0.84
		High risk	1 (1-1)	1 (1-1)	1 (1-1)	0.84
	Foot hygiene	Medium risk	1 (1-2)	1 (1-2)	1 (1-2)	0.30
		High risk	1 (1-2)	1 (1-2)	1 (1-1)	0.53
	Footwear	Medium risk	1 (1-2)	1 (1-2)	1 (1-2)	0.52
		High risk	1 (1-1)	1 (1-2)	1 (1-1)	0.60
	First aid	Medium risk	1 (1-3)	2 (1-2)	1 (1-3)	0.18
		High risk	1 (1-2)	2 (1-3)	1 (1-1)	0.21
Frequency of provision of prescription of footwear and orthotic interventions to patients at moderate to high risk of DFD with a significant foot deformity	Therapeutic footwear		2 (2-3)	3 (2-3)	2 (1-2)	0.23
	Custom-made footwear		3 (3-4)	4 (3-4)	2 (1-3)	**0.04**
	Custom-made orthoses		3 (2-3)	3 (2-4)	2 (1-2)	0.12
	Prefabricated insoles		3 (2-3)	3 (2-3)	2 (2-4)	0.12
	Toe orthoses		3 (2-3)	2 (2-3)	3 (2-4)	0.11
Frequency of treatment of people at moderate to high risk of DFD	Treat a pre-ulcerative sign or significant callus		2 (1-1)	2 (1-2)	1 (1-2)	0.27
	Treat ingrown toenails		2 (1-3)	2 (1-2)	1 (1-2)	0.41
	Treat fungal infections of the foot		2 (1-3)	2 (1-2)	3 (1-4)	0.48
Frequency of provision of exercise and mobility for people with diabetes who were at Low to Moderate Risk of DFD	Prescribe foot and mobility-related exercises		3 (3-4)	3 (2-4)	3 (3-4)	0.74
	Encourage daily walking		2 (1-2)	2 (1-2)	2 (2-3)	1.00
Frequency of provision of integrated healthcare for people with diabetes	Provide care as part of a multi-disciplinary team		3 (2-3)	3 (2-4)	2 (1-3)	**0.03**
	Provide telehealth services		5 (4-5)	5 (4-5)	5 (3-5)	0.46
	Provide care in remote locations		5 (3-5)	5 (3-5)	5 (4-5)	0.14
	Collaborate with Māori health providers		4 (3-5)	5 (3-5)	3 (2-4)	0.18
Frequency of referral for surgical offloading interventions			3 (1-3)	3 (1-5)	2 (1-3)	0.52
Frequency of referral for a nerve decompression procedure			5 (4-5)	5 (4-5)	5 (4-5)	0.49

Median Likert agreement value with interquartile range (IQR) for 5-point Likert scale responses; response options Always (1), Often (2), Sometimes (3), Seldom (4), Never (5); DFD, diabetes related lower extremity complication

Table 13 displays the education modalities employed. Nearly all participants reported using verbal education to discuss the nature of diabetes (98%), preventative strategies (100%), and management (94%). The provision of structured education was only used by 5% of practitioners. There were no significant differences between HRFS and private podiatrists in the provision of education.

Table 13. Frequency of education provision and modalities employed to achieve this[#]

	1:1 verbal education n (%)				Resources and Handouts n (%)				Links to external support networks n (%)				Structured Education Programme n (%)			
	Total	**Private**	**Public**	**P value**	**Total**	**Private**	**Public**	**P value**	**Total**	**Private**	**Public**	**P value**	**Total**	**Private**	**Public**	**P value**
The nature and effect of diabetes on the lower limb, n (%)	51 (98)	40 (98)	11 (100)	0.99	21 (40)	16 (38)	5 (45)	0.67	10 (19)	7 (17)	3 (27)	0.49	4 (8)	4 (10)	0 (0)	0.19
Preventative foot care behaviours, including hygiene and foot inspection	51 (100)	41 (100)	10 (91)	0.70	19 (37)	15 (37)	4 (36)	0.89	9 (18)	7 (17)	2 (18)	0.79	2 (4)	2 (5)	0 (0)	0.26
Management of special problems (particular to the patient)	47 (92)	37 (90)	10 (91)	0.90	22 (44)	17 (41)	5 (12)	0.78	6 (12)	5 (12)	1 (9)	0.97	4 (8)	3 (7)	1 (9)	0.75

[#]Participants were able to select multiple answers for this question

Table 14 presents referral options and barriers reported to accessing referral options. For foot ulcer referrals, 98% reported having access to general practitioner (GP) services, 88% multidisciplinary diabetes foot services, 63% vascular surgery and 58% orthopaedic options available for referrals, with no significant difference between public and private practitioners. In terms of barriers to the provision of preventative care, 73% identified resource barriers such as service availability, staffing and wait times for clinicians accessing referral options for people with active foot ulcers, 68% (n=30) patient factor barriers, and 43% (n=19) communication barriers.

Table 14. Referral options available and barriers to provision of care for an active ulceration or active risk foot

		Total n (%)	Private n (%)	Public n (%)	P value
Referral/clinical support options available[#]	Multi-disciplinary diabetic foot service	42 (88)	33 (87)	9 (90)	0.77
	Vascular Surgery Referral Pathway	30 (63)	22 (58)	8 (80)	0.28
	Orthopaedic Surgery Referral Pathway	28 (58)	21 (55)	7 (70)	0.47
	General Practitioner	47 (98)	38 (100)	9 (90)	0.70
Barriers/constraints experienced when caring for a foot ulceration which is not responding to appropriate therapy[#]	Communication barriers (including referrals, interdisciplinary connections, access to medical records)	19 (43)	15 (47)	4 (40)	0.89
	Resource barriers (including service availability, staffing and wait times)	32 (73)	27 (80)	5 (50)	0.40
	Practitioner knowledge barriers (including competence and confidence)	11 (25)	8 (20)	3 (30)	0.60
	Patient factor barriers (understanding, socioeconomic factors and geographical location)	30 (68)	20 (67)	7 (70)	0.45
	Other	15 (34)	12 (37)	3 (30)	0.94

[#]Participants were able to select multiple answers

Discussion

This study was the first to survey NZ podiatrists on their practices related to the prevention of DFU. The results indicate that the screening of the very low to moderate-risk foot was undertaken more frequently than guideline recommendations but that the screening of the high-risk foot was in alignment with international guidelines. Podiatrists indicated that they were generally applying recommendations for instructions on foot self-care, foot self-management, and treatment of risk factors or pre-ulcerative signs on the foot. Partial application of recommendations was found for the routine wearing of appropriate footwear, surgical interventions, foot-related exercise and weight-bearing activities, and integrated care. Only one recommendation on the provision of structured education was identified as not being applied in practice.

Less than half of respondents reported that they would screen the very low to moderate risk foot as per the guideline recommendation, indicating a high level of inconsistency between podiatrists in terms of screening frequency. This finding indicates that there may be an over-screening of people with low or very low risk of DFU. Although there is evidence that screening prevents the development of DFU in high-risk populations, there is limited evidence that population screening reduces the risk of DFU for all people with diabetes (22, 112, 123). This reinforces the need for the development of national guidelines for the prevention of DFU.

In the diagnostic tests employed by podiatrists in order to identify the at-risk foot, our findings showed that all respondents were consistent with the recommendations of the 2019 IWGDF prevention guidelines and the NZSSD risk stratification system (124). Manual pulse palpation continues to be the most frequently employed vascular assessment employed by podiatrists despite concerns around its accuracy, interpretation and prognostic utility in detecting the

presence of peripheral arterial disease (125, 126). This finding is consistent with a similar survey by Tehan (127), which identified that podiatrists in Australia and NZ continue to rely on subjective vascular assessment testing methods, such as pedal pulse palpation, over objective measurements such as the ankle-brachial index (ABI) and toe brachial index (TBI). In the application of tests relating to the detection of peripheral neuropathy, all respondents indicated the utilisation of the 10g monofilament in clinical practice, which has been found to provide the most consistent results in the prediction of foot ulceration (126).

In relation to education provision, podiatrists appear to mostly provide this through 1:1 verbal education, with the provision of structured education the least used form of all patient education modalities. The quality of evidence that structured education alone is effective in achieving clinically relevant reductions in foot ulcer risk is low, with a lack of association between structured education and clinically meaningful reductions in foot ulcer risk reported (115). However, the IWGDF prevention guidelines recommend structured education as preferable to other educational modalities as part of a larger movement away from didactic models of care in which the patient is a passive recipient of standardised information and towards the integration of psychosocial model and patient-centred programs (114, 128, 129). The survey findings are consistent with previous research, which has shown that implementing diabetes self-management education into routine clinical care can be challenging, as much of diabetes management centres around changing the behaviours of the individual with often multidimensional risk factors (96, 130, 131).

Education and encouragement of exercise and daily walking were found to be often recommended in clinical practice. Despite NZ podiatrists advocating for the importance of physical exercise and mobility, the results indicate that the education provided to patients around exercise is still largely based on the clinician's individual experience. Exercise has been identified as potentially playing an important role as an intervention in the non-pharmacological treatment of DFU, including the progression of diabetes-related peripheral neuropathy (132). However, despite an increased number of studies investigating the provision of foot and mobility-related exercise as an intervention to prevent foot ulcers, there continues to be a small research evidence base in this area (115, 133). The findings of our survey may indicate that clinicians need further support in the application of research in the provision of foot-related exercises and weight-bearing activity in the prevention of DFU.

The results surrounding multidisciplinary teams indicate there is a widespread establishment in NZ, but the delivery of preventive care more broadly through other integrated modalities of care such as Māori healthcare providers and telemedicine remains limited. For people with diabetes, integrated care has the potential to improve outcomes, disability, morbidity, and mortality, with

the utilisation of integrated health being associated with a reduction in first presentations of DFU (134, 135).

Partial application of footwear recommendations was identified, with more podiatrists utilising off-the-shelf therapeutic over custom-made footwear. Podiatrists in NZ indicated the preferential use of prefabricated insoles over custom insoles. This is consistent with the evidence on orthotic interventions, with previous research identifying a positive association between the use of therapeutic footwear and foot orthotics in foot ulcer prevention (136).

These survey findings should be interpreted in respect to limitations. Firstly, the sampling technique may have resulted in sampling bias. As the study undertaken was voluntary and entitled ‘diabetic foot care research’ and promoted through public health networks as well as through social media, it may be that most respondents were podiatrists who had experience in, or an interest with, the care of people with diabetes. The respondents to our survey were found to be broadly representative of the private podiatry workforce (73% versus 80% in overall employment), with a higher proportion of public podiatrists responding (21% versus 8% in the overall employment) (71). Secondly, using a non-validated survey tool decreases the reliability and external validity of our results. This limitation was minimised by the basing the concept and questions on a similar survey undertaken by Quinton et al. in Australia (85) and referencing several questions and wording from the IWGDF prevention guideline (114). It was further minimised by the undertaking of piloting with a small sample of experienced podiatric clinicians. Thirdly, the study had a low response rate (16% of NZ podiatrists with annual practising certificates). However, this response rate is approximately double that than the 8% reported by Quinton et al. (85) in their similar study on diabetes-related foot assessment practices of podiatrists in Australia and slightly higher than Yuncken et al. (131) who had a 10% response rate in a survey of podiatrists on the provision of education to people with diabetes. Additionally, previous research has identified that only a small percentage of the podiatry profession in NZ work primarily with people with diabetes on a daily basis (22%) (71) which may have contributed to the low response rate. Finally, approximately 50% of the respondents to this survey were from Auckland compared to regional areas of NZ. This may be a consideration when interpreting findings particularly to those relating to the access and availability of referral avenues and healthcare resources.

Conclusion

This study presents the first known data collected on the assessment and management used by NZ podiatrists to prevent DFD. NZ podiatrists generally follow international guideline recommendations with respect to the examination of the at-risk foot, instructions on foot self-

care, appropriate footwear and treatment of risk factors and pre-ulcerative signs; however, there may be some over-screening of the low-risk foot occurring in clinical practice. Increasing access to integrated healthcare, implementing structured educational programmes, and supporting clinicians in the provision of exercise and weight-bearing activities in people with diabetes appear to be areas of practice that need future development in NZ.

Chapter 3 References

6. Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, Duncan BB, et al. IDF Diabetes Atlas: Global, Regional and Country-Level Diabetes Prevalence Estimates for 2021 and Projections for 2045. Diabetes Res Clin Pract. 2022;183:109119.
8. Vos T, Lim SS, Abbafati C, Abbas KM, Abbasi M, Abbasifard M, et al. Global Burden of 369 Diseases and Injuries in 204 Countries and Territories, 1990–2019: A Systematic Analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396(10258):1204-22.
13. Armstrong DG, Boulton AJM, Bus SA. Diabetic Foot Ulcers and their Recurrence. N Engl J Med. 2017;376(24):2367-75.
16. Petrakis I, Kyriopoulos IJ, Ginis A, Athanasakis K. Losing a Foot Versus Losing a Dollar; A Systematic Review of Cost Studies in Diabetic Foot Complications. Expert Rev Pharmacoecon Outcomes Res. 2017;17(2):165-80.
22. Monteiro-Soares M, Vale-Lima J, Martiniano J, Pinheiro-Torres S, Dias V, Boyko EJ. A Systematic Review with Meta-Analysis of the Impact of Access and Quality of Diabetic Foot Care Delivery in Preventing Lower Extremity Amputation. J Diabetes Complications. 2021;35(4):107837.
27. Cumming J. New Zealand Health System Review. [[Internet]]. New Delhi: World Health Organization Regional Office for South-East Asia; 2022. Report No.: 9789290210122 Available from: https://apo.who.int/publications/i/item/new-zealand-health-system-review
28. Shepard-Wipiiti T, Brennan L. The Economic and Social Cost of Type 2 Diabetes. [Internet]. Ministry of Health; 2021. Available from: https://healthierlives.co.nz/report-on-the-economic-and-social-cost-of-type-2-diabetes/
35. Sagan A, McDaid D, Rajan S, Farrington J, McKee M. Screening: When Is It Appropriate and How Can We Get it Right? [Internet]. Copenhagen (Denmark): World Health Organization 2020; 2020. Available from: https://pubmed.ncbi.nlm.nih.gov/32716617/
56. International Working Group of the Diabetic Foot. About IWGDF Guidelines [Internet]. 2023 [cited 2023 May 8]. Available from: https://iwgdfguidelines.org/about-iwgdf-guidelines/.
67. Zhang Y, Lazzarini PA, McPhail SM, van Netten JJ, Armstrong DG, Pacella RE. Global Disability Burdens of Diabetes-Related Lower-Extremity Complications in 1990 and 2016. Diabetes Care. 2020;43(5):964-74.
71. Carroll M, Jepson H, Molyneux P, Brenton-Rule A. The New Zealand Podiatry Profession – A Workforce in Crisis? J Foot Ankle Res. 2020;13(1):1-7.
80. van Netten JJ, Woodburn J, Bus SA. The Future for Diabetic Foot Ulcer Prevention: A Paradigm Shift From Stratified Healthcare Towards Personalized Medicine. Diabetes Metab Res Rev. 2020;36(S1):1-7.
83. Fischer F, Lange K, Klose K, Greiner W, Kraemer A. Barriers and Strategies in Guideline Implementation; A Scoping Review. Healthcare. 2016;4(3):36.
85. Quinton TR, Lazzarini PA, Boyle FM, Russell AW, Armstrong DG. How do Australian Podiatrists Manage Patients with Diabetes? The Australian Diabetic Foot Management Survey. J Foot Ankle Res. 2015;8(1):1-8.
96. Chan J, Lim L-L, Wareham NJ, Shaw JE, Orchard TJ, Zhang P, et al. The Lancet Commission on Diabetes: Using Data to Transform Diabetes Care and Patient Lives. Lancet. 2020;396(10267):2019-82.
112. Siegel KR, Ali MK, Zhou X, Ng BP, Jawanda S, Proia K, et al. Cost-effectiveness of interventions to manage diabetes: has the evidence changed since 2008? Diabetes Care. 2020;43(7):1557-92.
114. Bus SA, Lavery LA, Monteiro‐Soares M, Rasmussen A, Raspovic A, Sacco I, et al. Guidelines on the Prevention of Foot Ulcers in Persons with Diabetes (IWGDF 2019 update). Diabetes Metab Res Rev. 2020;36(S1):1-18.
115. van Netten JJ, Raspovic A, Lavery LA, Monteiro‐Soares M, Rasmussen A, Sacco I, et al. Prevention of Foot Ulcers in the At‐Risk Patient with Diabetes: A Systematic Review. Diabetes Metab Res Rev. 2020;36(S1):1-22.
116. Djulbegovic B. A Framework to Bridge the Gaps Between Evidence-Based Medicine, Health Outcomes, and Improvement and Implementation Science. J Oncol Pract. 2014;10(3):200-2.

117. Jodheea-Jutton A, Hindocha S, Bhaw-Luximon A. Health Economics of Diabetic Foot Ulcer and Recent Trends to Accelerate Treatment. Foot. 2022;52:101909.
118. Schaper NC, van Netten JJ, Apelqvist J, Bus SA, Hinchliffe RJ, Lipsky BA. Practical Guidelines on the Prevention and Management of Diabetic Foot Disease (IWGDF 2019 update). Diabetes Metab Res Rev. 2020;36(S1):1-10.
119. Bus SA, van Netten JJ, Monteiro‐Soares M, Lipsky BA, Schaper NC. Diabetic Foot Disease: "the times they are a changin'". Diabetes Metab Res Rev. 2020;36(S1):1-3.
120. Stang D, Leese G. The Scottish Diabetes Foot Action Group 2016 Update of the Diabetic Foot Risk Stratification and Triage System. Diabet Foot Ankle. 2016;19(4):182-6.
121. Lazzarini PA, Gurr JM, Rogers JR, Schox A, Bergin SM. Diabetes Foot Disease: The Cinderella of Australian Diabetes Management? J Foot Ankle Res. 2012;5(1):1-9.
122. Eysenbach G. Improving the Quality of Web Surveys: The Checklist for Reporting Results of Internet E-Surveys (CHERRIES). J Med Internet Res. 2004;6(3):e132.
123. Jeffcoate WJ. Stratification of Foot Risk Predicts the Incidence of New Foot Disease, But Do We Yet Know that the Adoption of Routine Screening Reduces It? Diabetologia. 2011;54(5):991-3.
124. New Zealand Society for the Study of Diabetes. Updated Foot Screening Referral Pathways 2017 [Internet]. New Zealand Society for the Study of Diabetes; 2017 [cited 2023 Jan 21]. Available from: https://www.nzssd.org.nz/assets/table-files/resources-54-resource_file.pdf.
125. Azzopardi YM, Gatt A, Chockalingam N, Formosa C. Agreement of Clinical Tests for the Diagnosis of Peripheral Arterial Disease. Prim Care Diabetes. 2019;13(1):82-6.
126. Crawford F, Cezard G, Chappell FM, Murray GD, Price JF, Sheikh A, et al. A Systematic Review and Individual Patient Data Meta-Analysis of Prognostic Factors for Foot Ulceration in People with Diabetes: The International Research Collaboration for the Prediction of Diabetic Foot Ulcerations (PODUS). Health Technol Assess. 2015;19(57):1-210.
127. Tehan PE, Chuter VH. Vascular Assessment Techniques of Podiatrists in Australia and New Zealand: A Web-Based Survey. J Foot Ankle Res. 2015;8(1):1-8.
128. Chatterjee S, Davies MJ, Heller S, Speight J, Snoek FJ, Khunti K. Diabetes Structured Self-Management Education Programmes: A Narrative Review and Current Innovations. Lancet Diabetes Endocrinol. 2018;6(2):130-42.
129. Windrum P, García-Goñi M, Coad H. The Impact of Patient-Centered Versus Didactic Education Programs in Chronic Patients by Severity: The Case of Type 2 Diabetes Mellitus. Value Health. 2016;19(4):353-62.
130. Hermanns N, Ehrmann D, Finke‐Groene K, Kulzer B. Trends in Diabetes Self‐Management Education: Where are We Coming From and Where are We Going? A Narrative Review. Diabet Med. 2020;37(3):436-47.
131. Yuncken J, Haines T, Stolwyk RJ, Williams CM. PoDFEd: Podiatrists and Diabetes Footcare Education Survey - How do Australian Podiatrists Provide Diabetes Education? J Foot Ankle Res. 2020;13(1):1-8.
132. Ponirakis G, Al‐Janahi I, Elgassim E, Gad H, Petropoulos IN, Khan A, et al. Progressive Loss of Corneal Nerve Fibers is Associated with Physical Inactivity and Glucose Lowering Medication Associated with Weight Gain in Type 2 Diabetes. J Diabetes Investig. 2022;13(10):1703-10.
133. Matos M, Mendes R, Silva AB, Sousa N. Physical Activity and Exercise on Diabetic Foot Related Outcomes: A Systematic Review. Diabetes Res Clin Pract. 2018;139:81-90.
134. Boulton AJM, Vileikyte L, Ragnarson-Tennvall G, Apelqvist J. The Global Burden of Diabetic Foot Disease. Lancet. 2005;366(9498):1719-24.
135. Paisey RB, Abbott A, Paisey CF, Walker D, Birch R, Bowen B, et al. Diabetic Foot Ulcer Incidence and Survival with Improved Diabetic Foot Services: An 18‐year Study. Diabet Med. 2019;36(11):1424-30.
136. van Netten JJ, Sacco ICN, Lavery LA, Monteiro‐Soares M, Rasmussen A, Raspovic A, et al. Treatment of Modifiable Risk Factors for Foot Ulceration in Persons with Diabetes: A Systematic Review. Diabetes Metab Res Rev. 2020;36(S1):1-19.

Chapter 4: Discussion and Conclusion

Preamble

Limited attention has been placed on the prevention of DFU both in research as well as in clinical practice, with a significantly larger volume of clinical research and investment focussed on foot ulcer healing (80, 115). Given that DFD causes an estimated 2% of the global disease burden, larger than most conditions (137, 138), there have been growing calls for an increased focus on healthcare research and funding for the prevention of diabetes-related foot complications (13). Although research into prevention is challenging and often underrepresented, existing evidence suggests that there are significant savings to health systems with the application of guideline-recommended care (112). Estimates have been made that with the application of guideline-recommended strategies, more than 75% of DFU can be prevented (50) and LEA frequency is reduced (22, 28).

The intention of this thesis was to determine how guidelines relating to the prevention of DFU have been adopted into practice. Firstly, this translation of guidelines was considered in the international context, with a scoping review undertaken to evaluate the implementation of interventions to improve a component of recommended prevention into clinical practice in the form of diabetic foot screening. This review aimed to determine whether these interventions resulted in an increase in foot screening undertaken and considered any implementation project which involved interventions designed to increase foot screening rates, the population these were targeted, and the clinical environment in which they were applied. Secondly, this was considered in the local NZ context relating to the clinical application of prevention recommendations employed by NZ podiatrists, which was the first study to investigate how NZ podiatrists care for the feet of people with diabetes. This involved a survey of NZ registered podiatrists to determine what clinical care prevention practices were undertaken and what barriers and enablers existed to those in clinical practice, with the responses evaluated as to how they aligned with current international best practice recommendations.

This thesis has the following main findings: the scoping review identified that doctors continue to remain the population most often targeted for foot screening initiatives and that a range of interventions can result in an improvement of foot screening rates if their selection is guided by the needs of the population. The survey identified that NZ podiatrists generally follow international guidelines for preventing DFU. However, there may be an over-screening of people with very low to medium risk in clinical practice. Podiatrists are less adherent to more complex recommendations, such as structured education and integrated care, which may require resourcing.

Background

Key Findings

Table 15. Summary of research components

Chapter	Title	Study Design and Methods	Findings
Objective 1: To review studies which have evaluated interventions designed to increase guideline-recommended foot screening rates with health systems and to determine whether these interventions have resulted in a change in foot screenings undertaken			
2	Strategies Employed to Increase the Rate of Guideline-Recommended Foot Screening in People with Diabetes	Scoping Review of Published Literature	Doctors continue to be the population most often targeted for foot screening initiatives. If the needs of the population guide the selection of interventions, a range of interventions can improve foot screening rates.
Objective 2: To determine the alignment of assessment and management used in the prevention of diabetes-related foot disease by NZ podiatrists to the international prevention guideline recommendations			
3	How does the Clinical Practice of Aotearoa New Zealand Podiatrists Align with International Guidelines for the Prevention for Diabetes-Related Foot Disease?	Cross-Sectional Survey	NZ Podiatrists generally follow international guideline recommendations for the prevention of diabetes-related foot ulceration. However, in clinical practice, there may be an over-screening of people with very low to medium risk. Podiatrists are less adherent to more complex recommendations, such as structured education and integrated care, which may require resourcing.

Key Finding 1: Doctors continue to remain the population most often targeted for foot screening initiatives

The scoping review evaluated interventions designed to increase foot screening rates in people with diabetes, with one of the main findings being that doctors were the primary intervention target for most evaluation studies involving foot screening initiatives. Although this finding needs to be considered in light of the fact that a majority of the studies originated from North America, it potentially indicates that diabetic foot screening continues to be the domain of a single clinician or health professional in many parts of the world. Given that diabetes is estimated to affect 1 in 10 people worldwide currently and that this number will continue to expand rapidly into the future (6), the finding that doctors are the primary target for foot screening may indicate a misapplication of their knowledge and expertise on a task which may be better completed as part of a coordinated care team approach within high-income countries such as NZ (96). Foot screening and general foot care education within NZ is primarily provided in primary healthcare, with increasing role of practice nurses (139). However, in many guidelines, screening of the foot for risk factors for foot complications (which at a minimum includes a sensation check and pulse palpation) can be undertaken by any appropriately trained health healthcare worker and can even be undertaken in low-resource settings (118, 126). This, therefore, may open up options for policymakers to consider the utilisation of non-regulated healthcare professions for low-risk foot screening who are more readily available and cost-effective, with the triaging of care provision to more specialised healthcare providers such as doctors, nurses, and podiatrists as patient complexity increases (96). This additionally may open up opportunities within the NZ context for the further integration of foot screening within an equity-focused implementation framework, which may support an approach such as Kaupapa Māori (140, 141).

A range of interventions can result in an improvement in foot screening rates

The scoping review identified multiple intervention modalities employed within different health systems to increase foot screening rates, with education, practitioner resources, feedback reports, and infrastructure being the most commonly employed. The individual effectiveness of these commonly employed interventions is unclear, but attempts have been made to determine their relative effectiveness within previous research. It has been identified that didactic education and passive dissemination are ineffective, but interactive education is effective (142) and that effectiveness increases with the provision of practitioner resources that act to reduce system complexity (143). Effectiveness also increases when implementation strategies are utilised which allow for protected time and/or support decision-making (144), and when feedback mechanisms are involved which support changes in clinical practice (145). The selection in advance of the intervention strategies to be applied in the context of the health system that they are to be applied into is considered to be a critical factor in implementation success (83) with many health systems containing so many individual processes and structures that they struggle to adapt to

external environmental change (143). There still remain questions around the comparative effectiveness of different tools used within complex systems to influence practice, given the structurally complex and increasing variety of relationships between players within healthcare systems (97, 146). Of the evaluation studies included within the scoping review, 83% identified an improvement in foot screening rates, and although there were limitations to consider within each of the studies, such as the presence of the Hawthorne effect and selection bias, it appears that improvements in foot screening may occur with a variety of different intervention strategies. This occurs as long as the intervention strategies are suitable for the clinical environment that they are applied into (147), have a high level of clinician engagement (148), involve clinicians in the change process (148), are positioned in terms of benefits to patients or staff (148), and focus on areas where there is evidence between processes and patient outcomes (145).

Key Finding 2: New Zealand podiatrists are generally following international guideline recommendations

The survey of NZ podiatrists identified that referral and clinical support between podiatrists and some secondary support services was relatively high, with a majority having access to multidisciplinary diabetic foot service and general practitioners. However, the care provided within an integrated care model was much lower, with evidence of fragmented services identified with care often provided in isolation and limited access to integrative and preventative care. Although the application of prevention recommendations to an individual can be performed by a single discipline, such as podiatry, prevention itself at a population level is a complex task (149), best performed within an integrated healthcare model or within a healthcare system (57, 150). The survey also identified that in the provision of education to people with diabetes, the least often employed education modalities were the linking of people to external support networks and the availability and provision of structured education programs, both of which are components of an integrated model of healthcare (115). It is currently considered that prevention is best achieved within a multi-speciality group of providers that have a common objective (113), and in NZ there has been a limited number of interventions developed specifically designed for Māori communities with diabetes, with calls for more holistic, integrated, and comprehensive services for Pacific peoples as well as a reduction in barriers across care pathways (27, 151). This was also identified as a priority within the NZ Māori Health Action Plan, with the need to implement cross-system and effective primary health and community models of care (33). However, research on how DFU can be prevented continues to be limited and is hampered by poor-quality research (152). Despite support from the NZ government and the movement towards integration of healthcare in the literature, the survey of podiatrists identified existing challenges around components of integrative care within the health system continues to exist such as resource barriers (including service availability, staffing, and wait times) and patient factor barriers

(including patient understanding, socioeconomic factors, and geographical location) impacting on the care of people with diabetes.

Key Finding 3: There may be an over-screening of people at very low to medium risk occurring in clinical practice

The identification of a person at risk is ideally undertaken through population screening within an organised screening program, which includes the identification of the target population through treatment, monitoring, and evaluation (35) as without this organised approach, the short-term fall in incidences due to the identification of early diabetes-related foot changes through screening will be followed by a rise in step with the global epidemic (75). It is acknowledged that routine foot screening is of extreme importance in the prevention of DFD (153). The survey of NZ podiatrists included questions about the screening frequency of podiatrists of the low-risk, moderate-risk, and high-risk foot. The responses indicated that podiatrists within NZ are screening those at moderate-to-high risk of foot complications within the suggested timeframes by the IWGDF; however, in the screening of the low-risk foot, podiatrists may be over-screening this population cohort. Given the workforce shortages and specialised knowledge of podiatrists of the assessment and management of the lower limb, this finding may reflect a misapplication of healthcare resources in the care of the low-risk foot (71, 116).

This finding can be considered along with one of the other key findings of the survey in relation to the education provision of NZ podiatrists. Diabetes education has evolved from a previously knowledge- and compliance-centred approach to empowerment- and self-management-centred approach, with an emphasis on structured education and multidisciplinary team delivery (128, 130). However, the survey responses indicated that much of the prevention education by podiatrists in NZ for all prevention behaviours continues to be verbal in a 1:1 clinical setting. Although there is little evidence available to support the effectiveness of patient education alone for the prevention of diabetic-related foot complications, a finding from the UK indicates that podiatrists may lack an understanding of behaviour change techniques which have some evidence to support their effectiveness (154, 155, 156). These two findings, that podiatrists may be over-screening the low-risk foot and preferentially applying education through verbal 1:1 methods, may indicate that podiatric resources are misapplied in the screening of the low-risk foot and that educational delivery and a multidisciplinary care approach by podiatrists are unlikely to be effective. It may be that preventative care for people at low risk of DFU is more effectively and efficiently performed by health practitioners other than podiatrists within a NZ specific integrated healthcare model.

Strengths and Limitations of the Thesis

This thesis has the following strengths: firstly, it aimed to evaluate an area of identified need in preventing diabetic foot complications, namely the routine identification of foot complications through screening and the application of interventions to prevent foot complications. This is an area where there is limited research, and this thesis contributes to the understanding of the current clinical approach both internationally in relation to the improvement of foot screening within complex health systems and locally through the surveying of podiatrists on the application of prevention recommendations into clinical practice. Secondly, the methodology chosen for the evaluation of these areas of research was suitable for the nature of the clinical question. Given the breadth of clinical environments, clinicians involved, and study designs and interventions, a scoping review was the most appropriate methodology for reviewing the literature. A survey was utilised to understand the application of prevention recommendations by podiatrists, which resulted in a wide range of respondents from all practice levels and environments within NZ providing feedback on their clinical practice. Finally, this research provided some of the first insight into the application and utilisation of guideline recommendations within clinical practice and given the increasing role that these guidelines may play in clinical practice, this research is positioned to support future directions around the prevention of diabetic foot complications.

However, this thesis needs to be considered with respect to the following limitations. Firstly, the study designs emphasised self-reporting, with the survey responses self-reported by podiatrists and the scoping review evaluating individual studies focussing on foot screenings as recorded within medical records, which may not always accurately reflect what was undertaken in clinical practice. Therefore, in the survey and scoping review, the self-reported data is likely influenced by the second limitation, which is the combination of biases together, which is considered the 'Hawthorne effect' (157, 158). Thirdly, the research was challenged by the inherent complexity of the research areas. The study designs within the scoping review had a high level of heterogeneity and, in many cases, didn't consider health system complexity within the study design or evaluation framework, and the survey was complicated by the vastly different clinical working environments that exist for podiatrists in NZ (159). Lastly, determining the cause-and-effect relationships within complex health systems is challenging due to its non-linear nature, which was a barrier to determining which intervention resulted in an improvement in foot screening outcomes within the scoping review and ascertaining the degree to which guidelines are influencing practice within the survey (149).

Findings from this thesis centre on methods and the degree to which guideline recommendations in the prevention of diabetic foot complications can be applied to clinical practice. With the cost-effectiveness of the provision of guideline-based care growing (72, 112), there is an increasing emphasis on how this care takes place within clinical practice, with calls for the development of

large-scale collaborations between research and clinical care (80). In addition, there is an increasing need for research into the effective application of prevention strategies which allow for the voice and specific needs of those most likely to feel the impact of the diabetes epidemic, such as Māori, Pacific peoples, and Aboriginal and Torres Strait Islanders (28, 82) as well as those who have the highest social-economic and geographic deprivation (26, 33, 160, 161). Given the scale and the need for the prevention of DFU, as well as the enormous potential for prevention strategies to improve outcomes for health systems and people, it has been suggested that even small improvements in applying guideline recommendations appear worthwhile (72). Within this thesis, three future research areas of diabetic foot prevention were identified.

1. Development of a clinical model favouring the application of personalised and person-centred models of care.
2. Research into large-scale integration of healthcare systems for diabetes-related foot ulcer prevention.
3. Development into locally adapted and adopted guidelines based on internationally accepted recommendations to support the provision of diabetic foot care within a New Zealand context.

Future Direction 1: Development of a clinical model favouring the application of personalised and person-centred models of care.

There is a growing move towards person-centred care within the biomedical evidence-based practice model (114, 162) which is otherwise defined by a solid positivist or Humean approach, characterised by single disease guidelines, homogeneity, and universal treatment, and formulated by a statistical and quantitative methodology (163). Given this limitation of the evidence-based practice model, there have been suggestions that a move towards a personalised medicine approach may be appropriate (80). Personalised medicine can be considered a ‘customised’ approach to guide the care of the individual with a disease who – despite potentially having the same diagnostic label - may respond very differently to the application of lifestyle or therapeutic interventions (164). In the case of prevention of diabetic foot complications, personalised medicine is proposed to provide a method of navigating the application of clinical interventions, with prevention of diabetes involving risk factors which are multidimensional in nature, including age-related changes, environmental factors, socioeconomic factors, nutrition, depression, poverty, and low educational attainment (96). It may be that some degree of this personalisation of medicine in various forms is likely already occurring in clinical practice – with clinicians adapting intervention strategies based on patient's needs and resources (80).

Developing a conceptual framework for diabetes-related foot ulceration prevention

Supporting the movement towards a person-centred approach to prevention may require the development of a conceptual framework for the provision of care, with new developments in preventative care within the health sciences potentially providing a novel framework approach to prevention (165, 166). A focus on causation within prevention is one such development and can be considered a departure from the ontological theoretical framework of best practice guidelines (163, 167). A theoretical framework based on causation may allow for the consideration of a person's uniqueness, context sensitivity, and holism and move preventative healthcare away from a reductionist linear approach (168, 169). For example, in one suggested application of this model, the factors which contribute to foot ulceration may be considered as ‘vectors’ which dispose toward or away from the development of injury to the foot, with the magnitude and direction of these vectors individualised to the person under the guidance of a clinical practitioner (166). A future research direction surrounding developing and applying a framework for DFU, establishing vector model exemplars, and/or developing a causative inference model therefore could support the personalisation of preventative care for people with diabetes.

Future Direction 2: Research into large-scale integration of healthcare systems for diabetes-related foot ulcer prevention.

Integrated care can be considered the bringing together of care to people in need (170). An integrated care approach in the delivery of foot care to people at high risk of foot ulceration is strongly recommended by the IWGDF, which states that this, at a minimum, includes professional foot care, adequate footwear, and structured education about self-care (114). However, research within this thesis indicates that NZ podiatrists are limited in their application of an integrative care approach to diabetes, with the provision of structured education reported by less than 8% of responders along with the partial application of recommendations around access and availability of footwear, provision of exercise, care in geographically remote locations, and working alongside Māori health providers. There have been efforts to develop and pilot a diabetes self-management education specific to the needs of NZers. However, much of the education around diabetes appears to be inconsistently provided throughout NZ (171). A systematic review of the application of integrated health approaches to the prevention of foot ulceration in people with diabetes identified low-quality evidence (115). However, integration of care continues to be strongly recommended by the expert panel, with the 2023 IWGDF Prevention Guidelines stating that the effect of a ‘state-of-the-art’ integrated care program that combines all guideline recommendations is expected to be much stronger than that achieved by programs researched to date (73). Therefore, further research and investment are needed to bridge the apparent gap between the strength of the IWGDF prevention recommendations, the quality of the evidence, and the degree to which integrated care of the lower limb in a person with

diabetes can be effectively and consistently implemented throughout a fragmented and complex large-scale system such as the NZ health system.

One way that the implementation of integrated health care may occur is by considering complex system theories alongside and within an implementation science approach. Previously, NZ has trialled some education and implementation intervention projects for people with diabetes, which have been delivered to small groups with limited evidence of their efficacy (28). However, future projects may need to consider the system as a whole, with the goal of implementation science not to establish the health impact of clinical innovation but rather to identify the factors that affect its uptake into routine use (172). Another way of considering this is that if the complexity cannot be reduced within the system, then the absorption of complexity within the selected intervention and evaluation approach may be more effective (146, 173). In the scoping review, many intervention modalities were applied with the goal of increasing foot screening rates, a relatively simple undertaking which could be reasonably achieved through simple quality improvement strategies (172). Achieving integrated healthcare is much more complex, and it may be much less certain how it might consider its objectives achieved. There is a need for acceptance of standard components of care and pathways for referral, with consistency around referral behaviours (156), collaborative and widespread promotion of the importance of proactive rather than reactive footcare practices (87), and within NZ, the implementation of a cross-health system approach, including a national communication campaign and extension of effective primary health and community models of care (33). Currently, the Quality Standards for Diabetes Care 2020 have been developed to promote awareness of best practices and reporting, scaled to local diabetes prevalence and population characteristics alongside national and international guidance (174). Podiatrists within NZ have the potential to be facilitators of these recommendations within an overall diabetes lower limb strategy, particularly at the point of risk identification and escalation of care; however, there is more demand for podiatry services than capacity (71), and a high level of burnout and intention to leave the profession identified (175, 176). The expectation for podiatrists to be alone the leaders in the application of integrative care for DFU given the lack of investment by the government in the support of the profession (28) may be an unreasonable expectation, as it has been suggested that when a system is over-constrained as is the NZ health system (27, 160), any intervention, regardless of merit, will struggle to change system behaviour (143). However, if these barriers are navigated to create even small changes in the provision of guideline-based care to current practice (72), improve rates of complications between Māori and non-Māori (33), reduce access to diabetic foot care in geographically remote locations (177), reduce waste and overuse in healthcare (116), and assist in the integration of patient contributions, preferences, experiences and outcomes to inform care delivery (148), they are likely to be worthwhile.

Development of an integrated care approach to the prevention of diabetes-related foot ulceration

The provision of diabetic foot care within NZ is challenged by the lack of healthcare integration, particularly around the provision of care to those people without active foot ulcerations. Individuals with risk factors for foot ulceration have difficulty accessing timely, affordable, and integrated healthcare services, with much of the care fragmented through public and private healthcare services (28). However, to identify and address these, further enquiry into the exact barriers within NZ for providing preventative care to persons with diabetes is needed. This research may focus on specific geographical areas, workplaces, job roles or descriptions, and/or patient populations and require a mixed methods approach, with data collection (surveys, reporting data) analysed alongside patient cases or individual reports, which may allow for the development of an understanding of the barriers and enablers at the point of service delivery. Developing from this, a future direction for research in this area may be increasing the role and capacity of podiatry within the healthcare referral pathway/s with a focus on medium-high-risk foot care, which is suitable for the local context; along with the integration of podiatrists within medium to high-risk foot care services in primary community care and general practice; and/or the development and application of infrastructure to support of effective triaging which could support podiatrists to concentrate efforts on those with risk factors who are most likely to develop foot ulcerations. The development of initiatives designed to change how practice is undertaken and approached will need to incorporate implementation science principles given the complexity of large healthcare systems and may involve the consideration of research designs which allow for the implementation of an intervention over different time periods, such as the use of a stepped wedge cluster randomised trial (178).

Future Direction 3: New Zealand Diabetic Foot Guidelines

The diabetes epidemic will be a major challenge to the sustainability of healthcare resources and expenditure (96), with strong evidence suggesting that there is common and growing worldwide overuse and increasing unaffordability of healthcare resources in high-income countries such as NZ (160, 179). New Zealand, along with other health systems worldwide, is faced with the need to obtain the most value for health from the dollar spent, and the application of guideline-recommended foot care is considered a key component of reducing this cost (50, 180). A proposed solution to this overuse is in the identification and application of only those healthcare interventions that have been determined to be efficacious, effective, and efficient; however, it is considered unlikely that any clinician will ever have the skills as well as the time for the undertaking of sophisticated assessments of the evidence-base for their practice to achieve this (116, 162). This is where implementation science overlaps evidence-based medicine and aims to support the translation of external research evidence (‘do the right things’) with local processes (‘doing things right’), with the ultimate goal ‘to do the right things right’; as irrespective of the

strength or robustness of evidence, research is unable to change outcomes unless it is adopted into practice (111, 116, 181).

Given the utilisation of a risk stratification system and lack of guidelines for the care of DFU in NZ, components of care provision which allow podiatrists work within the full range of their scope along with the utilisation of the extent of their education, training, and experience in their routine activities may be less supported at a health policy and governance level than in countries such as Australia, which recently updated their guidelines based on those developed by the IWGDF (82). This can be seen from the findings in the survey which indicate that podiatrists face challenges accessing and funding therapeutic and custom footwear for patients, guiding people with diabetes on exercise and weight-bearing activities, have variable referral options for specialist services such as orthopaedic and vascular assessments, and seldom refer for consideration of surgical offloading. A structured implementation of guidelines can improve provision of care in these areas, but a lack of guideline application within NZ could potentially result in an uneven uptake of research findings within different healthcare settings (83, 181). There are no current local guidelines within NZ for the care of a person with diabetes, with podiatrists in the survey undertaken indicating their preferred use of the IWGDF Guidelines (56) and Australian Diabetic Foot Guidelines (82) to help with their provision of care. In the future, it may be that international guidelines could be adapted and adopted into the NZ context to support the prevention and treatment of diabetic foot complications, facilitate the application of a personalised and person-centred care approach with respect to Māori and Pacific voices, and allow for the promotion of healthcare service integration.

Development of Aotearoa New Zealand Guidelines for Diabetes-Related Foot Complications

New Zealand would benefit from local guidelines to support the care of the lower limb in people with diabetes-related foot complications. However, the cost, time, and expertise to develop local diabetic foot guidelines within NZ may outweigh their relative benefits. Guidelines can be a powerful tool in addressing several challenges which face the NZ health care system in relation to the prevention and management of DFU and can play a role in supporting and enabling the provision of cost-effective, timely, coordinated, and person-centred care to a person with diabetes. However, the uptake and referral to international guidelines are inconsistent throughout NZ and may largely depend on the individual clinician’s area of interest, time, availability, and clinical need. The Australian diabetic foot guidelines are based on the IWGDF and have been developed considering the local Australian context, including the representation and consideration of the voices and needs of Indigenous, remote, and geographically isolated peoples. A future avenue of developing local guidelines for NZ in a cost-effective and resource-considerate way may be to utilise the close trans-Tasman relationship and have NZ representation in developing and adapting the IWGDF guidelines. Alternatively, NZ could follow

the approach taken by Australia in the adaption of the IWGDF guidelines (182). Through this, guidelines will be able to be brought into the NZ context and adopted into the NZ healthcare framework while allowing the sharing of some of the methodological steps in approaching guideline adaption. Furthermore, having the implementation of guidelines through a similar methodological framework within both Australian and NZ health systems may support the care of the person with diabetes-related foot disease through the standardisation of care decision-making, similar use of language and classification systems - and in the case of podiatry - supporting the integration of podiatrists as a key player within the wider healthcare environment.

Conclusion

New Zealand, along with the rest of the world, is facing a rapidly increasing DFD burden. Much of the research and clinical resources relating to this burden have been focused on assessing and managing foot ulceration once developed. However, there are calls for an increased focus on preventing DFD and research into methods to prevent diabetic foot complications within complex health systems. Guidelines such as the IWGDF diabetic foot guidelines have been suggested as a method in which changes to practice can occur. However, the extent to which these recommendations have been adopted into practice is unknown. The research undertaken as part of this thesis, therefore, aimed to explore how diabetic foot guideline recommendations have been implemented into clinical practice in relation to the prevention of diabetic foot complications. This was undertaken through a scoping review of interventions designed to increase foot screening rates within health systems and a survey of NZ podiatrists on the clinical application of prevention recommendations. The scoping review identified that there appeared to be no single implementation target or modality which resulted in an increase in guideline-recommended foot screening rates, concluding in agreement with broader research into change practice that it was likely that a range of implementation strategies can result in improvements in foot screening rates depending on the needs and characteristics of the health system that they are applied into. The survey identified that most podiatrists generally follow international guideline recommendations with respect to the screening of the at-risk foot, instructions on foot self-care, appropriate footwear and treatment of risk factors and pre-ulcerative signs; however, there may be some over-screening of the low-risk foot occurring in clinical practice. Future directions include an increasing emphasis on the personalisation of preventative care strategies with the development of a conceptual framework guided by causation models, the need for podiatrists to be integrated within primary health services to support the care of the medium-high risk person with diabetes, and the potential need for locally adapted guidelines to support the provision of diabetic foot care within NZ.

Chapter 4 References

6. Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, Duncan BB, et al. IDF Diabetes Atlas: Global, Regional and Country-Level Diabetes Prevalence Estimates for 2021 and Projections for 2045. Diabetes Res Clin Pract. 2022;183:109119.
13. Armstrong DG, Boulton AJM, Bus SA. Diabetic Foot Ulcers and their Recurrence. N Engl J Med. 2017;376(24):2367-75.
22. Monteiro-Soares M, Vale-Lima J, Martiniano J, Pinheiro-Torres S, Dias V, Boyko EJ. A Systematic Review with Meta-Analysis of the Impact of Access and Quality of Diabetic Foot Care Delivery in Preventing Lower Extremity Amputation. J Diabetes Complications. 2021;35(4):107837.
26. Zhang Y, Van Netten JJ, Baba M, Cheng Q, Pacella R, McPhail SM, et al. Diabetes-Related Foot Disease in Australia: A Systematic Review of the Prevalence and Incidence of Risk Factors, Disease and Amputation in Australian Populations. J Foot Ankle Res. 2021;14(1):1-16.
27. Cumming J. New Zealand Health System Review. [[Internet]]. New Delhi: World Health Organization Regional Office for South-East Asia; 2022. Report No.: 9789290210122 Available from: https://apo.who.int/publications/i/item/new-zealand-health-system-review
28. Shepard-Wipiiti T, Brennan L. The Economic and Social Cost of Type 2 Diabetes. [Internet]. Ministry of Health; 2021. Available from: https://healthierlives.co.nz/report-on-the-economic-and-social-cost-of-type-2-diabetes/
33. Ministry of Health. Whakamaua: Māori Health Action Plan 2020-2025. [Internet]. Wellington: Ministry of Health 2020. Report No.: 7429 Available from: https://www.health.govt.nz/publication/whakamaua-maori-health-action-plan-2020-2025
35. Sagan A, McDaid D, Rajan S, Farrington J, McKee M. Screening: When Is It Appropriate and How Can We Get it Right? [Internet]. Copenhagen (Denmark): World Health Organization 2020; 2020. Available from: https://pubmed.ncbi.nlm.nih.gov/32716617/
50. Bus SA, van Netten JJ. A Shift in Priority in Diabetic Foot Care and Research: 75% of Foot Ulcers are Preventable. Diabetes Metab Res Rev. 2016;32:195-200.
56. International Working Group of the Diabetic Foot. About IWGDF Guidelines [Internet]. 2023 [cited 2023 May 8]. Available from: https://iwgdfguidelines.org/about-iwgdf-guidelines/.
57. Schaper NC, Van Netten JJ, Apelqvist J, Bus SA, Fitridge R, Game F, et al. Practical Guidelines on the Prevention and Management of Diabetes-Related Foot Disease (IWGDF 2023 update). Diabetes Metab Res Rev. 2023.
71. Carroll M, Jepson H, Molyneux P, Brenton-Rule A. The New Zealand Podiatry Profession – A Workforce in Crisis? J Foot Ankle Res. 2020;13(1):1-7.
72. Zhang Y, Carter HE, Lazzarini PA, Cramb S, Pacella R, van Netten JJ, et al. Cost-Effectiveness of Guideline-Based Care Provision for Patients with Diabetes-Related Foot Ulcers: A Modelled Analysis Using Discrete Event Simulation. Diabet Med. 2023;40(1):1-11.
73. Schaper NC, van Netten JJ, Apelqvist J, Bus SA, Fitridge R, Game F, et al. Guidelines on the Prevention of Foot Ulcers in Persons with Diabetes. Diabetes Metab Res Rev. 2023;36(57):1-14.
75. Jeffcoate W, Young B. Reducing Amputation in Diabetes: Work from the West Country Provides both Evidence and a Tool-kit. Diabet Med. 2018;35(1):8-9.
80. van Netten JJ, Woodburn J, Bus SA. The Future for Diabetic Foot Ulcer Prevention: A Paradigm Shift From Stratified Healthcare Towards Personalized Medicine. Diabetes Metab Res Rev. 2020;36(S1):1-7.
82. Kaminski MR, Golledge J, Lasschuit JWJ, Schott K-H, Charles J, Cheney J, et al. Australian Guideline on Prevention of Foot Ulceration: Part of the 2021 Australian Evidence-Based Guidelines for Diabetes-Related Foot Disease. J Foot Ankle Res. 2022;15(1):1-33.
83. Fischer F, Lange K, Klose K, Greiner W, Kraemer A. Barriers and Strategies in Guideline Implementation; A Scoping Review. Healthcare. 2016;4(3):36.
87. Mullan L, Wynter K, Driscoll A, Rasmussen B. Prioritisation of Diabetes-Related Footcare Amongst Primary Care Healthcare Professionals. J Clin Nurs. 2020;29(23-24):4653-73.

96. Chan J, Lim L-L, Wareham NJ, Shaw JE, Orchard TJ, Zhang P, et al. The Lancet Commission on Diabetes: Using Data to Transform Diabetes Care and Patient Lives. Lancet. 2020;396(10267):2019-82.
97. Doherty JA, Crelia SJ, Smith MW, Rosenblum SF, Rumsey EM, Mabry-Hernandez IR, et al. Large Health Systems' Prevention Guideline Implementation: a Qualitative Study. Am J Prev Med. 2018;54(1):S88-S94.
111. Carroll Á, Collins C, McKenzie J, Stokes D, Darley A. Application of Complexity Theory in Health and Social Care Research: A Scoping Review. BMJ Open. 2023;13(3):e069180.
112. Siegel KR, Ali MK, Zhou X, Ng BP, Jawanda S, Proia K, et al. Cost-effectiveness of interventions to manage diabetes: has the evidence changed since 2008? Diabetes Care. 2020;43(7):1557-92.
113. Lavery LA, La Fontaine J, Kim PJ. Preventing the First or Recurrent Ulcers. Med Clin North Am. 2013;97(5):807-20.
114. Bus SA, Lavery LA, Monteiro-Soares M, Rasmussen A, Raspovic A, Sacco I, et al. Guidelines on the Prevention of Foot Ulcers in Persons with Diabetes (IWGDF 2019 update). Diabetes Metab Res Rev. 2020;36(S1):1-18.
115. van Netten JJ, Raspovic A, Lavery LA, Monteiro-Soares M, Rasmussen A, Sacco I, et al. Prevention of Foot Ulcers in the At-Risk Patient with Diabetes: A Systematic Review. Diabetes Metab Res Rev. 2020;36(S1):1-22.
116. Djulbegovic B. A Framework to Bridge the Gaps Between Evidence-Based Medicine, Health Outcomes, and Improvement and Implementation Science. J Oncol Pract. 2014;10(3):200-2.
118. Schaper NC, van Netten JJ, Apelqvist J, Bus SA, Hinchliffe RJ, Lipsky BA. Practical Guidelines on the Prevention and Management of Diabetic Foot Disease (IWGDF 2019 update). Diabetes Metab Res Rev. 2020;36(S1):1-10.
126. Crawford F, Cezard G, Chappell FM, Murray GD, Price JF, Sheikh A, et al. A Systematic Review and Individual Patient Data Meta-Analysis of Prognostic Factors for Foot Ulceration in People with Diabetes: The International Research Collaboration for the Prediction of Diabetic Foot Ulcerations (PODUS). Health Technol Assess. 2015;19(57):1-210.
128. Chatterjee S, Davies MJ, Heller S, Speight J, Snoek FJ, Khunti K. Diabetes Structured Self-Management Education Programmes: A Narrative Review and Current Innovations. Lancet Diabetes Endocrinol. 2018;6(2):130-42.
130. Hermanns N, Ehrmann D, Finke-Groene K, Kulzer B. Trends in Diabetes Self-Management Education: Where are We Coming From and Where are We Going? A Narrative Review. Diabet Med. 2020;37(3):436-47.
137. Lazzarini PA, Raspovic KM, Meloni M, van Netten JJ. A New Declaration for Feet's Sake: Halving the Global Diabetic Foot Disease Burden from 2% to 1% with Next Generation Care. Diabetes Metab Res Rev. 2023;37(47):1-12.
138. Lazzarini PA, Cramb SM, Golledge J, Morton JI, Magliano DJ, Van Netten JJ. Global Trends in the Incidence of Hospital Admissions for Diabetes-Related Foot Disease and Amputations: A Review of National Rates in the 21st Century. Diabetologia. 2023;66(2):267-87.
139. Daly B, Arroll B, Nirantharakumar K, Scragg RKR. Improved Foot Management of People with Diabetes by Primary Healthcare Nurses in Auckland, New Zealand. N Z Med J. 2020;133(1527):39-50.
140. Gustafson P, Lambert M, Bartholomew K, Ratima M, Aziz YA, Kremer L, et al. Adapting an Aquity-Focused Implementation Process Framework with a Focus on Ethnic Health Inequities in the Aotearoa New Zealand Context. Int J Equity Health. 2024;23(1).
141. Oetzel J, Scott N, Hudson M, Masters-Awatere B, Rarere M, Foote J, et al. Implementation Framework for Chronic Disease Intervention Effectiveness in Māori and Other Indigenous Communities. Global Health. 2017;13(1).
142. Prior M, Guerin M, Grimmer-Somers K. The Effectiveness of Clinical Guideline Implementation Strategies–A Synthesis of Systematic Review Findings. J Eval Clin Pract. 2008;14(5):888-97.
143. Coiera E. Why System Inertia Makes Health Reform So Difficult. BMJ. 2011;342:1-5.
144. Nikitara M, Constantinou CS, Andreou E, Diomidous M. The Role of Nurses and the Facilitators and Barriers in Diabetes Care: A Mixed Methods Systematic Literature Review. Behav Sci. 2019;9(6):61.

145. Ivers N, Jamtvedt G, Young JM, Kristoffersen DT, Thomson O'Brien MA, Oxman AD. Audit and Feedback: Effects on Professional Practice and Health Care Outcomes. Cochrane Database Syst Rev. 2012(3):1-209.
146. Zimmerman BJ, Dubois N, Houle J, Lloyd S, Mercier C, Brousselle A, et al. How Does Complexity Impact Evaluation? An Introduction to the Special Issue. Can J Program Eval. 2011;26(3):1-6.
147. Atun R, de Jongh T, Secci F, Ohiri K, Adeyi O. Integration of Targeted Health Interventions into Health Systems: A Conceptual Framework for Analysis. Health Policy Plan. 2009;25(2):104-11.
148. Harrison R, Fischer S, Walpola RL, Chauhan A, Babalola T, Mears S, et al. Where do Models for Change Management, Improvement and Implementation Meet? A Systematic Review of the Applications of Change Management Models in Healthcare. J Healthc Leadersh. 2021;13:85-108.
149. McGill E, Er V, Penney T, Egan M, White M, Meier P, et al. Evaluation of Public Health Interventions From a Complex Systems Perspective: A Research Methods Review. Soc Sci Med. 2021;272:113697.
150. Messina J, Campbell S, Morris R, Eyles E, Sanders C. A Narrative Systematic Review of Factors Affecting Diabetes Prevention in Primary Care Settings. PLoS One. 2017;12(5):e0177699.
151. Masters-Awatere B, Cassim S, Tamatea J, Scott N, Simpson C, Paekau C. He Pikinga Waiora Kimi Ora lifestyle programme: case study of a successful community-based Indigenous diabetes intervention. N Z Med J. 2021;134(1545):68-78.
152. Crawford F, Nicolson DJ, Amanna AE, Smith M. Reliability of the Evidence to Guide Decision-Making in Foot Ulcer Prevention in Diabetes: An Overview of Systematic Reviews. BMC Med Res Methodol. 2022;22(1).
153. Pérez-Panero AJ, Ruiz-Muñoz M, Cuesta-Vargas AI, Gónzalez-Sánchez M. Prevention, Assessment, Diagnosis and Management of Diabetic Foot Based on Clinical Practice Guidelines: A Systematic Review. Medicine. 2019;98(35):e16877.
154. Dorresteijn JA, Kriegsman DM, Assendelft WJ, Valk GD. Patient Education for Preventing Diabetic Foot Ulceration. Cochrane Database Syst Rev. 2014(12):1-44.
155. Egan C, Lycett D, Tighe B. What is the Practice and Understanding of Podiatrists Towards Patient-Centred Consultations Regarding Diabetic Foot Care? Diabetic Foot. 2021;24(4):1-5.
156. Jeffcoate WJ, Vileikyte L, Boyko EJ, Armstrong DG, Boulton AJM. Current Challenges and Opportunities in the Prevention and Management of Diabetic Foot Ulcers. Diabetes Care. 2018;41(4):645-52.
157. Chen LF, Vander Weg MW, Hofmann DA, Reisinger HS. The Hawthorne Effect in Infection Prevention and Epidemiology. Infect Control Hosp Epidemiol. 2015;36(12):1444-50.
158. Berkhout C, Berbra O, Favre J, Collins C, Calafiore M, Peremans L, et al. Defining and Evaluating the Hawthorne Effect in Primary Care, A Systematic Review and Meta-Analysis. Front Med. 2022;9:1-15.
159. Perla RJ, Bradbury E, Gunther-Murphy C. Large-Scale Improvement Initiatives in Healthcare: A Scan of the Literature. J Healthc Qual. 2013;35(1):30-40.
160. Holder-Pearson L, Chase JG. Socio-economic Inequity: Diabetes in New Zealand. Front Med. 2022;9:756223.
161. Hurst JE, Barn R, Gibson L, Innes H, Bus SA, Kennon B, et al. Geospatial Mapping and Data Linkage Uncovers Variability in Outcomes of Foot Disease According to Multiple Deprivation: A Population Cohort Study of People with Diabetes. Diabetologia. 2020;63(3):659-67.
162. Djulbegovic B, Guyatt GH. Progress in Evidence-Based Medicine: A Quarter Century On. Lancet. 2017;390(10092):415-23.
163. Anjum R. Evidence-Based or Person-Centered? An Ontological Debate. Eur J Pers Cent Healthc. 2016;4(2):421.
164. McCarthy MI. Painting a New Picture of Personalised Medicine for Diabetes. Diabetologia. 2017;60(5):793-9.
165. Ross LN, Bassett DS. Causation in Neuroscience: Keeping Mechanism Meaningful. Nat Rev Neurosci. 2024;25(2):81-90.

166. Vaz DV, Stilwell P, Coninx S, Low M, Liebenson C. Affordance-Based Practice: An Ecological-Enactive Approach to Chronic Musculoskeletal Pain Management. Braz J Phys Ther. 2023;27(5):100554.
167. Mumford S, Anjum RL. Getting Causes from Powers [Internet]. USA: Oxford University Press; 2011 16th March 2024]. Available from: https://doi.org/10.1093/acprof:oso/9780199695614.001.0001.
168. Low M. A Novel Clinical Framework: The Use of Dispositions in Clinical Practice. A Person Centred Approach. J Eval Clin Pract. 2017;23(5):1062-70.
169. Anjum RL, Rocca E. From Ideal to Real Risk: Philosophy of Causation Meets Risk Analysis. Risk Anal. 2019;39(3):729-40.
170. Goodwin N. Understanding Integrated Care. Int J Integr Care. 2016;16(4):1-4.
171. Gamble E, Parry-Strong A, Coppell KJ, McBain L, Bingham LJ, Dutton L, et al. Development of a Structured Diabetes Self-Management Education Program Specific to the Cultural and Ethnic Population of New Zealand. Nutr Diet. 2017;74(4):415-22.
172. Bauer MS, Damschroder L, Hagedorn H, Smith J, Kilbourne AM. An Introduction to Implementation Science for the Non-Specialist. BMC Psychol. 2015;3(1):1-12.
173. Dayan PS, Ballard DW, Shelton RC, Kuppermann N. Implementation Trials that Change Practice: Evidence Alone is Never Enough. Ann Emerg Med. 2022;80(4):344-6.
174. New Zealand Government. Quality Standards for Diabetes Care 2020. In: Ministry of Health, editor. 2020.
175. Couch A, Menz HB, O'Sullivan B, Haines T, Williams CM. Describing the Factors Related to Rural Podiatry Work and Retention in the Podiatry Workforce: A National Survey. J Foot Ankle Res. 2023;16(1):1-12.
176. Clarke M, Frecklington M, Stewart S. Burnout among the podiatry profession: A survey of podiatrists in Aotearoa New Zealand. Journal of Foot and Ankle Research. 2024;17(2).
177. Lazzarini PA, Fitridge R. Regional Variations in Amputation Rates: Are Regional Diabetic Foot Services the Reason? ANZ J Surg. 2019;89(7-8):796-7.
178. Hemming K, Haines TP, Chilton PJ, Girling AJ, Lilford RJ. The Stepped Wedge Cluster Randomised Trial: Rationale, Design, Analysis, and Reporting. BMJ. 2015;350(feb06 1):350-7.
179. Brownlee S, Chalkidou K, Doust J, Elshaug AG, Glasziou P, Heath I, et al. Evidence for Overuse of Medical Services Around the World. Lancet. 2017;390(10090):156-68.
180. Saini V, Brownlee S, Elshaug AG, Glasziou P, Heath I. Addressing Overuse and Underuse Around the World. Lancet. 2017;390(10090):105-7.
181. Eccles MP, Mittman BS. Welcome to Implementation Science. Implement Sci. 2006;1(1):1-3.
182. Lazzarini PA, Raspovic A, Prentice J, Commons RJ, Fitridge RA, Charles J, et al. Guidelines development protocol and findings: part of the 2021 Australian evidence-based guidelines for diabetes-related foot disease. Journal of Foot and Ankle Research. 2022;15(1).

Thesis Reference List

1. World Health Organization. Definition and Diagnosis of Diabetes Mellitus and Intermediate Hyperglycemia. Report of a WHO/IDF Consultation [Internet]. Geneva: World Health Organization; 2006. 9241594934 Available from: https://www.who.int/publications/i/item/definition-and-diagnosis-of-diabetes-mellitus-and-intermediate-hyperglycaemia
2. Schellenberg ESD, M; D, Vandermeer B, Ha C, Korownyk C. Lifestyle Interventions for Patients With and At Risk for Type 2 Diabetes. Ann Intern Med. 2013;159(8):543-51.
3. Gurney J, Stanley J, Sarfati D. The Inequity of Morbidity: Disparities in the Prevalence of Morbidity Between Ethnic Groups in New Zealand. J Comorb. 2020;10:2235042x20971168.
4. Yu D, Osuagwu UL, Pickering K, Baker J, Cutfield R, Wang Z, et al. Adverse Clinical Outcomes Attributable to Socioeconomic and Ethnic Disparities Among People with Type 2 Diabetes in New Zealand Between 1994–2018: A Multiple Linked Cohort Study. Clin Epidemiol. 2023;Volume 15:511-23.
5. World Health Organization. Diabetes Fact Sheet [Internet]. 2022 [Available from: https://www.who.int/news-room/fact-sheets/detail/diabetes.
6. Sun H, Saeedi P, Karuranga S, Pinkepank M, Ogurtsova K, Duncan BB, et al. IDF Diabetes Atlas: Global, Regional and Country-Level Diabetes Prevalence Estimates for 2021 and Projections for 2045. Diabetes Res Clin Pract. 2022;183:109119.
7. Mikkelsen B. Surveillance of Noncommunicable Diseases "About Us" [Internet]. World Health Organization; 2020 [Available from: https://www.who.int/teams/surveillance-of-noncommunicable-diseases/about/ncds.
8. Vos T, Lim SS, Abbafati C, Abbas KM, Abbasi M, Abbasifard M, et al. Global Burden of 369 Diseases and Injuries in 204 Countries and Territories, 1990–2019: A Systematic Analysis for the Global Burden of Disease Study 2019. Lancet. 2020;396(10258):1204-22.
9. Struijs JN, Baan CA, Schellevis FG, Westert GP, Van Den Bos GA. Comorbidity in Patients with Diabetes Mellitus: Impact on Medical Health Care Utilization. BMC Health Serv Res. 2006;6(1):1-9.
10. Williams R, Karuranga S, Malanda B, Saeedi P, Basit A, Besançon S, et al. Global and Regional Estimates and Projections of Diabetes-Related Health Expenditure: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. Diabetes Res Clin Pract. 2020;162:108072.
11. The Emerging Risk Factors Collaboration. Diabetes Mellitus, Fasting Blood Glucose Concentration, and Risk of Vascular Disease: A Collaborative Meta-Analysis of 102 Prospective Studies. Lancet. 2010;375(9733):2215-22.
12. United States Renal Data System. 2018 USRDS Annual Data Report: Epidemiology of Kidney Disease in the United States. [Internet]. Bethesda, MD: National Institutes of Health, National Institute of Diabetes and Digestive and Kidney Diseases; 2018. Available from: https://www.niddk.nih.gov/about-niddk/strategic-plans-reports/usrds/prior-data-reports/2018
13. Armstrong DG, Boulton AJM, Bus SA. Diabetic Foot Ulcers and their Recurrence. N Engl J Med. 2017;376(24):2367-75.
14. Steinmetz JD, Bourne RR, Briant PS, Flaxman SR, Taylor HR, Jonas JB, et al. Causes of Blindness and Vision Impairment in 2020 and Trends over 30 Years, and Prevalence of Avoidable Blindness in Relation to VISION 2020: the Right to Sight: an analysis for the Global Burden of Disease Study. Lancet Glob Health. 2021;9(2):e144-e60.
15. van Netten JJ, Bus SA, Apelqvist J, Chen P, Chuter V, Fitridge R, et al. Definitions and Criteria for Diabetes‐Related Foot Disease (IWGDF 2023 update). Diabetes Metab Res Rev. 2023.
16. Petrakis I, Kyriopoulos IJ, Ginis A, Athanasakis K. Losing a Foot Versus Losing a Dollar; A Systematic Review of Cost Studies in Diabetic Foot Complications. Expert Rev Pharmacoecon Outcomes Res. 2017;17(2):165-80.
17. Mairghani M, Jassim G, Elmusharaf K, Patton D, Eltahir O, Moore Z, et al. Methodological Approaches for Assessing the Cost of Diabetic Foot Ulcers: A Systematic Literature Review. J Wound Care. 2019;28(5):261-6.

18. Lazzarini PA, Pacella RE, Armstrong DG, Van Netten JJ. Diabetes-Related Lower-Extremity Complications are a Leading Cause of the Global Burden of Disability. Diabet Med. 2018;35(9):1297-9.
19. Kerr M, Barron E, Chadwick P, Evans T, Kong WM, Rayman G, et al. The Cost of Diabetic Foot Ulcers and Amputations to the National Health Service in England. Diabet Med. 2019;36(8):995-1002.
20. Lazzarini PA, Hurn SE, Kuys SS, Kamp MC, Ng V, Thomas C, et al. The Silent Overall Burden of Foot Disease in a Representative Hospitalised Population. Int Wound J. 2017;14(4):716-28.
21. Pena G, Cowled P, Dawson J, Johnson B, Fitridge R. Diabetic Foot and Lower Limb Amputations: Underestimated Problem with a Cost to Health System and to the Patient. ANZ J Surg. 2018;88(7-8):666-7.
22. Monteiro-Soares M, Vale-Lima J, Martiniano J, Pinheiro-Torres S, Dias V, Boyko EJ. A Systematic Review with Meta-Analysis of the Impact of Access and Quality of Diabetic Foot Care Delivery in Preventing Lower Extremity Amputation. J Diabetes Complications. 2021;35(4):107837.
23. Albright RH, Manohar NB, Murillo JF, Kengne LAM, Delgado-Hurtado JJ, Diamond ML, et al. Effectiveness of Multidisciplinary Care Teams in Reducing Major Amputation Rate in Adults with Diabetes: A Systematic Review & Meta-Analysis. Diabetes Res Clin Pract. 2020;161:107996.
24. Lombardo FL, Maggini M, De Bellis A, Seghieri G, Anichini R. Lower Extremity Amputations in Persons with and without Diabetes in Italy: 2001–2010. PLoS One. 2014;9(1):e86405.
25. Krishnan S, Nash F, Baker N, Fowler D, Rayman G. Reduction in Diabetic Amputations Over 11 Years in a Defined U.K. Population. Diabetes Care. 2008;31(1):99-101.
26. Zhang Y, Van Netten JJ, Baba M, Cheng Q, Pacella R, McPhail SM, et al. Diabetes-Related Foot Disease in Australia: A Systematic Review of the Prevalence and Incidence of Risk Factors, Disease and Amputation in Australian Populations. J Foot Ankle Res. 2021;14(1):1-16.
27. Cumming J. New Zealand Health System Review. [[Internet]]. New Delhi: World Health Organization Regional Office for South-East Asia; 2022. Report No.: 9789290210122 Available from: https://apo.who.int/publications/i/item/new-zealand-health-system-review
28. Shepard-Wipiiti T, Brennan L. The Economic and Social Cost of Type 2 Diabetes. [Internet]. Ministry of Health; 2021. Available from: https://healthierlives.co.nz/report-on-the-economic-and-social-cost-of-type-2-diabetes/
29. Dinh NTT, De Graaff B, Campbell JA, Jose MD, John B, Saunder T, et al. Costs of Major Complications in People With and Without Diabetes in Tasmania, Australia. Aust Health Rev. 2022;46(6):667-78.
30. Gurney JK, Stanley J, York S, Sarfati D. Lower-Limb Amputation in New Zealand: Temporal Changes and the Role of Diabetes Mellitus. NZ Med J. 2018;131(1484):71-3.
31. Health New Zealand [Te Whatu Ora]. Virtual Diabetes Register and Web Tool: New Zealand Government; 2022 [Available from: https://www.tewhatuora.govt.nz/for-health-professionals/data-and-statistics/virtual-diabetes-tool/#:~:text=In%202022%2C%20about%20307%2C400%20people,CI%3A%2043.0%2C%2043.3).
32. Robinson TE, Kenealy T, Garrett M, Bramley D, Drury PL, Elley CR. Ethnicity and Risk of Lower Limb Amputation in People with Type 2 Diabetes: A Prospective Cohort Study. Diabet Med. 2016;33(1):55-61.
33. Ministry of Health. Whakamaua: Māori Health Action Plan 2020-2025. [Internet]. Wellington: Ministry of Health 2020. Report No.: 7429 Available from: https://www.health.govt.nz/publication/whakamaua-maori-health-action-plan-2020-2025
34. Stokes T, Tumilty E, Doolan-Noble F, Gauld R. HealthPathways Implementation in a New Zealand Health Region: Qualitative Study Using the Consolidated Framework for Implementation Research. BMJ Open. 2018;8(12):e025094.
35. Sagan A, McDaid D, Rajan S, Farrington J, McKee M. Screening: When Is It Appropriate and How Can We Get it Right? [Internet]. Copenhagen (Denmark): World Health Organization 2020; 2020. Available from: https://pubmed.ncbi.nlm.nih.gov/32716617/

36. Schünemann HJ, Reinap M, Piggott T, Laidmäe E, Köhler K, Põld M, et al. The Ecosystem of Health Decision Making: From Fragmentation to Synergy. Lancet Public Health. 2022;7(4):e378-e90.
37. Parkhurst JO, Abeysinghe S. What Constitutes "Good" Evidence for Public Health and Social Policy-making? From Hierarchies to Appropriateness. Soc Epistemol. 2016;30(5-6):665-79.
38. Howick J, Koletsi D, Ioannidis JPA, Madigan C, Pandis N, Loef M, et al. Most Healthcare Interventions Tested in Cochrane Reviews are not Effective According to High Quality Evidence: A Systematic Review and Meta-Analysis. J Clin Epidemiol. 2022;148:160-9.
39. Zha M-L, Cai J-Y, Chen H-L. A Bibliometric Analysis of Global Research Production Pertaining to Diabetic Foot Ulcers in the Past Ten Years. J Foot Ankle Surg. 2019;58(2):253-9.
40. Montori VM, Brito JP, Murad MH. The Optimal Practice of Evidence-Based Medicine. JAMA. 2013;310(23):2503.
41. Brownson RC, Fielding JE, Green LW. Building Capacity for Evidence-Based Public Health: Reconciling the Pulls of Practice and the Push of Research. Annu Rev Public Health. 2018;39(1):27-53.
42. Albarqouni L, Hoffmann T, Straus S, Olsen NR, Young T, Ilic D, et al. Core Competencies in Evidence-Based Practice for Health Professionals. JAMA Network Open. 2018;1(2):e180281.
43. Kredo T, Bernhardsson S, Machingaidze S, Young T, Louw Q, Ochodo E, et al. Guide to Clinical Practice Guidelines: The Current State of Play. Int J Qual Health Care. 2016;28(1):122-8.
44. Brouwers MC, Spithoff K, Kerkvliet K, Alonso-Coello P, Burgers J, Cluzeau F, et al. Development and Validation of a Tool to Assess the Quality of Clinical Practice Guideline Recommendations. JAMA Network Open. 2020;3(5):e205535.
45. Thomas L, Cullum N, McColl E, Rousseau N, Soutter J, Steen N. Guidelines in Professions Allied to Medicine. Cochrane Database Syst Rev. 2000(2):Cd000349.
46. Tan MKH, Goodall R, Hughes W, Langridge B, Shalhoub J, Davies AH. A Methodological Assessment of Diabetic Foot Syndrome Clinical Practice Guidelines. Eur J Vasc Endovasc Surg. 2020;60(2):274-81.
47. Sheldon TA, Cullum N, Dawson D, Lankshear A, Lowson K, Watt I, et al. What's the Evidence that NICE Guidance has been Implemented? Results From a National Evaluation Using Time Series Analysis, Audit of Patients' Notes, and Interviews. BMJ. 2004;329(7473):999.
48. Fischer F, Lange K, Klose K, Greiner W, Kraemer A. Barriers and Strategies in Guideline Implementation—A Scoping Review. Healthcare. 2016;4(3):36.
49. Grimshaw J, Thomas R, Maclennan G, Fraser C, Ramsay C, Vale L, et al. Effectiveness and Efficiency of Guideline Dissemination and Implementation Strategies. Health Technol Assess. 2004;8(6):1-72.
50. Bus SA, van Netten JJ. A Shift in Priority in Diabetic Foot Care and Research: 75% of Foot Ulcers are Preventable. Diabetes Metab Res Rev. 2016;32:195-200.
51. Baker M. 1,500 Scientists Lift the Lid on Reproducibility. Nature. 2016;533(7604):452-4.
52. Munafò MR, Chambers C, Collins A, Fortunato L, Macleod M. The Reproducibility Debate is an Opportunity, Not a Crisis. BMC Res Notes. 2022;15(1).
53. Eshre Capri Workshop Group. Protect Us from Poor-Quality Medical Research. Hum Reprod. 2018;33(5):770-6.
54. van Netten JJ, Apelqvist J, Bus SA, Fitridge R, Game F, Monteiro-Soares M, et al. The International Working Group on the Diabetic Foot: Stories and Numbers Behind Three Decades of Evidence-Based Guidelines for the Management of Diabetes-Related Foot Disease. Diabetes Ther. 2023;15:19-31.
55. Bus SA, van Netten JJ, Hinchliffe RJ, Apelqvist J, Lipsky BA, Schaper NC, et al. Standards for the Development and Methodology of the 2019 International Working Group on the Diabetic Foot Guidelines. Diabetes Metab Res Rev. 2020;36:e3267.
56. International Working Group of the Diabetic Foot. About IWGDF Guidelines [Internet]. 2023 [cited 2023 May 8]. Available from: https://iwgdfguidelines.org/about-iwgdf-guidelines/.
57. Schaper NC, Van Netten JJ, Apelqvist J, Bus SA, Fitridge R, Game F, et al. Practical Guidelines on the Prevention and Management of Diabetes‐Related Foot Disease (IWGDF 2023 update). Diabetes Metab Res Rev. 2023.

58. Chen P, Vilorio NC, Dhatariya K, Jeffcoate W, Lobmann R, McIntosh C, et al. Guidelines on Interventions to Enhance Healing of Foot Ulcers in People with Diabetes (IWGDF 2023 update). Diabetes Metab Res Rev. 2024;40(3):e3644.
59. van Netten JJ, Apelqvist J, Bus SA, Fitridge R, Game F, Monteiro-Soares M, et al. The Unique Multidisciplinarity of Diabetes-Related Foot Disease. Diabetes Metab Res Rev. 2024;40(4):e3804.
60. van Netten J, Lazzarini P, Fitridge R, Kinnear E, Griffiths I, Malone M, et al. Australian Diabetes-Related Foot Disease Strategy 2018-2022: The First Step Towards Ending Avoidable Amputations Within a Generation. [Internet]. Brisbane: Diabetic Foot Australia, Wound Management CRC; 2017. Available from: https://www.diabetesfeetaustralia.org/australian-diabetes-related-foot-disease-strategy-2018-2022/
61. Blanchette V, Patry J, Brousseau-Foley M, Todkar S, Libier S, Leclerc A-M, et al. Diabetic Foot Complications Among Indigenous Peoples in Canada: A Scoping Review Through the PROGRESS-PLUS Equity Lens. Front Endocrinol. 2023;14.
62. Asiniwasis R, Stonechild AB, Queen D, Sibbald RG. Indigenous Diabetic Foot-Related Lower Extremity Amputations: Integrating Traditional Indigenous and Western Health Models for Improved Outcomes. Adv Skin Wound Care. 2023;36(2):63.
63. Bonevski B, Randell M, Paul C, Chapman K, Twyman L, Bryant J, et al. Reaching the Hard-to-Reach: a Systematic Review of Strategies for Improving Health and Medical Research with Socially Disadvantaged Groups. BMC Med Res Methodol. 2014;14(1):42.
64. Bacon D, Borthwick AM. Charismatic Authority in Modern Healthcare: The Case of the 'Diabetes Specialist Podiatrist'. Sociol Health Illn. 2013;35(7):1080-94.
65. Davies A, Bennett P, Nancarrow S, Cuesta-Vargas A. Specialisation Versus Special Interest - the Australian Podiatry Experience. J Foot Ankle Res. 2015;8(1).
66. Boulton AJM, Vileikyte L, Ragnarson-Tennvall G, Apelqvist J. The global burden of diabetic foot disease. Lancet. 2005;366(9498):1719-24.
67. Zhang Y, Lazzarini PA, McPhail SM, van Netten JJ, Armstrong DG, Pacella RE. Global Disability Burdens of Diabetes-Related Lower-Extremity Complications in 1990 and 2016. Diabetes Care. 2020;43(5):964-74.
68. Pallin JA, Buckley-O'Farrell K, Riordan F, McGrath N, O'Neill K, Macloughlin D, et al. Implementing an Integrated Diabetic Foot Care Programme in Ireland: Podiatrists' Experience. BMC Health Serv Res. 2023;23(1).
69. New Zealand Society for the Study of Diabetes. Diabetic Foot Special Interest Group [Internet]. NZSSD; 2022 [16th March 2024]. Available from: https://www.nzssd.org.nz/special-interest-groups/group/3/diabetic-foot-special-interest-group.
70. Formosa C, Gatt A, Chockalingam N. A Critical Evaluation of Existing Diabetic Foot Screening Guidelines. Rev Diabet Stud. 2016;13(2-3):158-86.
71. Carroll M, Jepson H, Molyneux P, Brenton-Rule A. The New Zealand Podiatry Profession – A Workforce in Crisis? J Foot Ankle Res. 2020;13(1):1-7.
72. Zhang Y, Carter HE, Lazzarini PA, Cramb S, Pacella R, van Netten JJ, et al. Cost‐Effectiveness of Guideline‐Based Care Provision for Patients with Diabetes‐Related Foot Ulcers: A Modelled Analysis Using Discrete Event Simulation. Diabet Med. 2023;40(1):1-11.
73. Schaper NC, van Netten JJ, Apelqvist J, Bus SA, Fitridge R, Game F, et al. Guidelines on the Prevention of Foot Ulcers in Persons with Diabetes. Diabetes Metab Res Rev. 2023;36(57):1-14.
74. Parker CN, Van Netten JJ, Parker TJ, Jia L, Corcoran H, Garrett M, et al. Differences Between National and International Guidelines for the Management of Diabetic Foot Disease. Diabetes Metab Res Rev. 2019;35(2):e3101.
75. Jeffcoate W, Young B. Reducing Amputation in Diabetes: Work from the West Country Provides both Evidence and a Tool-kit. Diabet Med. 2018;35(1):8-9.
76. Galicia-Garcia U, Benito-Vicente A, Jebari S, Larrea-Sebal A, Siddiqi H, Uribe KB, et al. Pathophysiology of Type 2 Diabetes Mellitus. Int J Mol Sci. 2020;21(17):6275.
77. Armstrong DG, Swerdlow MA, Armstrong AA, Conte MS, Padula WV, Bus SA. Five Year Mortality and Direct Costs of Care for People with Diabetic Foot Complications are Comparable to Cancer. J Foot Ankle Res. 2020;13(1).

78. Armstrong DG, Tan T-W, Boulton AJM, Bus SA. Diabetic Foot Ulcers. JAMA. 2023;330(1):62-75.
79. Martins-Mendes D, Monteiro-Soares M, Boyko EJ, Ribeiro M, Barata P, Lima J, et al. The Independent Contribution of Diabetic Foot Ulcer on Lower Extremity Amputation and Mortality Risk. J Diabetes Complications. 2014;28(5):632-8.
80. van Netten JJ, Woodburn J, Bus SA. The Future for Diabetic Foot Ulcer Prevention: A Paradigm Shift From Stratified Healthcare Towards Personalized Medicine. Diabetes Metab Res Rev. 2020;36(S1):1-7.
81. Chappell FM, Crawford F, Horne M, Leese GP, Martin A, Weller D, et al. Development and Validation of a Clinical Prediction Rule for Development of Diabetic Foot Ulceration: An Analysis of Data From Five Cohort Studies. BMJ Open Diabetes Res Care. 2021;9(1):e002150.
82. Kaminski MR, Golledge J, Lasschuit JWJ, Schott K-H, Charles J, Cheney J, et al. Australian Guideline on Prevention of Foot Ulceration: Part of the 2021 Australian Evidence-Based Guidelines for Diabetes-Related Foot Disease. J Foot Ankle Res. 2022;15(1):1-33.
83. Fischer F, Lange K, Klose K, Greiner W, Kraemer A. Barriers and Strategies in Guideline Implementation; A Scoping Review. Healthcare. 2016;4(3):36.
84. Maaløe N, Ørtved AMR, Sørensen JB, Sequeira Dmello B, Van Den Akker T, Kujabi ML, et al. The Injustice of Unfit Clinical Practice Guidelines in Low-Resource Realities. Lancet Glob Health. 2021;9(6):e875-e9.
85. Quinton TR, Lazzarini PA, Boyle FM, Russell AW, Armstrong DG. How do Australian Podiatrists Manage Patients with Diabetes? The Australian Diabetic Foot Management Survey. J Foot Ankle Res. 2015;8(1):1-8.
86. Vansteenland I, Forss R. What are the Current Diabetic Foot Assessment Methods in Private Podiatry Practices in Flanders, Belgium: an Exploratory Mixed Method Study. J Foot Ankle Res. 2022;16(17).
87. Mullan L, Wynter K, Driscoll A, Rasmussen B. Prioritisation of Diabetes‐Related Footcare Amongst Primary Care Healthcare Professionals. J Clin Nurs. 2020;29(23-24):4653-73.
88. Munn Z, Peters MDJ, Stern C, Tufanaru C, McArthur A, Aromataris E. Systematic Review or Scoping Review? Guidance for Authors When Choosing Between a Aystematic or Scoping Review Approach. BMC Med Res Methodol. 2018;18(1):1-7.
89. Peters MDJ, Godfrey C, McInerney P, Khalil H, Larsen P, Marnie C, et al. Best Practice Guidance and Reporting Items for the Development of Scoping Review Protocols. JBI Evidence Synthesis. 2022;20(4):953-68.
90. Page P. Beyond Statistical Significance: Clinical Interpretation of Rehabilitation Research Literature. Int J Sports Phys Ther. 2014;9(5):726-36.
91. Aromataris E, Munn Z. JBI Manual for Evidence Synthesis [Internet]. Joanna Briggs Institute; 2020 [16th March 2024]. Available from: https://doi.org/10.46658/JBIMES-20-01.
92. Tricco A, Lillie, E, Zarin, W, O'Brien, KK, Colquhoun, H, Levac, D, Moher, D, Peters, MD, Horsley, T, Weeks, L, Hempel, S et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. Ann Intern Med. 2018;169(7):467-73.
93. Johnson E, Webb W, McDowall J, Chasson L, Oser C, R J, et al. A Field-Based Approach to Support Improved Diabetes Care in Rural States. Prev Chronic Dis. 2005;2(4):A08.
94. Ciemins E, Coon P, Peck R, Holloway B, Min S-J. Using Telehealth to Provide Diabetes Care to Patients in Rural Montana: Findings From the Promoting Realistic Individual Self-Management Program. Telemed J E Health. 2011;17(8):596-602.
95. Zieff G, Kerr ZY, Moore JB, Stoner L. Universal Healthcare in the United States of America: A Healthy Debate. Medicina. 2020;56(11):580.
96. Chan J, Lim L-L, Wareham NJ, Shaw JE, Orchard TJ, Zhang P, et al. The Lancet Commission on Diabetes: Using Data to Transform Diabetes Care and Patient Lives. Lancet. 2020;396(10267):2019-82.
97. Doherty JA, Crelia SJ, Smith MW, Rosenblum SF, Rumsey EM, Mabry-Hernandez IR, et al. Large Health Systems' Prevention Guideline Implementation: a Qualitative Study. Am J Prev Med. 2018;54(1):S88-S94.
98. Gupta DM, Boland RJ, Aron DC. The physician's experience of changing clinical practice: a struggle to unlearn. Implement Sci. 2017;12(1).

99. Herman DD, Weiss CH, Thomson CC. Educational Strategies for Training in Quality Improvement and Implementation Medicine. ATS Sch. 2020;1(1):20-32.
100. Presseau J, Mackintosh J, Hawthorne G, Francis JJ, Johnston M, Grimshaw JM, et al. Cluster Randomised Controlled Trial of a Theory-Based Multiple Behaviour Change Intervention Aimed at Healthcare Professionals to Improve Their Management of Type 2 Diabetes in Primary Care. Implement Sci. 2018;13(1):1-10.
101. Braithwaite J. Changing How We Think About Healthcare Improvement. BMJ. 2018(361):1-5.
102. Geerligs L, Rankin NM, Shepherd HL, Butow P. Hospital-based interventions: a systematic review of staff-reported barriers and facilitators to implementation processes. Implement Sci. 2018;13(1).
103. Ivers NM, Grimshaw JM, Jamtvedt G, Flottorp S, O'Brien MA, French SD, et al. Growing Literature, Stagnant Science? Systematic Review, Meta-Regression and Cumulative Analysis of Audit and Feedback Interventions in Health Care. J Gen Intern Med. 2014;29(11):1534-41.
104. Grimshaw J, Ivers N, Linklater S, Foy R, Francis JJ, Gude WT, et al. Reinvigorating Stagnant Science: Implementation Laboratories and a Meta-Laboratory to Efficiently Advance the Science of Audit and Feedback. BMJ Qual Saf. 2019;28(5):416-23.
105. Leeman J, Birken SA, Powell BJ, Rohweder C, Shea CM. Beyond "Implementation Strategies": Classifying the Full Range of Strategies Used in Implementation Science and Practice. Implement Sci. 2017;12(1).
106. Glasziou P, Ogrinc G, Goodman S. Can Evidence-Based Medicine and Clinical Quality Improvement Learn From Each Other? BMJ Qual Saf. 2011;20(Suppl 1):i13-i7.
107. Luo J, Wu M, Gopukumar D, Zhao Y. Big Data Application in Biomedical Research and Health Care: a Literature Review. Biomed Inform Insights. 2016;8:1-10.
108. Klaic M, Kapp S, Hudson P, Chapman W, Denehy L, Story D, et al. Implementability of healthcare interventions: an overview of reviews and development of a conceptual framework. Implement Sci. 2022;17(1):1-20.
109. Bauer MS, Kirchner J. Implementation Science: What Is It and Why Should I Care? Psychiatry Res. 2020;283:112376.
110. Clarke GM, Conti S, Wolters AT, Steventon A. Evaluating the Impact of Healthcare Interventions Using Routine Data. BMJ. 2019;365(12239):1-7.
111. Carroll Á, Collins C, McKenzie J, Stokes D, Darley A. Application of Complexity Theory in Health and Social Care Research: A Scoping Review. BMJ Open. 2023;13(3):e069180.
112. Siegel KR, Ali MK, Zhou X, Ng BP, Jawanda S, Proia K, et al. Cost-effectiveness of interventions to manage diabetes: has the evidence changed since 2008? Diabetes Care. 2020;43(7):1557-92.
113. Lavery LA, La Fontaine J, Kim PJ. Preventing the First or Recurrent Ulcers. Med Clin North Am. 2013;97(5):807-20.
114. Bus SA, Lavery LA, Monteiro‐Soares M, Rasmussen A, Raspovic A, Sacco I, et al. Guidelines on the Prevention of Foot Ulcers in Persons with Diabetes (IWGDF 2019 update). Diabetes Metab Res Rev. 2020;36(S1):1-18.
115. van Netten JJ, Raspovic A, Lavery LA, Monteiro‐Soares M, Rasmussen A, Sacco I, et al. Prevention of Foot Ulcers in the At‐Risk Patient with Diabetes: A Systematic Review. Diabetes Metab Res Rev. 2020;36(S1):1-22.
116. Djulbegovic B. A Framework to Bridge the Gaps Between Evidence-Based Medicine, Health Outcomes, and Improvement and Implementation Science. J Oncol Pract. 2014;10(3):200-2.
117. Jodheea-Jutton A, Hindocha S, Bhaw-Luximon A. Health Economics of Diabetic Foot Ulcer and Recent Trends to Accelerate Treatment. Foot. 2022;52:101909.
118. Schaper NC, van Netten JJ, Apelqvist J, Bus SA, Hinchliffe RJ, Lipsky BA. Practical Guidelines on the Prevention and Management of Diabetic Foot Disease (IWGDF 2019 update). Diabetes Metab Res Rev. 2020;36(S1):1-10.
119. Bus SA, van Netten JJ, Monteiro‐Soares M, Lipsky BA, Schaper NC. Diabetic Foot Disease: "the times they are a changin'". Diabetes Metab Res Rev. 2020;36(S1):1-3.

120. Stang D, Leese G. The Scottish Diabetes Foot Action Group 2016 Update of the Diabetic Foot Risk Stratification and Triage System. Diabet Foot Ankle. 2016;19(4):182-6.
121. Lazzarini PA, Gurr JM, Rogers JR, Schox A, Bergin SM. Diabetes Foot Disease: The Cinderella of Australian Diabetes Management? J Foot Ankle Res. 2012;5(1):1-9.
122. Eysenbach G. Improving the Quality of Web Surveys: The Checklist for Reporting Results of Internet E-Surveys (CHERRIES). J Med Internet Res. 2004;6(3):e132.
123. Jeffcoate WJ. Stratification of Foot Risk Predicts the Incidence of New Foot Disease, But Do We Yet Know that the Adoption of Routine Screening Reduces It? Diabetologia. 2011;54(5):991-3.
124. New Zealand Society for the Study of Diabetes. Updated Foot Screening Referral Pathways 2017 [Internet]. New Zealand Society for the Study of Diabetes; 2017 [cited 2023 Jan 21]. Available from: https://www.nzssd.org.nz/assets/table-files/resources-54-resource_file.pdf.
125. Azzopardi YM, Gatt A, Chockalingam N, Formosa C. Agreement of Clinical Tests for the Diagnosis of Peripheral Arterial Disease. Prim Care Diabetes. 2019;13(1):82-6.
126. Crawford F, Cezard G, Chappell FM, Murray GD, Price JF, Sheikh A, et al. A Systematic Review and Individual Patient Data Meta-Analysis of Prognostic Factors for Foot Ulceration in People with Diabetes: The International Research Collaboration for the Prediction of Diabetic Foot Ulcerations (PODUS). Health Technol Assess. 2015;19(57):1-210.
127. Tehan PE, Chuter VH. Vascular Assessment Techniques of Podiatrists in Australia and New Zealand: A Web-Based Survey. J Foot Ankle Res. 2015;8(1):1-8.
128. Chatterjee S, Davies MJ, Heller S, Speight J, Snoek FJ, Khunti K. Diabetes Structured Self-Management Education Programmes: A Narrative Review and Current Innovations. Lancet Diabetes Endocrinol. 2018;6(2):130-42.
129. Windrum P, García-Goñi M, Coad H. The Impact of Patient-Centered Versus Didactic Education Programs in Chronic Patients by Severity: The Case of Type 2 Diabetes Mellitus. Value Health. 2016;19(4):353-62.
130. Hermanns N, Ehrmann D, Finke‐Groene K, Kulzer B. Trends in Diabetes Self‐Management Education: Where are We Coming From and Where are We Going? A Narrative Review. Diabet Med. 2020;37(3):436-47.
131. Yuncken J, Haines T, Stolwyk RJ, Williams CM. PoDFEd: Podiatrists and Diabetes Footcare Education Survey - How do Australian Podiatrists Provide Diabetes Education? J Foot Ankle Res. 2020;13(1):1-8.
132. Ponirakis G, Al‐Janahi I, Elgassim E, Gad H, Petropoulos IN, Khan A, et al. Progressive Loss of Corneal Nerve Fibers is Associated with Physical Inactivity and Glucose Lowering Medication Associated with Weight Gain in Type 2 Diabetes. J Diabetes Investig. 2022;13(10):1703-10.
133. Matos M, Mendes R, Silva AB, Sousa N. Physical Activity and Exercise on Diabetic Foot Related Outcomes: A Systematic Review. Diabetes Res Clin Pract. 2018;139:81-90.
134. Boulton AJM, Vileikyte L, Ragnarson-Tennvall G, Apelqvist J. The Global Burden of Diabetic Foot Disease. Lancet. 2005;366(9498):1719-24.
135. Paisey RB, Abbott A, Paisey CF, Walker D, Birch R, Bowen B, et al. Diabetic Foot Ulcer Incidence and Survival with Improved Diabetic Foot Services: An 18‐year Study. Diabet Med. 2019;36(11):1424-30.
136. van Netten JJ, Sacco ICN, Lavery LA, Monteiro‐Soares M, Rasmussen A, Raspovic A, et al. Treatment of Modifiable Risk Factors for Foot Ulceration in Persons with Diabetes: A Systematic Review. Diabetes Metab Res Rev. 2020;36(S1):1-19.
137. Lazzarini PA, Raspovic KM, Meloni M, van Netten JJ. A New Declaration for Feet's Sake: Halving the Global Diabetic Foot Disease Burden from 2% to 1% with Next Generation Care. Diabetes Metab Res Rev. 2023;37(47):1-12.
138. Lazzarini PA, Cramb SM, Golledge J, Morton JI, Magliano DJ, Van Netten JJ. Global Trends in the Incidence of Hospital Admissions for Diabetes-Related Foot Disease and Amputations: A Review of National Rates in the 21st Century. Diabetologia. 2023;66(2):267-87.
139. Daly B, Arroll B, Nirantharakumar K, Scragg RKR. Improved Foot Management of People with Diabetes by Primary Healthcare Nurses in Auckland, New Zealand. N Z Med J. 2020;133(1527):39-50.

140. Gustafson P, Lambert M, Bartholomew K, Ratima M, Aziz YA, Kremer L, et al. Adapting an Aquity-Focused Implementation Process Framework with a Focus on Ethnic Health Inequities in the Aotearoa New Zealand Context. Int J Equity Health. 2024;23(1).
141. Oetzel J, Scott N, Hudson M, Masters-Awatere B, Rarere M, Foote J, et al. Implementation Framework for Chronic Disease Intervention Effectiveness in Māori and Other Indigenous Communities. Global Health. 2017;13(1).
142. Prior M, Guerin M, Grimmer‐Somers K. The Effectiveness of Clinical Guideline Implementation Strategies–A Synthesis of Systematic Review Findings. J Eval Clin Pract. 2008;14(5):888-97.
143. Coiera E. Why System Inertia Makes Health Reform So Difficult. BMJ. 2011;342:1-5.
144. Nikitara M, Constantinou CS, Andreou E, Diomidous M. The Role of Nurses and the Facilitators and Barriers in Diabetes Care: A Mixed Methods Systematic Literature Review. Behav Sci. 2019;9(6):61.
145. Ivers N, Jamtvedt G, Young JM, Kristoffersen DT, Thomson O'Brien MA, Oxman AD. Audit and Feedback: Effects on Professional Practice and Health Care Outcomes. Cochrane Database Syst Rev. 2012(3):1-209.
146. Zimmerman BJ, Dubois N, Houle J, Lloyd S, Mercier C, Brousselle A, et al. How Does Complexity Impact Evaluation? An Introduction to the Special Issue. Can J Program Eval. 2011;26(3):1-6.
147. Atun R, de Jongh T, Secci F, Ohiri K, Adeyi O. Integration of Targeted Health Interventions into Health Systems: A Conceptual Framework for Analysis. Health Policy Plan. 2009;25(2):104-11.
148. Harrison R, Fischer S, Walpola RL, Chauhan A, Babalola T, Mears S, et al. Where do Models for Change Management, Improvement and Implementation Meet? A Systematic Review of the Applications of Change Management Models in Healthcare. J Healthc Leadersh. 2021;13:85-108.
149. McGill E, Er V, Penney T, Egan M, White M, Meier P, et al. Evaluation of Public Health Interventions From a Complex Systems Perspective: A Research Methods Review. Soc Sci Med. 2021;272:113697.
150. Messina J, Campbell S, Morris R, Eyles E, Sanders C. A Narrative Systematic Review of Factors Affecting Diabetes Prevention in Primary Care Settings. PLoS One. 2017;12(5):e0177699.
151. Masters-Awatere B, Cassim S, Tamatea J, Scott N, Simpson C, Paekau C. He Pikinga Waiora Kimi Ora lifestyle programme: case study of a successful community-based Indigenous diabetes intervention. N Z Med J. 2021;134(1545):68-78.
152. Crawford F, Nicolson DJ, Amanna AE, Smith M. Reliability of the Evidence to Guide Decision-Making in Foot Ulcer Prevention in Diabetes: An Overview of Systematic Reviews. BMC Med Res Methodol. 2022;22(1).
153. Pérez-Panero AJ, Ruiz-Muñoz M, Cuesta-Vargas AI, Gónzalez-Sánchez M. Prevention, Assessment, Diagnosis and Management of Diabetic Foot Based on Clinical Practice Guidelines: A Systematic Review. Medicine. 2019;98(35):e16877.
154. Dorresteijn JA, Kriegsman DM, Assendelft WJ, Valk GD. Patient Education for Preventing Diabetic Foot Ulceration. Cochrane Database Syst Rev. 2014(12):1-44.
155. Egan C, Lycett D, Tighe B. What is the Practice and Understanding of Podiatrists Towards Patient-Centred Consultations Regarding Diabetic Foot Care? Diabetic Foot. 2021;24(4):1-5.
156. Jeffcoate WJ, Vileikyte L, Boyko EJ, Armstrong DG, Boulton AJM. Current Challenges and Opportunities in the Prevention and Management of Diabetic Foot Ulcers. Diabetes Care. 2018;41(4):645-52.
157. Chen LF, Vander Weg MW, Hofmann DA, Reisinger HS. The Hawthorne Effect in Infection Prevention and Epidemiology. Infect Control Hosp Epidemiol. 2015;36(12):1444-50.
158. Berkhout C, Berbra O, Favre J, Collins C, Calafiore M, Peremans L, et al. Defining and Evaluating the Hawthorne Effect in Primary Care, A Systematic Review and Meta-Analysis. Front Med. 2022;9:1-15.
159. Perla RJ, Bradbury E, Gunther-Murphy C. Large-Scale Improvement Initiatives in Healthcare: A Scan of the Literature. J Healthc Qual. 2013;35(1):30-40.

160. Holder-Pearson L, Chase JG. Socio-economic Inequity: Diabetes in New Zealand. Front Med. 2022;9:756223.
161. Hurst JE, Barn R, Gibson L, Innes H, Bus SA, Kennon B, et al. Geospatial Mapping and Data Linkage Uncovers Variability in Outcomes of Foot Disease According to Multiple Deprivation: A Population Cohort Study of People with Diabetes. Diabetologia. 2020;63(3):659-67.
162. Djulbegovic B, Guyatt GH. Progress in Evidence-Based Medicine: A Quarter Century On. Lancet. 2017;390(10092):415-23.
163. Anjum R. Evidence-Based or Person-Centered? An Ontological Debate. Eur J Pers Cent Healthc. 2016;4(2):421.
164. McCarthy MI. Painting a New Picture of Personalised Medicine for Diabetes. Diabetologia. 2017;60(5):793-9.
165. Ross LN, Bassett DS. Causation in Neuroscience: Keeping Mechanism Meaningful. Nat Rev Neurosci. 2024;25(2):81-90.
166. Vaz DV, Stilwell P, Coninx S, Low M, Liebenson C. Affordance-Based Practice: An Ecological-Enactive Approach to Chronic Musculoskeletal Pain Management. Braz J Phys Ther. 2023;27(5):100554.
167. Mumford S, Anjum RL. Getting Causes from Powers [Internet]. USA: Oxford University Press; 2011 16th March 2024]. Available from: https://doi.org/10.1093/acprof:oso/9780199695614.001.0001.
168. Low M. A Novel Clinical Framework: The Use of Dispositions in Clinical Practice. A Person Centred Approach. J Eval Clin Pract. 2017;23(5):1062-70.
169. Anjum RL, Rocca E. From Ideal to Real Risk: Philosophy of Causation Meets Risk Analysis. Risk Anal. 2019;39(3):729-40.
170. Goodwin N. Understanding Integrated Care. Int J Integr Care. 2016;16(4):1-4.
171. Gamble E, Parry‐Strong A, Coppell KJ, McBain L, Bingham LJ, Dutton L, et al. Development of a Structured Diabetes Self‐Management Education Program Specific to the Cultural and Ethnic Population of New Zealand. Nutr Diet. 2017;74(4):415-22.
172. Bauer MS, Damschroder L, Hagedorn H, Smith J, Kilbourne AM. An Introduction to Implementation Science for the Non-Specialist. BMC Psychol. 2015;3(1):1-12.
173. Dayan PS, Ballard DW, Shelton RC, Kuppermann N. Implementation Trials that Change Practice: Evidence Alone is Never Enough. Ann Emerg Med. 2022;80(4):344-6.
174. New Zealand Government. Quality Standards for Diabetes Care 2020. In: Ministry of Health, editor. 2020.
175. Couch A, Menz HB, O'Sullivan B, Haines T, Williams CM. Describing the Factors Related to Rural Podiatry Work and Retention in the Podiatry Workforce: A National Survey. J Foot Ankle Res. 2023;16(1):1-12.
176. Clarke M, Frecklington M, Stewart S. Burnout among the podiatry profession: A survey of podiatrists in Aotearoa New Zealand. Journal of Foot and Ankle Research. 2024;17(2).
177. Lazzarini PA, Fitridge R. Regional Variations in Amputation Rates: Are Regional Diabetic Foot Services the Reason? ANZ J Surg. 2019;89(7-8):796-7.
178. Hemming K, Haines TP, Chilton PJ, Girling AJ, Lilford RJ. The Stepped Wedge Cluster Randomised Trial: Rationale, Design, Analysis, and Reporting. BMJ. 2015;350(feb06 1):350-7.
179. Brownlee S, Chalkidou K, Doust J, Elshaug AG, Glasziou P, Heath I, et al. Evidence for Overuse of Medical Services Around the World. Lancet. 2017;390(10090):156-68.
180. Saini V, Brownlee S, Elshaug AG, Glasziou P, Heath I. Addressing Overuse and Underuse Around the World. Lancet. 2017;390(10090):105-7.
181. Eccles MP, Mittman BS. Welcome to Implementation Science. Implement Sci. 2006;1(1):1-3.
182. Lazzarini PA, Raspovic A, Prentice J, Commons RJ, Fitridge RA, Charles J, et al. Guidelines development protocol and findings: part of the 2021 Australian evidence‐based guidelines for diabetes‐related foot disease. Journal of Foot and Ankle Research. 2022;15(1).

Appendices

Appendix 1: Ethics Approval

Auckland University of Technology Ethics Committee (AUTEC)

Auckland University of Technology
D-88, Private Bag 92006, Auckland 1142, NZ
T: +64 9 921 9999 ext. 8316
E: ethics@aut.ac.nz
www.aut.ac.nz/researchethics

6 July 2022

Matthew Carroll
Faculty of Health and Environmental Sciences

Dear Matthew

Re Ethics Application: **22/129 Do New Zealand podiatrists follow best practice guidelines for the prevention of diabetes related foot ulcers?**

Thank you for providing evidence as requested, which satisfies the points raised by the Auckland University of Technology Ethics Committee (AUTEC).

Your ethics application has been approved for three years until 6 July 2025.

Non-Standard Conditions of Approval

1. Please provide the prize draw survey.
2. At the beginning of the survey remove all the consent bullet points and use the consent statement -'By completing this survey you agree to take part'.

Non-standard conditions must be completed before commencing your study. Non-standard conditions do not need to reviewed by AUTEC before commencing your study, but send through requested documents for file.

Standard Conditions of Approval

1. The research is to be undertaken in accordance with the Auckland University of Technology Code of Conduct for Research and as approved by AUTEC in this application.
2. A progress report is due annually on the anniversary of the approval date, using the EA2 form.
3. A final report is due at the expiration of the approval period, or, upon completion of project, using the EA3 form.
4. Any amendments to the project must be approved by AUTEC prior to being implemented. Amendments can be requested using the EA2 form.
5. Any serious or unexpected adverse events must be reported to AUTEC Secretariat as a matter of priority.
6. Any unforeseen events that might affect continued ethical acceptability of the project should also be reported to the AUTEC Secretariat as a matter of priority.
7. It is your responsibility to ensure that the spelling and grammar of documents being provided to participants or external organisations is of a high standard and that all the dates on the documents are updated.
8. AUTEC grants ethical approval only. You are responsible for obtaining management approval for access for your research from any institution or organisation at which your research is being conducted and you need to meet all ethical, legal, public health, and locality obligations or requirements for the jurisdictions in which the research is being undertaken.

Please quote the application number and title on all future correspondence related to this project.

For any enquiries please contact ethics@aut.ac.nz. The forms mentioned above are available online through http://www.aut.ac.nz/research/researchethics

(This is a computer-generated letter for which no signature is required)

The AUTEC Secretariat
Auckland University of Technology Ethics Committee

Cc: hannah.jepson@aut.ac.nz

Appendix 2: Participant Information Sheet

Participant Information Sheet

Date Information Sheet Produced:

2nd May 2022

Project Title

Does New Zealand podiatrist's practice align with international best practice guidelines for the prevention of diabetes-related foot ulceration?

An Invitation

Thank you for considering this invitation to participate in our research. My name is Hannah Jepson and this research is undertaken as part of a Masters of Philosophy at Auckland University of Technology (AUT). In developing this research, I am working with my primary supervisor, Associate Professor Matthew Carroll, and secondary supervisors Associate Professor Peter Lazzarini and Michele Garrett. The survey will comprise of three sections. The first section will ask you about your practice (location and experience). The second section will contain questions relating to the 16 recommendations as outlined in the International Working Group of the Diabetic Foot (IWGDF) prevention guideline. The third section will focus on access and availability of resources, including barriers and enablers within clinical practice.

What is the purpose of this research?

Although guidelines for the prevention of complications in the diabetes foot have been developed, little research has been undertaken to investigate the extent that which they are adopted into clinical practice. This research has two aims: to investigate the extent to which the recommendations developed by international guidelines are adopted; and to gain insight into current clinical practice, including barriers and enablers to care, that exist within New Zealand. The findings of this research will be disseminated via journal publications and conference presentations.

How was I identified and why am I being invited to participate in this research?

You have been invited to participate through the promotion of this survey within professional and peer networks within New Zealand podiatric clinical practice.

How do I agree to participate in this research?

Your participation in this research is voluntary (it is your choice) and whether or not you choose to participate will neither advantage nor disadvantage you. You are able to withdraw from the study at any time by exiting the survey before clicking the submit button.

What will happen in this research?

If you choose to participate, you will be taken to the first page of the survey. In total, there are 36 questions to complete. Please complete all the questions. The survey will then be submitted to me. The submitted answers are anonymous, meaning I will not know who they have come from.

What are the discomforts and risks?

There are no anticipated discomforts or risks with completing this survey.

What are the benefits?

Findings from this survey will give New Zealand podiatrists an understanding of current care for the prevention of foot complications as exists within clinical practice. You will be also able to claim the time you invest in completing this survey toward your 2022-2023 CPD evidence portfolio. You will also have the option of entering a prize draw to win one of five $100 Westfield vouchers at the completion of the survey. You will be taken to a separate survey to preserve anonymity.

How will my privacy be protected?

All collected information will be confidential and stored securely at AUT for six years. All collected data will be anonymous. The research will not be able to link any survey responses to individual participants.

What are the costs of participating in this research?

There will be no financial cost to you if you decide to participate in this research, other than your time. It is anticipated that the survey will take between 10-15 minutes to complete.

What opportunity do I have to consider this invitation?

The survey link will remain open for six weeks.

Will I receive feedback on the results of this research?

The results of this research will be available through a peer-reviewed open access journal and through conference presentations. Once published, the research article URL will be made available through various social media channels and through the Podiatry NZ professional society. Alternatively, a copy of the research can be provided by contacting the lead researcher Hannah Jepson on hannah.jepson@aut.ac.nz.

What do I do if I have concerns about this research?

Any concerns regarding the nature of this project should be notified in the first instance to the Project Supervisor, Associate Professor Matthew Carroll (matthew.carroll@aut.ac.nz) or phone 09 9219999 x7305.

Concerns regarding the conduct of the research should be notified to the Executive Secretary of AUTEC, ethics@aut.ac.nz , (+649) 921 9999 ext 6038.

Whom do I contact for further information about this research?

Please keep this Information Sheet and a copy of the Consent Form for your future reference. You are also able to contact the research team as follows:

You are also able to contact the research team as follows:

Researcher Contact Details:

Hannah Jepson (hannah.jepson@aut.ac.nz)

Project Supervisor Contact Details:

Associate Professor Matthew Carroll (matthew.carroll@aut.ac.nz) or phone 09 9219999 x7305

The research was approved by the Auckland University of Technology Ethics Committee (AUTEC) on 6 May 2021, AUTEC Reference number 22/129.

Appendix 3: Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	30
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	30
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	33
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	32
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	N/A
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	33
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	34
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	Appendix 4

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	34
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	34-35
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	35
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	N/A
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	35
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	34
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Appendix 6
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	N/A
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Appendix 6
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	37-41
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and	41-43

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
		objectives, and consider the relevance to key groups.	
Limitations	20	Discuss the limitations of the scoping review process.	43-44
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	45
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	N/A

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMAScR): Checklist and Explanation. Ann Intern Med. 2018;169:467–473. doi: 10.7326/M18-0850.

Appendix 4: Pilot Search Strategy

Table 1 *Search terms for CINAHL Complete and Medline**

1	Keywords	(foot OR feet OR “lower limb”) N8 (diabet*)
2	Keywords	Prevent* OR risk OR complication*
3	Keywords	(Recommendation* OR guideline* OR standard* OR "best practice*" OR consensus) N8 (Implement* OR screen* OR adopt* OR identif* OR adherence OR exam* OR improve* OR audit OR uptake)
4	COMBINE	1 AND 2 AND 3

Table 1.1 *Search terms for CINAHL Complete and Medline* (revised with change of question) 13.9.22*

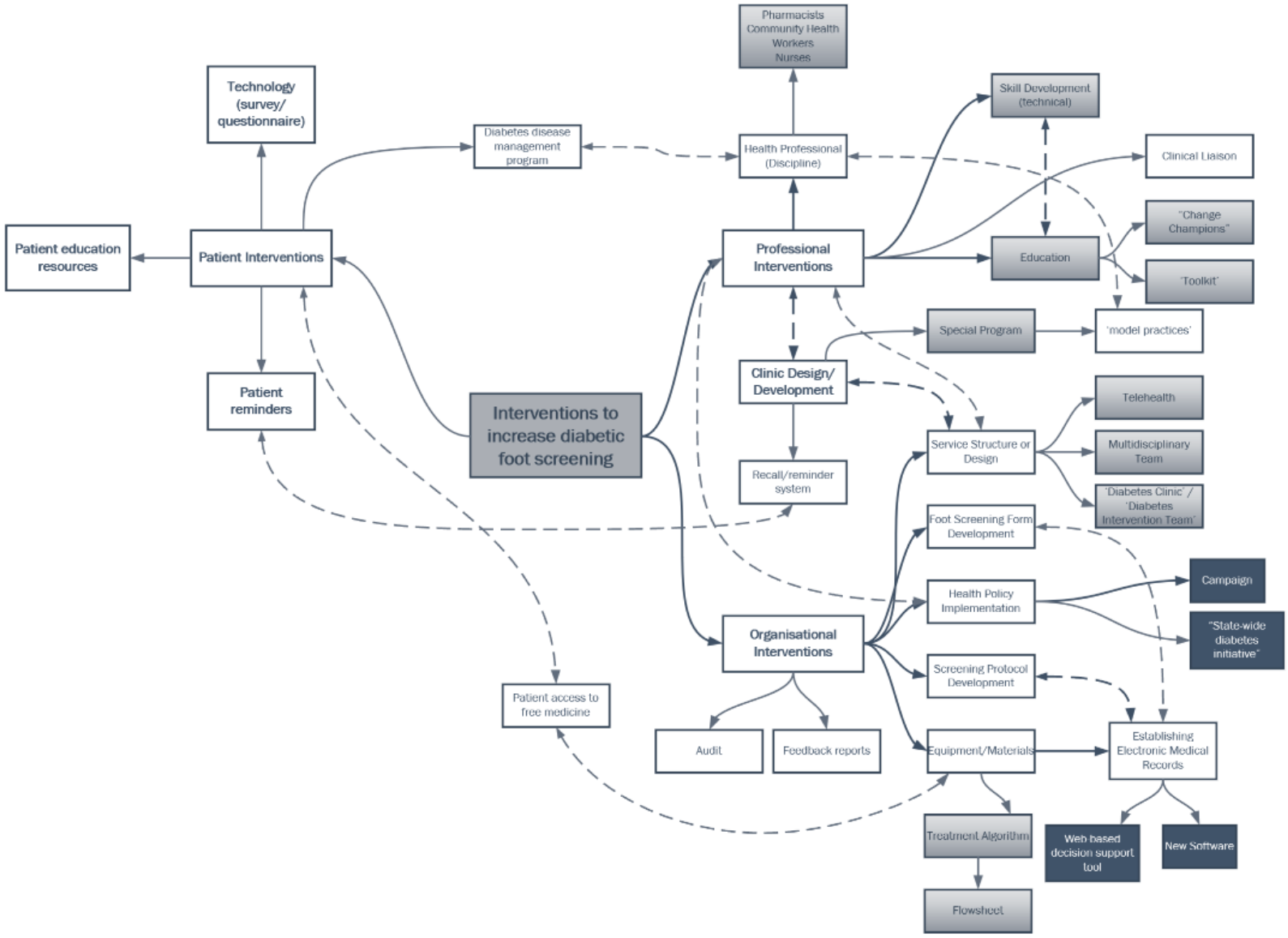
1	Keywords	(foot OR feet OR "lower limb") N5 (diabet*)
2	Keywords	(diabet*) N5 (Prevent* OR risk OR complication* OR management)
3	Keywords	(Recommendation* OR guideline* OR standard* OR "best practice*" OR consensus OR "quality improvement") N8 (Implement* OR screen* OR adopt* OR identif* OR adherence OR exam* OR improve* OR audit OR impact OR uptake)
4	COMBINE	1 AND 2 AND 3

Search Table1(S4) NOT Table1.1(S4) =

Table 2 *Search terms for Scopus*

1	Keywords	(foot OR feet OR "lower limb") W/8 (diabet*)
2	Keywords	Prevent* OR risk OR complication*
3	Keywords	(Recommendation* OR guideline* OR standard* OR "best practice*" OR consensus) W/8 (Implement* OR screen* OR adopt* OR identif* OR adherence OR exam* OR improve* OR audit OR uptake)
4	COMBINE	1 AND 2 AND 3

Appendix 5: Intervention map



Appendix 3 Map of interventions utilised to increase diabetic foot screening within preliminary search literature.

Appendix 6: Characteristics of included studies: Data Collection Table

Intervention target: Doctors, Physicians, General Practitioners

Author, year	Guidelines referenced	Aim	Patient population characteristics	Number and type of clinical setting	Number and type of clinicians	Intervention Categories	Study duration	Number of patients in final evaluation	Funding sources	Primary findings	Was there an improvement in foot screenings identified?
Country/Region: America											
Adamson and Gullion, 1986	American Diabetes Association	To evaluate the effectiveness of a diabetes professional education program on improving the quality of care for patients with diabetes in a rural/suburban community	T1DM, T2DM	NS Clinical (clinics)	N=31 Physicians	*Education/Upskilling* (91-page syllabus) *Feedback reports* (individual physician compared with others in sample) *Peer network support* (telephone conference calls)	12 months	N=397	Government	The success of the educational program was limited. The care provided did not reflect the ideal treatment model. Data indicated an improvement in the recording of foot examinations.	Yes
Ciemins et al. 2009	American Diabetes Association	To examine a specialised intervention strategy that incorporates several key "critical success factors" (e.g., use of disease registries, workflow integration, and real-time clinical guideline support) to improve physicians' adherence to diabetes care guidelines and control of patient risk factors.	Diabetes Mellitus	NS Hospital Clinical (medical practices)	NS Physicians	*Education/Upskilling* (targeted education program, posters) *Forms, templates* *Infrastructure* (integrated electronic health record system, workflow) *Practitioner resources* (Financial and professional incentives) *Patient education* (information support, report card, patient take-home materials)	6 years	N=495	Government Private	Implementation was associated with increased adherence to ADA guidelines. Incorporation of previously identified "critical success factors" potentially contributed to the success of the program, as did use of a two-phase approach. Implementation of an electronic health record is necessary, but not sufficient, for a successful chronic disease management program.	Yes

Demakis et al. 2000	Unclear "existing published medical guidelines and literature search strategies"	We examined whether providing computerised reminders of well accepted standards of care to resident physicians in ambulatory care clinics can increase compliance with those standards	Veterans Affairs patients	N=12 Clinical (veterans affairs ambulatory care clinics)	N=275 Resident physicians	*Reminder Systems* (computerised)	17 months	N=4370	Government	The results show that residents' responsiveness to the reminders decreased throughout the study. Visit-specific adherence rates in both the reminder and control groups were low. The standards with the lowest adherence rates tended to be prevention rather than treatment oriented.	No
Herrin et al. 2006	American Diabetes Association	To test the effectiveness of a diabetes resource nurse in improving diabetes care for Medicare patients in a multisite, fee for-service primary care setting.	Medicare diabetes patients (Medicare insurance coverage)	N=22 Clinical (internal medicine and family practice units)	N=92 Physicians	*Clinical resources* (diabetes resource nurse)	12 months	N=1891	Industry Private	No difference in clinical outcomes or processes of care were found between patients treated at practices with a Diabetes Resource Nurse.	No
Herrin et al. 2015	American Diabetes Association	To examine the impact of Diabetes Management Form for use on diabetes related process and outcome measures in a cohort of patients with diabetes seen from 2007 through 2009 at the 20 primary	Diabetes aged ≥40 years	N=20 Clinical (primary care practices)	NS Physicians	*Forms, templates* (decision support tool, Diabetes Management Form) *Feedback reports* (semi-annual performance reports on the recommended diabetes-related quality and outcome measures) *Practitioner resources* (pay-for-performance program)	5 years, 5 months	N=2108	Government Private	This study found that the incremental effect of the Diabetes Management Form is negative or mixed. Increases in foot exams were likely related to improved documentation with use of the structured form.	Yes

		practices that implemented the electronic health record (incorporating the diabetes management form) prior to January 1, 2007.									
Ilag et al. 2003	Local [UMHS Clinical Care Guideline (Michigan Neuropathy Screening Instrument)]	To evaluate the impact of systematic patient evaluation and patient and provider feedback on the processes and intermediate outcomes of diabetes care in Independent Practice Association model internal medicine practices.	Type 2 diabetes	N=9 Clinical (university-affiliated primary care internal medicine practices)	NS Physicians	*Feedback reports* (results mailed to subjects, providers, incorporated into medical records with guideline-generated suggestions for treatment and follow-up)	24 months	N=154	Private	Systematic patient education and patient and provider feedback improved processes of diabetes care in the primary care setting. A greater proportion of intervention-site subjects underwent foot examinations.	Yes
Kiefe et al. 2001	American Diabetes Association	To evaluate the effectiveness of using achievable benchmarks to enhance typical physician performance feedback and improve care.	fee-for service Medicare patients with diabetes mellitus	NS Clinical (medical practices, clinics, health centres)	N=70 Physicians	*Feedback reports* (chart review and physician-specific feedback with or without achievable benchmark feedback)	24 months	N=2978	Private	Use of achievable benchmarks significantly enhances the effectiveness of physician performance feedback in the setting of a multimodal quality improvement intervention	Yes
Kirkman et al. 2002	American Diabetes Association	To determine the state of diabetes care given by independently practicing primary care physicians in	Rural	N=7 Clinical (medical practices)	N=7 Physicians	*Education/Upskilling* (linked physician and patient education sessions) *Feedback reports* (baseline performance data,	3 years	N=161	Private	Changes in diabetes care are difficult to effect in busy primary care environments, especially when physicians work	Yes

		a rural county in Indiana and whether a multifaceted intervention targeting primary care physicians, patients, and the health care system would improve adherence to diabetes guidelines.				individual report, group report) *Reminder systems* (stickers, chart flow sheets) *Patient education* (sessions)				independently and without computer support for data organization and reminders. The two areas with sustained improvements (blood pressure measurement and foot examinations) were behaviours controlled or initiated by nonphysician staff.	
Montori et al. 2002	American Diabetes Association	The Mayo Health System Diabetes Translation Project sought to assess models of community-based diabetes care and use of a diabetes electronic management system (DEMS). Planned care is a redesigned model of chronic disease care that involves guideline implementation, support of self-management, and use of clinical information systems.	≥18 years of age with diagnoses of type 1 or type 2 diabetes	N=2 Clinical (Mayo Health System practice sites that cared for >300 patients)	N=16 Physicians	*Forms, templates* (referral forms to diabetes self-management support sessions, and chronic disease management flow sheets) *Infrastructure* (diabetes electronic management system) *Feedback reports* (practice audit with feedback to the providers)	24 months	N=200	Industry Private	The delivery of planned care either alone or in conjunction with an electronic management system in a primary care setting improved metabolic outcomes. Diabetes electronic management system use was associated with significantly improved documentation of foot examinations.	Yes
Rask et al. 2001	American Diabetes Association	To evaluate the impact of two strategies designed to increase the rate at which diabetes	Diabetes	N=4 Clinical (community-based clinics)	N=28 Physicians	*Clinical resources* (nurse facilitator) *Feedback reports* (site level feedback reports)	12 months	N=491	Private	Feedback alone might not be a sufficient intervention to improve preventative screening.	Yes – nurse facilitator only

		patients receive preventative services according to guidelines								Although a nurse-facilitated intervention is more labour intensive to implement, it was more effective than site-level feedback alone in promoting screening and risk factor management	
Schmidt et al. 2003	American Diabetes Association	The purpose of this study was to develop and test two interventions designed to improve provider compliance with diabetes management guidelines: the use of a diabetes management flowsheet inserted into patient charts and the use of a diabetes management flowsheet plus quarterly provider feedback about compliance levels.	Diabetes (excluded gestational diabetes, diabetes insipidus, steroid-induced diabetes)	N=6 Clinical (family practice clinics)	NS Physicians	*Forms, templates* (flowsheet) *Feedback reports* (quarterly provider feedback)	12 months	N=210	NS	The use of the flowsheet was associated with improved provider compliance in the completion of foot examinations only. Providers involved in the study believed that the process of the flowsheet plus feedback contributed to their greater awareness of diabetes management guidelines.	Yes
Country/Region: Australia											
Zwar et al. 2007	National: Diabetes Australia and the Royal Australian College of General Practitioners	The aim of this study was to evaluate whether multidisciplinary enhanced primary care planning for patients with type	Diabetes	NS Clinical (medical practices)	N=26 Physicians	*Resources* (funding [EPC package for care planning/ multidisciplinary care plans])	12 months	N=230	Private	Following the care plan, care provided adhered significantly more closely to process guidelines in relation to weight, foot and	Yes

		2 diabetes was associated with improved provision of multidisciplinary care; and whether process and outcomes of care were closer to national guidelines for diabetes care" following the preparation of the enhanced primary care plan								microalbumin examinations.	
Country/Region: Canada											
Harris et al. 2013	Canadian Diabetes Association Clinical Practice Guidelines	The purpose of this study was to use an external, concurrent, mixed-methods, multi-measure evaluation design to: (1) determine the effect of a quality improvement program (Partnerships for Health) on clinical process and outcome measures for diabetes; (2) assess how the level of program involvement effected the results; and (3) obtain the views of program participants	Diabetes	NS Clinical (medical practices, clinics, health centres)	N=35 Physicians	Education/Upskilling *Infrastructure* (computer systems, electronic processes) Peer network support	12 months	N=998	Government	Chart audit results showed significantly improved diabetes clinical processes and outcomes for the monitoring and management of glycaemic control and related diabetes complication risk factors. Clinical process measures showed statistically significant improvements in testing and documentation for all measures	Yes

		regarding the elements that influenced improvement in diabetes clinical processes and outcomes.									
Harris et al. 2015	Canadian Diabetes Association Clinical Practice Guideline	Evaluation of the Quality Improvement and Innovation Partnership Learning Collaborative (QIIP-LC), an Ontario wide primary health care quality improvement program targeting type 2 diabetes management, colorectal cancer screening, access to care, and team functioning.	Diabetes Mellitis	NS Clinical (medical practices, clinics, health centres)	N=68 Physicians	Education/Upskilling (learning sessions) Forms, templates *Infrastructure* (computer systems, electronic processes) *Clinical resources* (additional clinicians, specialised clinical support) Feedback reports (monthly reporting measures) Reminder systems Peer network support (web-based virtual office) Clinical/administrative leadership (practice coaches) *Resources* (funding, equipment) Patient education	24 months	N=809	Government Private	The program did not demonstrate statistically significant between-group differences in the primary outcome measures.	No
Country/Region: France											
Vurroud-Vial et al. 1999	National: International consensus and the French diabetes society	To evaluate a programme set up in the Essonne (France) between 1994 and 1998 to	Diabetes	NS Clinical (medical practices)	N=73 Physicians	*Education/Upskilling* (education program, published guidelines) *Forms, templates* (monitoring form,	12 months	N=604	NS	This study shows that cooperation between general practitioners and diabetes specialists is feasible and effective in the	Yes

		improve the quality of care for Type 2 diabetic patients				information cards, management algorithms)				context of a district-wide approach, and that it facilitates the adoption of international guidelines by local physicians. The most remarkable progress concerned screening for risk of foot complications.	
Vurroud-Vial et al. 2001	Local Departmental Council of Diabetes of the Essonne	To improve the quality of diabetes care in general practice by the use of audit	Diabetes	NS Clinical (medical practices, clinics)	N=213 Physicians	*Forms, templates* (audit form: clinicians could modify) *Feedback reports* (audits)	12 months	N=2125	Industry	This pilot study confirms the feasibility of using clinical audit at the national level. It seems to be an effective measure to improve the management of patients with type 2 diabetes in primary care.	Yes
Country/Region: Europe											
Frijling et al. 2002 **Netherlands**	National "Dutch College of General Practitioners"	The objective of this study was to evaluate the effectiveness of a multifaceted intervention to improve the process of diabetes care. The intervention targeted key aspects of the clinical decision making of GPs for patients with Type 2 diabetes mellitus.	Type 2 diabetes	N=124 Clinical (medical practices, clinics, health centres)	N=185 Physicians	Education/Upskilling *Clinical resources* (additional clinicians, specialised clinical support) Feedback reports	21 months	N=1449	Research Grant (NFP)	The intervention resulted in statistically significant improvement for the indicators pertaining to foot examination and eye examination.	Yes

Meulepas et al. 2006 **Netherlands**	National "Dutch College of General Practitioners guidelines"	To implement guidelines for type 2 diabetes by introducing a diabetes support service (DSS) to support the care delivered by the GP	Type 2 Diabetes	NS Clinical (general practice)	N=78 General Practitioners	*Infrastructure* (Diabetes Support Service) *Reminder systems* (Logistic support from Diabetes Support Service)	24 months	N=482	NS	Simple logistic support by a diabetes support service without taking over patient care improved adherence to general practice guidelines for diabetes care. Study identified that the content of the check-ups was more in line with the guidelines than for patients not supported by the diabetes support service.	Yes
Vidal-Pardo et al. 2013 **Spain**	American Diabetes Association	To evaluate the effect of an educational intervention among primary care physicians on several indicators of good clinical practice in diabetes care.	Diabetes aged 40 years and above and with more than 1 year of diagnosis of type 2 diabetes. Excluded gestational diabetes	NS Clinical (primary care)	N=103 Physicians	*Education/Upskilling* (distribution of educational materials, an online course and three on-site educational workshops on diabetes) *Feedback reports* (audit with personalised feedback, physicians' specific bench-marking information)	12 months	N=5886	Industry Private	The identification of indicators with very low level of compliance and the implementation of a simple intervention in physicians to correct them is effective in improving the quality of care of diabetic patients. This study shows that an intervention such as an audit with personalised feedback and teaching activities (face-to-face and on-line), can achieve improvements of modest magnitude in selected quality of care indicators among diabetic	Yes

										patients, especially those who are far from optimal compliance at baseline.	
Country/Region: Asia											
Moharram and Farahat, 2007 **Saudi Arabia**	Canadian Diabetes Association	To show that the use of a flow sheet would improve performance of family physicians in diabetes care.	Diabetes. Clinics serve military personnel and their families	N=7 Clinical (family practice clinics)	N=7 Physicians N=8 Residents	*Forms, templates* (flow sheet)	12 months	N=371	NS	The use of flow sheet was associated with an increase in the documentation of quality indicators.	Yes
Country/Region: United Kingdom											
Campbell et al. 2007	National. "Validated set of criteria"	To determine whether the high levels of quality attained after the pay-for-performance contract was introduced in 2004 reflect improvements that were already under way or whether existing trends toward improvement were accelerated.	T2DM, on medication with repeat prescriptions within the previous 6 months	N=42 Clinical (medical practices, clinics, health centres)	NS Physicians	*Resources* (Funding)	7 years	N=1482	Government	The introduction of pay for performance was associated with a modest acceleration in improvement for two of these three conditions: diabetes and asthma.	Yes
Williams et al. 1990	National: British Diabetic Association	To establish whether mini-clinics improve the process of care for diabetic patients	Diabetes Children and gestational diabetes excluded	N=14 Clinical (medical practices)	NS Physicians	*Clinical resources* (specialised clinical support "mini-clinics" [protected time])	3 years	N=991	Private	This study shows that organised and audited general practice mini-clinics can improve the process of care for diabetic patients	Yes
Carney and Helliwell, 1995	Local ('local protocols')	The aim of this study was to determine whether the initiative achieved	Diabetes Mellitus	N=12 Clinical (medical practices, clinics, health centres)	NS Physicians Nurses	Education/Upskilling (continuing education: lectures, demonstrations, open meetings,	24 months	N=668	None reported	The use of a continuing educational format, which included lectures,	Yes

		an overall change in professional behaviour and set standards which were adhered to, and more importantly whether the initiative influenced the health of diabetic patients.				questionnaires, individual audits, frank discussions)				demonstrations, open meetings, questionnaires, individual audits, and frank discussions, is an effective way of producing protocols that are adhered to by all concerned.	

Intervention target: Health Centres, Clinics and Primary care practices

Author, year	Guidelines referenced	Aim	Patient population characteristics	Number and type of clinical setting	Number and type of clinicians	Intervention Categories	Study duration	Number of patients in final evaluation	Funding sources	Primary findings	Was there an improvement in foot screenings identified?
Region/Country: America											
Bell et al. 2005	Four national guidelines (DQIP, HEDIS, NCEP and ADA) were used as benchmarks.	To describe a unique community-based initiative implemented in North Carolina designed to improve the quality of care and quality of life of many of the state's vulnerable diabetes population.	Diabetes Mellitus	N=14 programs Clinical (medical practices, clinics, health centres) Hospices Pharmacies	Unclear	*Infrastructure* (computer systems, electronic processes) *Clinical Resources* (additional clinicians, specialised clinical support) Clinical/Administrative Leadership *Resources* (Funding)	3 years	N=656	Private	Programs that customize the delivery of healthcare to fit the unique needs of the community can be successful in improving the quality of care that patients, particularly those of low-income communities, receive in primary care settings.	Yes
Johnson et al. 2005	American Diabetes Association	To describe the experience and outcomes of a collaboration between two state health departments	Diabetes	N=37 Clinical (medical practices, clinics, health centres)	Unclear	*Infrastructure* (computer systems, electronic processes)	32-38 months	N=8126	None reported	In Montana there were significant improvements in HbA1c testing, glycaemic control, LDL-C testing, foot	Unclear

		and the University of North Dakota working with primary care practices in Montana and Wyoming to implement and sustain a successful diabetes quality-improvement effort.				*Clinical Resources* (additional clinicians, specialised clinical support) *Clinical/Administrative Leadership*				and dilated retinal examinations, and pneumococcal vaccinations. Wyoming decreased the rate of foot examinations.	
Landon et al. 2007	American Diabetes Association	To report the results of a controlled, national evaluation of these collaboratives for the care of patients with three prevalent chronic medical conditions, diabetes, asthma, and hypertension.	All patients with diabetes and without bilateral amputation. Many patients from ethnic and racial minority groups and uninsured patients	N=44 health centres Clinical (medical practices, clinics, health centres)	NS	*Education/Upskilling* (2-day learning sessions) *Infrastructure* (computer systems, electronic processes) *Resources* (free passes local gym) *Peer network support* (collaborative users' group) *Clinical/Administrative Leadership* (incentive plan, management support)	12 months	N=9658	Government Private	Compared with the external control centres, the intervention centres had significant improvements in the measures of prevention and screening.	Yes
Peterson et al. 2008	American Diabetes Association	The purpose of this study was to determine whether implementation of a multicomponent organisational intervention can produce significant change in diabetes care and outcomes in community primary care practices.	Practices with the greatest racial and ethnic diversity and staff interest in the study were selected. Type 2 Diabetes	N=24 Clinical (community primary care practices)	N=238 Physicians	*Education* (educational updates) *Infrastructure* (clinical information system, electronic diabetes registry) *Reminder Systems* (decision support, sticker affixed to medical records of patients with diabetes, 'alert' identified all incomplete or overdue tests)	12 months	N=7101	Government	Intervention practices made a significantly greater net improvement in all process measures than control practices. Diabetes process measures increased significantly more in intervention than in control practices.	Yes
Ramesh et al. 2008	National: Indian Health Service	The Alaska Native Medical Centre diabetes program analysed Diabetes	American Indian/Alaska Native Diabetes	N=14 Hospital Clinical (clinics)	NS Physicians Nurses (nurse practitioner)	*Infrastructure* (diabetes registries)	10 years	N=2587	NS	An enhanced health care infrastructure, an accurate registry, standardized	Yes

	standards of care	Care and Outcomes Audit data from 1994–2004 to evaluate the impact of the Special Diabetes Program for Indians (SDPI) funding on process and intermediate outcomes			Medical Assistants (physician assistant)	*Clinical Resources* (Diabetes teams with a dietitian and/or a diabetes educator were added or expanded) *Resources* (Access to blood glucose monitoring supplies and medications, government funding for staff)				guidelines for care and annual evaluation and feedback to clinicians have resulted in positive changes in intermediate outcomes for American Indian/Alaska Native people with diabetes.	
Region/Country: Australia											
Bailie et al. 2007	Local (Central Australian Rural Practitioner Association)	To assess the impact of a quality improvement intervention on primary care systems, processes, and intermediate outcomes of care for the management of diabetes in the remote Indigenous community primary care setting.	Australian Aboriginal T2DM	N=12 health centres Clinical (health centres)	NS Medical Assistants (staff – unspecified)	Education/Upskilling Forms, templates *Infrastructure* (computer systems, electronic processes) *Clinical Resources* (additional clinicians, specialised clinical support) Peer network support *Clinical/Administrative Leadership*	24 months	N=295	Government	This quality improvement intervention has proved to be highly acceptable in the Indigenous Australian primary care setting and has been associated with significant improvements in systems and processes of care and some intermediate outcomes.	Yes
Lazzarini et al. 2012	National "[Diabetes Australia] National evidence-based guidelines for the management of type 2 Diabetes Mellitus (NHMRC endorsed)"	To report the clinical practice changes resulting from strategies to standardise diabetic foot clinical management in three diverse ambulatory service sites in Queensland, Australia.	Diabetes with 'at-risk' foot and higher	N=3 Hospital (remote and metropolitan) Clinical (health centre)	NS	Education/Upskilling *Forms, templates* (clinical pathways, diabetic foot form) *Infrastructure* (telehealth) *Feedback Reports* (Clinical Performance Indicators) *Peer network support* (multidisciplinary teams) Leadership	23 months	N=406	Government	Large scale diabetes quality improvement projects to standardise best practice can improve clinical practice.	Yes

Region/Country: Canada											
O'Reilly et al. 2014	Canadian Diabetes Association	The objective was to measure the difference between optimal diabetes care and actual diabetes care before and after the introduction of a computerized chronic disease management systems.	Diabetes	N=9 Clinical (family practices)	N=38 Physicians or nurse practitioners	*Infrastructure* (computerised chronic disease management system)	12 months	N=2320	NS	At baseline, data were unavailable or not up to date almost all patients. By the end of the study, the proportion of patients with up-to-date monitoring had decreased for all care and treatment elements. This community-based, real-world evaluation of a web-based chronic disease management systems for the treatment and management of diabetes failed to impact physician practice due to limited engagement and use of this system in the majority of practices.	No
Reichert et al. 2017	Canadian Diabetes Association	We evaluated the Quality Improvement and Innovation Partnership (QIIP) on diabetes outcomes and associated vascular risk factors.	Diabetes	N=68 Clinical (community health centres, family health teams)	N=68 Physicians	*Education/Upskilling* (learning sessions, summative congress) *Clinical Resources* (Quality Improvement Coaches) *Peer network support* (virtual office, teleconferences)	15-17.5 months	N=809	NS	While QIIP improved some diabetes process measures, no improvements in clinical outcome measures were noted.	No
Vitale et al. 2020	Canadian Practice Guidelines	To evaluate the impact of the integration of onsite diabetes education teams in primary care on processes of care indicators	Excluded any patients who required more intense and specialised treatment, such as those with type 1	N=11 Clinical (primary care practices, clinics)	NS Allied Health Professionals [Dietitian] Nurses	*Clinical Resources* (onsite diabetes education teams) Patient Education	4 years, 9 months	N=771	NS	Onsite education teams in primary care settings can potentially improve diabetes management as shown in two process	Yes

		according to practice guidelines.	diabetes, gestational diabetes, or those on multiple daily insulin regimes.							of care indicators: medical visits and foot exams. The results support the benefits of having education teams in primary care settings to increase adherence to practice guidelines.	
Region/Country: Europe											
Petek and Mlakar, 2016 **Slovenia**	National 'Slovenian guidelines for clinical management of type 2 diabetes in adult patients'	The aim of the study is to compare the quality of management of patients with diabetes mellitus type 2 before and after the introduction of model practices	Type 2 Diabetes	N=10 Clinical (medical practices)	N=1 Nurses	*Clinical Resources* (0.5 full-time equivalent nurse practitioner)	35 months	N=132	NS	Significantly increased rate of HbA1c testing, biochemical lab tests, and foot and eye exams. The rates of most process quality indicators exceed the 80% benchmark, with the exemption of foot exams. The biggest change was observed in the number of foot exams.	Yes
Region/Country: UK											
Presseau et al. 2018	UK NICE diabetes quality standards	To evaluate the effectiveness of an implementation intervention to improve six guideline recommended health professional behaviours in managing type 2 diabetes in primary care: prescribing for blood pressure and glycaemic control,	Type 2 Diabetes	N=44 Clinical (general medical practices)	N=325 Physicians (GP's) Nurses Medical Assistants	*Education/Upskilling* (education sessions, behaviour change sessions, materials, videos) *Clinical Resources* (content expert [nurse or MD] and a behaviour change expert)	12 months	N= 1,138,105	Private	This trial evaluated an intervention aiming to improve six guideline recommended behaviours for type 2 diabetes delivered using outreach visits to primary care teams that went well-beyond knowledge-based educational outreach and showed no	No

		providing physical activity and nutrition advice, and providing updated diabetes education and foot examination.								evidence of its effectiveness. Despite widespread use of outreach interventions worldwide, there is a need to better understand which techniques at which intensity are optimally suited to address the multiple clinical behaviours involved in improving care for type 2 diabetes.	

Intervention target: Health Professionals [Other]

Author, year	Guidelines referenced	Aim	Patient population characteristics	Number and type of clinical setting	Number and type of clinicians	Intervention Categories	Study duration	Number of patients in final evaluation	Funding sources	Primary findings	Was there an improvement in foot screenings identified?
Region/Country: America											
Fera et al. 2009	American Diabetes Association	To assess the economic and clinical outcomes for the Diabetes Ten City Challenge, a multisite community pharmacy health management program for patients with diabetes.	Diabetes	N=8 sites Clinical (medical practices, clinics, health centres) Pharmacies Home care/Home visits/Workplaces	N=102 Pharmacists	*Education/Upskilling* (training program for participating pharmacists) *Resources [funding]* (The employer/health plan agreed to invest in incentives for patients and pharmacist providers) *Patient education* (Patients were assigned to a pharmacist coach in their geographic area by a local network coordinator)	12 months	N=573	Industry Profession	The patient self-management training and assessment credential equipped patients with the knowledge, skills, and performance-monitoring priorities needed to actively participate in managing their diabetes. Positive clinical and economic outcomes were identified.	Yes
Garrett and Bluml, 2005	American Diabetes Association	To assess the outcomes for the first year following the initiation of a multisite community pharmacy care services program for patients with diabetes. The practice model was designed to bring about a high level of collaboration in care by increasing communications among patients, pharmacists, physicians, and other	Patients with diabetes covered by self-insured employers' health plans	N=5 sites Pharmacies	N=80 Pharmacists	*Education/Upskilling* (training program for pharmacists) *Resources [funding]* (waived copayments for patients, reimbursement for pharmacists) *Patient education* (structured series of visits that focused on knowledge, skills, and performance)	22 months	N=256	Industry	Pharmacists who receive special training in diabetes disease management will improve patients' health, enhance patients' satisfaction with diabetes care, and reduce overall health care costs for people with diabetes.	Yes

		members of the health care team.									
Region/Country: Australia											
McDermott et al. 2001	National "National Diabetes Outcomes Quality Review Initiative guidelines"	To evaluate a system for improving diabetes care in remote Indigenous communities	Diabetes Torres Strait Islander or Aboriginal descent	N=21 Clinical (primary healthcare centres)	NS Allied Health Professionals [Primary Healthcare Staff]	*Education/Upskilling* (staff training, workshop) *Reminder Systems* (diabetes recall system, phone calls from project officer, newsletter)	12 months	N=732	Government Private	Diabetes care can be improved in the community setting in remote areas and that this improvement can have a significant and early impact on hospitalisations.	Yes
Region/Country: Europe											
Pedersen and Jacobsen, 2011 Greenland	National 'The Danish College of General Practitioners'	To estimate the prevalence of diagnosed Type 2 diabetes mellitus in Greenland and to evaluate the quality of the diabetes care before and after implementation of a new diabetes programme.	Type 2 diabetes	N=16 Hospital Clinical (Primary Health Care Clinic which also had to function as a local hospital)	NS Allied Health Professionals [local healthcare professionals]	*Education/Upskilling* (guidelines developed, distributed, education provided) Feedback Reports *Reminder Systems* (coding in medical records)	24 months	N=691	Industry	All process indicators improved significantly between the two observations. The high quality of the diabetes care at the end of this study was demonstrated in small as well as in large towns. Even in the settlements where the lowest level of the quality in healthcare service was expected, high screening rates were demonstrated.	Yes
Mata-Cases et al. 2012 **Spain**	National "Group for the Study of Diabetes in Primary Care (GEDAPS) guidelines"	To assess the evolution of type 2 diabetes mellitus quality indicators in primary care centres as part of the Group for the Study of Diabetes in Primary Care Continuous Quality Improvement programme in Catalonia.	Diabetes	N=151 Clinical (primary care teams)	N=289 Health professionals	*Education/Upskilling* (courses, seminars, workshops to disseminate Guidelines and recommendations) *Feedback Reports* (feedback of the results of clinical indicators)	15 years	N=23501	Industry Private	The analysis of the evolution of process indicators highlight the improvement of laboratory measurements that are essential to assess the need or the effect of treatments as well as patient risk. However, the limited improvement observed in foot and fundoscopy	Yes

										examinations noted in the study should be carefully analysed because such explorations are essential to early detection.	
Region/Country: United Kingdom											
Eccles et al. 2007	National "locally-adapted, national evidence-based guidelines"	To evaluate the effectiveness and efficiency of an area-wide, 'extended' computerised diabetes register incorporating a full-structured recall and management system, actively involving patients, and including individualised patient-management prompts to primary care clinicians based on locally adapted, evidence-based guidelines.	> 35 years Type 2 diabetes	N=58 Clinical (medical practices, clinics, health centres)	NS Allied Health Professionals [other] Nurses	*Forms, templates* (diabetes register) *Reminder Systems* (individualised patient-management prompts, structured recall)	15 months	N=3608	Government	This study has shown benefits from an area-wide, computerised diabetes register incorporating a full structured recall and individualised patient management system. All of the provider adherence and all of the clinical variables showed a direction of effect in favour of the intervention.	Yes
New et al. 2000	Local 'district guidelines'	To examine changes in diabetes care provision after the introduction of a district diabetes information system.	Alive, living within Salford district (defined by postcode) and diagnosed as having diabetes	NS Hospital Clinical (medical practices, clinics, health centres)	NS	*Infrastructure* (diabetes information system (DDIS))	5 years	N=6544	NS	For glycaemic check, neurovascular foot examination and dilated fundoscopy there were clinically significant improvements in process measurements between 1993 and 1994 which then remained high and stable. These improvements could, in part, be attributable to the way in which the district diabetes	Yes

										information system has facilitated the structured cascade of diabetes care.	

Intervention target: Patients

Author, year	Guidelines referenced	Aim	Patient population characteristics	Number and type of clinical setting	Number and type of clinicians	Intervention Categories	Study duration	Number of patients in final evaluation	Funding sources	Primary findings	Was there an improvement in foot screenings identified?
Country/Region: America											
Ciemins et al. 2011	American Diabetes Association	(1) to establish the feasibility of providing a team approach to diabetes care via telehealth and (2) to determine whether telehealth technology is comparable to face-to-face care.	Diabetes and an uncontrolled risk factor	N=6 (5 rural and 1 urban clinic) Clinical (medical practices, clinics, health centres)	NS Allied Health Professionals [other] Nurses (interdisciplinary)	*Infrastructure* (computer systems, electronic processes, telehealth)	3 years	N=206	Government	Few differences between telehealth and face-to-face intervention patients were detected. Monofilament foot testing rates for telehealth patients increased more slowly over time compared with face-to-face patients, but within 2 years rates were comparable.	No
Rivo et al. 2016	American Diabetes Association	To evaluate the impact of pre-visit preparation, a key component of Patient-Centred Medical Home guidelines, on compliance with recommended tests and screenings in a diabetic patient population receiving care in Federally Qualified Health	Underserved, underinsured population receiving care in a community health care setting. Diabetes	N=7 Clinical (patient centred medical home)	NS Medical Secretaries and Administrative Assistants (centralised care team member)	*Reminder Systems (patient)* (patient reminder/pre-visit phone call)	24 months	N=7491	Private	That proactive pre-visit preparation may be a key strategy for primary care practices to improve areas critical for chronic disease management.	Yes

		Centres in Miami-Dade County.									
Snyder et al. 2003	American Diabetes Association	This paper describes a program (Diabetes Decisions) procured by a purchaser for their participants with diabetes.	Diabetes Retired educators	NS Home care/Home visits/Workplaces (Diabetes Decisions' office)	NS Physicians Nurses	*Clinical Resources* (specially trained nurse) *Reminder Systems (patient)* ("care calls to patients") *Patient Education* (calls to patients focus on education, progress toward goals, standards of care reminders, adherence to treatment plans, and identification of new problems)	3 years	N=662	Industry	The Diabetes Decisions program achieved significant improvements in the key process measures for continuously participating participants.	Yes
Country/Region: Asia											
Hayashino et al. 2015 **Japan**	Japan Diabetes Society clinical practice guidelines	To evaluate the effect of multifaceted interventions using the Achievable Benchmark of Care method for improving the technical quality of diabetes care in primary care settings.	Type 2 diabetes Aged 40-64 years	N=22 Clinical (medical practices, clinics, health centres)	N=192 Physicians	*Reminder Systems (patient)* (reminders for medical visits and lifestyle advice) *Feedback* (monthly letter on quality of diabetes care score and the benchmarks for each indicator) *Patient Education* (sessions on lifestyle advice)	12 months	N=2199	Government	Multifaceted interventions were effective in improving the technical quality of care in patients with Type 2 diabetes in primary care settings, thereby offering promising strategies for improving technical quality of care in primary care settings.	Yes

Intervention target: Nurses

Author, year	Guidelines referenced	Aim	Patient population characteristics	Number and type of clinical setting	Number and type of clinicians	Intervention Categories	Study duration	Number of patients in final evaluation	Funding sources	Primary findings	Was there an improvement in foot screenings identified?
Region/Country: Canada											
Davies et al. 2008	National. "Registered Nurses Association of Ontario	To document the process of best practice guideline implementation by topic, to	Diabetes	n=2 (1 hospital, 1 home visit) Hospital	N=179 Nurses	*Education/Upskilling* (structured presentation, toolkit, 2-hour training session, education sessions)	12 months	N=123 charts	Government	There were statistically significant improvements in more than half of	Yes

	(RNAO) guideline"	describe facilitators and barriers to implementation and to determine the impact of indicators related to process and patient outcomes.		Home care/Home visits		*Forms, templates* (new assessment tool) Clinical/Administrative Leadership *Clinical Resources* (additional clinicians, specialised clinical support)				the indicators for the asthma, diabetes foot care and venous leg ulcer guidelines. Lack of time and workload considerations were reported as barriers across all guideline implementation initiatives.	
Higuchi et al. 2010	National "Reducing Foot Complications for People with Diabetes Best Practice Guideline"	To report on a three-year follow-up evaluation in Canada of nursing care indicators following the implementation of the Adult Asthma Care Best Practice Guideline and the Reducing Foot Complications for People with Diabetes Best Practice Guideline and to describe the contextual changes in the clinical settings.	Type 1 and type 2 diabetes	N=1* Hospital *intervention applied in 5 sites, data taken from one site	NS Nurses	*Education/Upskilling* (one-day workshops, toolkit and educators' resource) *Infrastructure* (electronic documentation system) *Forms, templates* (new chart documents [chiropody report]) *Resources (funding)* (allocation of financial resources) *Patient education* (printed materials and videos) *Clinical/Administrative Leadership* (commitment	3 years	N=65	Private Government	There was an increase in the 'assessment of risk factors for foot ulcers' and the assessment of structural or biochemical abnormalities. There was also improvement in the level of documented use of a 'monofilament to assess sensation' in the feet. Sustainability of guideline implementation recommendations was enhanced with the use of an	Yes

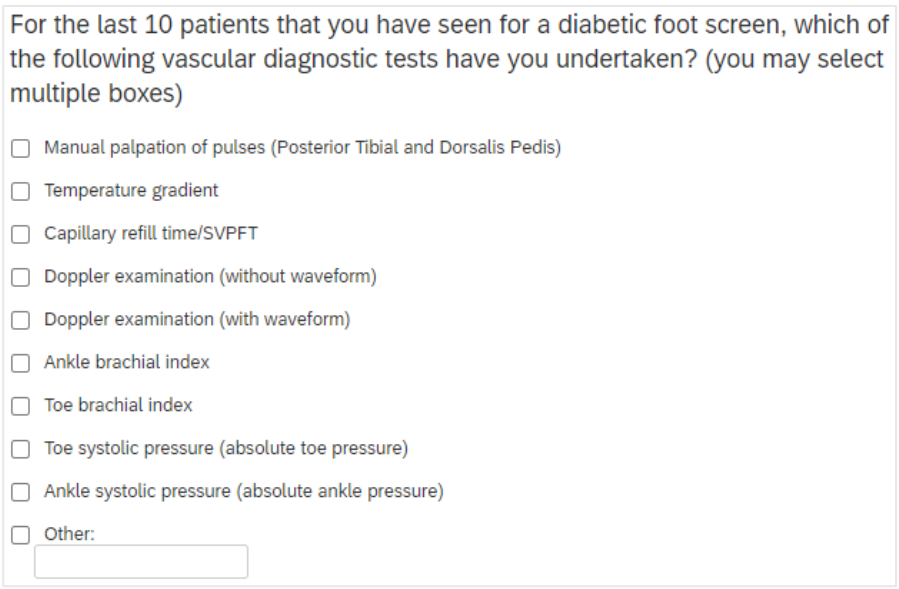
						of senior level management support)				electronic documentation system.	
Region/Country: Europe											
Pieruzzi et al. 2020 Italy	International Working Group for the Diabetic Foot American Diabetes Association	To test the efficacy of proactive screening – autonomously managed by nurses in a community setting – in detecting patients at high risk of diabetic foot ulcer, as an integrated part of a chronic care model strategy.	community setting in northwest Tuscany mixed urban/rural area Diabetes	NS Clinical (dedicated ambulatory setting)	N=324 Nurses	*Education/Upskilling* (training module/integrated training/assessment) Form/Template *Resources [practitioner]* (clinical time, clinicians, dedicated ambulatory setting)	36 months	N=23218	NS	Our data confirm the efficacy of a proactive screening programme to detect diabetic foot ulcer patients at an early stage in order to adequately and in a timely manner refer them to specialist care. Findings strongly support the beneficial effect of proactive screening for the interception of diabetic feet in a heterogeneous, at-risk population.	Yes

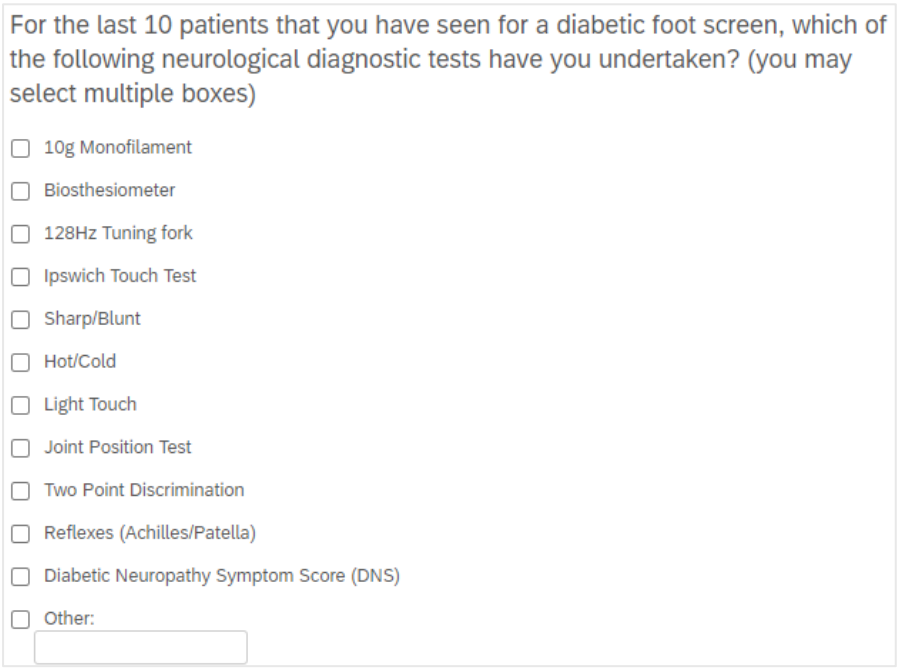
Appendix 7: Questions mapped to IWGDF recommendations.

Identifying the at-risk foot

Recommendation #1

Examine a person with diabetes at very low risk of foot ulceration (IWGDF risk 0) annually for signs or symptoms of loss of protective sensation and peripheral artery disease, to determine if they are at increased risk for foot ulceration. (GRADE recommendation: Strong; Quality of evidence: High)





Regularly inspecting and examining the at-risk foot

Recommendation #2

Screen a person with diabetes at risk of foot ulceration (IWGDF risk 1-3) for:

- *a history of foot ulceration or lower-extremity amputation;*
- *diagnosis of end-stage renal disease;*
- *presence or progression of foot deformity;*
- *limited joint mobility;*

- *abundant callus; and*
- *any pre-ulcerative sign on the foot.*

Repeat this screening once every 6-12 months for those classified as IWGDF risk 1, once every 3-6 months for IWGDF risk 2, and once every 1-3 months for IWGDF risk 3. (Strong; High)

In your clinical practice, how often would you examine or re-examine a person with diabetes who is found to have the following:

	Initial Consult Only	Every 1-3 Months	Every 3-6 Months	Every 6-12 Months	Annually	Never
No risk factors (Low Risk)	○	○	○	○	○	○
One risk factor (Moderate Risk)	○	○	○	○	○	○
Two or more risk factors (High Risk)	○	○	○	○	○	○

For the last 10 patients who presented for a diabetes foot screen and who is at Moderate-High Risk, how often did you check for:

	Always	Often	Sometimes	Seldom	Never
History of foot ulceration	○	○	○	○	○
History of lower extremity amputation	○	○	○	○	○
Diagnosis of end-stage renal disease	○	○	○	○	○
Presence or progression of foot deformity	○	○	○	○	○
Limited joint mobility	○	○	○	○	○
Significant callus	○	○	○	○	○
Pre-ulcerative signs	○	○	○	○	○

Instructions on foot self-care

<u>Recommendation #3</u>

Instruct a person with diabetes who is at risk of foot ulceration (IWGDF risk 1-3) to protect their feet by not walking barefoot, in socks without shoes, or in thin-soled slippers, whether indoors or outdoors. (Strong; Low)

For the last 10 patients who are identified at Moderate or High Risk, how often would you provide education on:

	NZSSD Medium Risk	NZSSD High Risk	Do you provide any specific advice? please detail below
Foot care			
Foot hygiene			
Footwear			
First aid			

<u>Recommendation #4</u>

Instruct, and after that encourage and remind, a person with diabetes who is at risk of foot ulceration (IWGDF risk 1-3) to: inspect daily the entire surface of both feet and the inside of the shoes that will be worn; wash the feet daily (with careful drying, particularly between the

toes); use emollients to lubricate dry skin; cut toenails straight across; and, avoid using chemical agents or plasters or any other technique to remove callus or corns. (Strong; Low)

Providing structured education about foot self-care

Recommendation #5

Provide structured education to a person with diabetes who is at risk of foot ulceration (IWGDF risk 1-3) about appropriate foot self-care for preventing a foot ulcer. (Strong; Low)

Considering the last 10 patients you saw who were at either Moderate or High Risk for foot ulceration, which of the following means of education did you use for each topic listed?

	1:1 verbal education	Resources and Handouts	Links to external support networks	Structured Education Program
The nature and effect of diabetes on the lower limb	☐	☐	☐	☐
Preventative foot care behaviors, including hygiene and foot inspection	☐	☐	☐	☐
Management of special problems (particular to the patient)	☐	☐	☐	☐

Instructions about foot self-management

Recommendation #6

Consider instructing a person with diabetes who is at moderate or high risk of foot ulceration (IWGDF risk 2-3) to self-monitor foot skin temperatures once per day to identify any early signs of foot inflammation and help prevent a first or recurrent plantar foot ulcer. If the temperature difference is above-threshold between similar regions in the two feet on two consecutive days, instruct the patient to reduce ambulatory activity and consult an adequately trained health care professional for further diagnosis and treatment. (Weak, Moderate)

This recommendation was not included in the survey as the technology has not become widespread for its use.

Ensuring routine wearing of appropriate footwear

Recommendation #7

Instruct a person with diabetes who is at moderate risk for foot ulceration (IWGDF risk 2) or who has healed from a non-plantar foot ulcer (IWGDF risk 3) to wear therapeutic footwear that accommodates the shape of the feet and that fits properly, to reduce plantar pressure and help prevent a foot ulcer. When a foot deformity or a pre-ulcerative sign is present, consider prescribing custom-made footwear, custom-made insoles, or toe orthoses. (Strong; Low)

For the last 10 people with diabetes who were been identified as Moderate to High Risk with a significant foot deformity, how often did you prescribe:

	Always	Often	Sometimes	Seldom	Never
Therapeutic footwear (off-shelf)	○	○	○	○	○
Custom-made footwear	○	○	○	○	○
Custom-made (prescription) orthoses	○	○	○	○	○
Pre-fabricated (pre-formed) insoles	○	○	○	○	○
Toe orthoses (e.g. interdigital spacers, toe silicone)	○	○	○	○	○

Recommendation #8

Consider prescribing orthotic interventions, such as toe silicone or (semi-)rigid orthotic devices, to help reduce abundant callus in a person with diabetes who is at risk for foot ulceration (IWGDF risk 1-3). (Weak; Low)

Recommendation #9

In a person with diabetes who has a healed plantar foot ulcer (IWGDF risk 3), prescribe therapeutic footwear that has a demonstrated plantar pressure relieving effect during walking, to help prevent a recurrent plantar foot ulcer; furthermore, encourage the patient to consistently wear this footwear. (Strong; Moderate)

Have you encountered any barriers or have any comments around accessing appropriate footwear for people who are at Moderate to High Risk with significant foot deformity? (please note, you do not need to provide an answer for this question)

Treatment of risk factors or pre-ulcerative signs on the foot

Recommendation #10

Treat any pre-ulcerative sign or abundant callus on the foot, ingrown toenail, and fungal infection on the foot, to help prevent a foot ulcer in a person with diabetes who is at risk of foot ulceration (IWGDF risk 1-3). (Strong; Low)

For the last 10 people with diabetes who were at Moderate to High Risk of foot complications, how often did you:

	Always	Often	Sometimes	Seldom	Never
Treat a pre-ulcerative sign or significant callus	○	○	○	○	○
Treat ingrown toenails	○	○	○	○	○
Treat fungal infections of the foot	○	○	○	○	○

Surgical Interventions

Recommendation #11

In a person with diabetes and abundant callus or an ulcer on the apex or distal part of a non-rigid hammertoe that has failed to heal with non-surgical treatment, consider digital flexor tendon tenotomy for preventing a first foot ulcer or recurrent foot ulcer once the active ulcer has healed (Weak; Low).

Recommendation #12

In a person with diabetes and a plantar forefoot ulcer that has failed to heal with non-surgical treatment, consider Achilles tendon lengthening, single or pan metatarsal head resection, metatarsophalangeal joint arthroplasty or osteotomy, to help prevent a recurrent plantar forefoot ulcer once the active ulcer has healed. (Weak; Low)

For the last 10 patients who had diabetes and **a history of ulceration which has failed to heal with non-surgical intervention**, how often did you refer for surgical offloading interventions to help prevent future ulcer re-occurrence:

- ○ Always
- ○ Often
- ○ Sometimes
- ○ Seldom
- ○ Never

What were the reasons that you *were* or *were not* able to refer for surgical offloading interventions?

Recommendation #13

We suggest not to use a nerve decompression procedure, in preference to accepted standards of good quality care, to help prevent a foot ulcer in a person with diabetes who is at moderate or high risk of foot ulceration (IWGDF risk 2-3) and who is experiencing neuropathic pain. (Weak; Low)

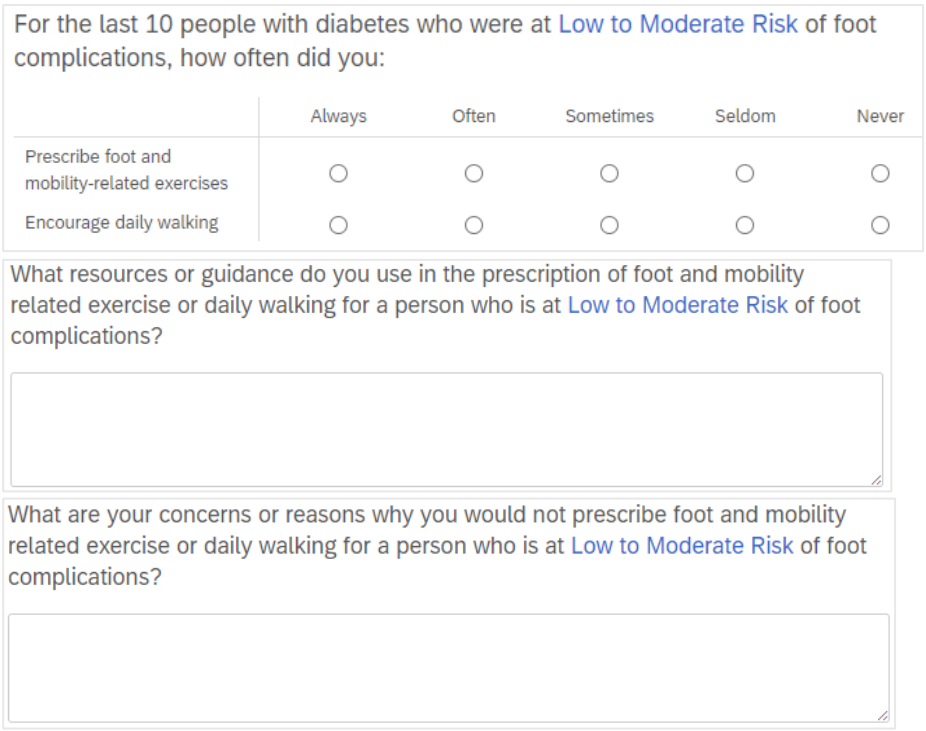
For the last 10 patients who had diabetes who is at High Risk of foot complications and who were experiencing neuropathic pain, how often did you consider referral for a nerve decompression procedure to help prevent a foot ulcer?

- ○ Always
- ○ Often
- ○ Sometimes
- ○ Seldom
- ○ Never

Foot-related exercises and weight-bearing activity

Recommendation #14

Consider advising a person with diabetes who is at low or moderate risk for foot ulceration (IWGDF risk 1 or 2) to perform foot and mobility-related exercises with the aim of reducing risk factors of ulceration, that is, decreasing peak pressure and increasing foot and ankle range of motion, and with the aim of improving neuropathy symptoms. (Weak; Moderate)



Recommendation #15

Consider communicating to a person with diabetes who is at low or moderate risk for foot ulceration (IWGDF risk 1 or 2) that a moderate increase in the level of walking-related weight-bearing activity (ie, an extra 1.000 steps/day) is likely to be safe. Advise this person to wear appropriate footwear when undertaking weight-bearing activities, and to frequently monitor the skin for pre-ulcerative signs or breakdown. (Weak; Low)

Integrated foot care

Recommendation #16

Provide integrated foot care for a person with diabetes who is at high risk of foot ulceration (IWGDF risk 3) to help prevent a recurrent foot ulcer. This integrated foot care includes professional foot care, adequate footwear and structured education about self-care. Repeat this foot care or re-evaluate the need for it once every one to three months, as necessary. (Strong; Low)

For the last 10 patients who were at High Risk of foot complications, how often did you:

	Always	Often	Sometimes	Seldom	Never
Provide care as part of a multi-disciplinary team	○	○	○	○	○
Provide telehealth services	○	○	○	○	○
Provide care in remote locations	○	○	○	○	○
Collaborate with Māori health providers	○	○	○	○	○

Appendix 8: Checklist for Reporting Results of Internet E-Surveys (CHERRIES)

Checklist Item	Explanation	Page Number
Describe survey design	Describe target population, sample frame. Is the sample a convenience sample? (In “open” surveys this is most likely.)	54,57
IRB approval	Mention whether the study has been approved by an IRB.	54
Informed consent	Describe the informed consent process. Where were the participants told the length of time of the survey, which data were stored and where and for how long, who the investigator was, and the purpose of the study?	54
Data protection	If any personal information was collected or stored, describe what mechanisms were used to protect unauthorized access.	54
Development and testing	State how the survey was developed, including whether the usability and technical functionality of the electronic questionnaire had been tested before fielding the questionnaire.	56
Open survey versus closed survey	An “open survey” is a survey open for each visitor of a site, while a closed survey is only open to a sample which the investigator knows (password-protected survey).	56
Contact mode	Indicate whether or not the initial contact with the potential participants was made on the Internet. (Investigators may also send out questionnaires by mail and allow for Web-based data entry.)	56
Advertising the survey	How/where was the survey announced or advertised? Some examples are offline media (newspapers), or online (mailing lists – If yes, which ones?) or banner ads (Where were these banner ads posted and what did they look like?). It is important to know the wording of the announcement as it will heavily influence who chooses to participate. Ideally the survey announcement should be published as an appendix.	56

Web/E-mail	State the type of e-survey (eg, one posted on a Web site, or one sent out through e-mail). If it is an e-mail survey, were the responses entered manually into a database, or was there an automatic method for capturing responses?	54
Context	Describe the Web site (for mailing list/newsgroup) in which the survey was posted. What is the Web site about, who is visiting it, what are visitors normally looking for? Discuss to what degree the content of the Web site could pre-select the sample or influence the results. For example, a survey about vaccination on a anti-immunization Web site will have different results from a Web survey conducted on a government Web site	56
Mandatory/voluntary	Was it a mandatory survey to be filled in by every visitor who wanted to enter the Web site, or was it a voluntary survey?	56
Incentives	Were any incentives offered (eg, monetary, prizes, or non-monetary incentives such as an offer to provide the survey results)?	56
Time/Date	In what timeframe were the data collected?	54
Randomization of items or questionnaires	To prevent biases items can be randomized or alternated.	N/A
Adaptive questioning	Use adaptive questioning (certain items, or only conditionally displayed based on responses to other items) to reduce number and complexity of the questions.	54-57
Number of Items	What was the number of questionnaire items per page? The number of items is an important factor for the completion rate.	54-57
Number of screens (pages)	Over how many pages was the questionnaire distributed? The number of items is an important factor for the completion rate.	54-57
Completeness check	It is technically possible to do consistency or completeness checks before the questionnaire is submitted. Was this done, and if “yes”, how (usually JAVAScript)? An alternative is to check for completeness after the questionnaire has been submitted (and highlight	Not done

	mandatory items). If this has been done, it should be reported. All items should provide a non-response option such as “not applicable” or “rather not say”, and selection of one response option should be enforced.	
Review step	State whether respondents were able to review and change their answers (eg, through a Back button or a Review step which displays a summary of the responses and asks the respondents if they are correct).	56
Unique site visitor	If you provide view rates or participation rates, you need to define how you determined a unique visitor. There are different techniques available, based on IP addresses or cookies or both.	N/A
View rate (Ratio of unique survey visitors/unique site visitors)	Requires counting unique visitors to the first page of the survey, divided by the number of unique site visitors (not page views!). It is not unusual to have view rates of less than 0.1 % if the survey is voluntary.	N/A
Participation rate (Ratio of unique visitors who agreed to participate/unique first survey page visitors)	Count the unique number of people who filled in the first survey page (or agreed to participate, for example by checking a checkbox), divided by visitors who visit the first page of the survey (or the informed consents page, if present). This can also be called “recruitment” rate.	N/A
Completion rate (Ratio of users who finished the survey/users who agreed to participate)	The number of people submitting the last questionnaire page, divided by the number of people who agreed to participate (or submitted the first survey page). This is only relevant if there is a separate “informed consent” page or if the survey goes over several pages. This is a measure for attrition. Note that “completion” can involve leaving questionnaire items blank. This is not a measure for how completely questionnaires were filled in. (If you need a measure for this, use the word “completeness rate”.)	56
Cookies used	Indicate whether cookies were used to assign a unique user identifier to each client computer. If so, mention the page on which the cookie was set and read, and how long the cookie was valid. Were duplicate entries avoided	unsure

	by preventing users access to the survey twice; or were duplicate database entries having the same user ID eliminated before analysis? In the latter case, which entries were kept for analysis (eg, the first entry or the most recent)?	
IP check	Indicate whether the IP address of the client computer was used to identify potential duplicate entries from the same user. If so, mention the period of time for which no two entries from the same IP address were allowed (eg, 24 hours). Were duplicate entries avoided by preventing users with the same IP address access to the survey twice; or were duplicate database entries having the same IP address within a given period of time eliminated before analysis? If the latter, which entries were kept for analysis (eg, the first entry or the most recent)?	54
Log file analysis	Indicate whether other techniques to analyze the log file for identification of multiple entries were used. If so, please describe.	Unsure
Registration	In “closed” (non-open) surveys, users need to login first and it is easier to prevent duplicate entries from the same user. Describe how this was done. For example, was the survey never displayed a second time once the user had filled it in, or was the username stored together with the survey results and later eliminated? If the latter, which entries were kept for analysis (eg, the first entry or the most recent)?	N/A
Handling of incomplete questionnaires	Were only completed questionnaires analyzed? Were questionnaires which terminated early (where, for example, users did not go through all questionnaire pages) also analyzed?	56
Questionnaires submitted with an atypical timestamp	Some investigators may measure the time people needed to fill in a questionnaire and exclude questionnaires that were submitted too soon. Specify the timeframe that was used as a cut-off point, and describe how this point was determined.	N/A

Statistical correction	Indicate whether any methods such as weighting of items or propensity scores have been used to adjust for the non-representative sample; if so, please describe the methods.	N/A