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EVIDENCE BRIEF

Implementation Factors for Virtual Delivery of Type 2 Diabetes Prevention

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Key Messages

- The COVID-19 pandemic necessitated increased adoption and uptake of virtual programs delivered via digital devices or web-based platforms. Virtual delivery of Type 2 Diabetes (T2D) prevention programs is one way to expand programs to digital platforms to improve access and reach of initiatives offered. As digital programs continue to advance, it is important to consider factors that influence implementation.

- Virtual T2D prevention programs included a variety of health and lifestyle targets, including weight loss, diet modification, physical activity, health knowledge, and behaviour change, however implementation characteristics for virtual diabetes prevention programs were minimally reported in the literature reviewed. Information was available around the source of the program (details of program providers and evaluators) and its evidence base (impact/effectiveness).

- Factors that facilitated the implementation of virtual diabetes prevention programs included meaningful engagement in design and implementation, and adapting programs to needs and contexts (i.e., feasibility to implement and scale, usability of the program for participants, reach extended to rural populations).

- Factors that created barriers for implementation included: structural characteristics (i.e., technology infrastructure, internet connection, rurality), and available resources (i.e., time and financial barriers, access to knowledge and information). Aspects of the implementation process and the innovation itself were not reported in enough detail to identify more granular barriers to implementation. Lack of engagement during the implementation process (i.e., planning and development) and through intervention delivery was the only notable barrier highlighted in the evidence we reviewed.

- Implementation science approaches, including use of evidence based and tested frameworks (i.e., Consolidated Framework for Implementation Science [CFIR]), theories (i.e., Behaviour Change Theory [BCT]) and models (i.e., process models) can support adapting and translating diabetes prevention programs into online platforms. Although diabetes prevention research and impacts are well established, implementation theories, models and frameworks were not cited, or used in any discernible way in the design of included interventions. More examples of evidence based practice that systematically consider implementation in design, evaluation and reporting are needed to inform future virtually delivered diabetes prevention efforts.

- There is potential for more consistent attention to health equity (i.e., via use of frameworks such as PROGRESS Plus) and the influence of the social determinants of health on the

implementation of virtual diabetes prevention programs to support tailored, person-centred, and equity-informed program development and delivery for populations that experience higher prevalence and incidence of T2D (e.g., racialized communities and communities facing marginalization). Tailoring to language, needs and experiences of populations with engagement throughout the development and implementation process could strengthen the impacts of diabetes prevention programs.

Issue and Research Question

Recent projections indicate that by 2050, more than 1.27 billion people across the globe will be affected by Type 2 Diabetes (T2D).[1-3] Diabetes-related complications include nerve and blood vessel damage, blindness, kidney failure, heart attacks, stroke, lower limb amputation and premature death.[4,5] Canada spends $9 billion annually on health care, disability, work loss, and premature death costs related to diabetes.[6] In Canada, the burden of diabetes is predicted to increase demand on the health system with estimates that, between 2011/2012 and 2021/2022, new cases of diabetes are expected to result in $15.36 billion in health care costs.[6] As of 2023, 30% of Ontarians live with diabetes or pre-diabetes resulting in the direct cost of 1.7 billion to the health care system.[4,7]

The benefits of existing diabetes prevention programs (e.g., promoting lifestyle changes, weight loss) are well established and reported. However rates of T2D continue to rise suggesting that gaps remain in understanding and optimizing the delivery of programs.[8,9] Implementation science aims to systematically close the gap between what we know and what we do in practice by understanding and addressing the barriers that impact uptake of proven interventions and evidence based practices to maximize outcomes.[10] Implementation practice (distinct from the 'science')[11] requires using the established evidence base of frameworks, theories and models to inform implementation of programs and services, and supports value for money in service research and delivery.[10] The use of theories is encouraged to address the challenges associated with implementation and to support the development and evaluation of tools (i.e., frameworks and models) that enable researchers and practitioners to identify, describe, and explain important elements of implementation processes and their outcomes.[12-14] The Consolidated Framework for Implementation Research (CFIR) is a comprehensive framework that gives structure to the contextual factors that could influence implementation.[15,16] CFIR includes five core domains: the individual, the inner setting, the outer setting, the implementation process, and the innovation itself. Evidence based approaches can strengthen success (effectiveness, reach, uptake) of existing programs by applying lessons learned from past diabetes prevention research and programs.[17]

Evolving digital and 'smart' technologies and electronic healthcare present an opportunity to innovate and refine how we deliver prevention care and services. Virtual delivery of diabetes prevention programs have gained attention in recent years and were amplified throughout the COVID-19 pandemic.[2,3,18] Digital delivery of healthcare has the potential to address a number of issues and challenges faced in the Canadian health system, including the shortage of health care professionals, limited access to health services in remote regions, and ability to ensure timely access to care, including prevention services.[19] A number of countries have moved towards adapting a digital health approach and have released strategies (NHS in the UK[20]; Ma Santé 2022 in France[21]; Australian Digital Health Agency[19]), providing a foundation for incorporating virtual and digital health research and services in other jurisdictions with similar healthcare systems and technological capabilities. Challenges for implementing virtual delivery may involve: equity considerations, access to internet (e.g., for rural and Northern locations), unclear processes for scale up, integration with existing systems, absence of standards and tools for comparative assessment, fast evolving digital solutions, lack of evidence to articulate guidance, lack of collaboration with government / ministries of health, and lack of collaboration with private sector (mobile networks and operations).[22]

This evidence brief addresses the following question: *For virtual T2D prevention programs, what are characteristics of the implementation process that can help promote their success?*

Methods

Public Health Ontario (PHO) Library Services searched MEDLINE, Embase, CINAHL, PsycInfo, Health Policy Reference Center, and Scopus. Search strategies were peer-reviewed by members of the Library Services team. All searches were limited to papers published 2013 and later, in English and research involving human subjects within OECD countries only. Primary studies and review-level evidence were included, while commentaries, editorials, books, and conference proceedings, were excluded. Terms for diabetic foot and other diabetes complications were excluded. Search strategies are available on request, including search vocabulary.

Search results from all databases were combined by PHO Library Services and duplicates were removed, leaving 1,816 results to screen. The PRISMA flow diagram is available upon request from PHO. Results were screened at title and abstract level against relevant criteria by two reviewers who each independently screened the same 20% of results, reaching agreement on any conflicting reviews by consensus. The remaining set was screened independently by one reviewer. All potentially relevant papers were retrieved and screened against the same criteria. Full text screening of the 339 articles that met initial criteria was completed by three reviewers. An additional layer of screening was applied. For inclusion, papers needed to: focus on diabetes prevention (not management), be relevant study type (review or primary study), include implementation outcomes, and be delivered virtually via digital platform. “Digital health” is often used as a broad umbrella term encompassing eHealth, mHealth, telehealth, and developing areas, such as the use of advanced computing sciences.[22] Screening at the full document level was validated by the lead reviewer and any questions reconciled for a final decision.

In order to capture community-driven initiatives and evaluations that may have been more informal, studies without use of formal theory or frameworks were included. Quality assessment (QA) was not completed due to the limited number of included studies and need to include the range of evidence available to address the question, in particular community-led evaluations. Considerations that result from study designs and methodological quality have been incorporated into the findings section that follows.

To inform our data extraction characteristics, we reviewed, adapted and applied frameworks related to implementation (CFIR)[15,16], equity considerations (PROGRESS-Plus, PRISMA-E)[23,24] and methods (Cochrane Methods Group).[25-27] Elements that addressed implementation, regardless of the authors linking them to implementation theory were extracted. CFIR was used to guide our analysis of factors specific to virtual T2D implementation.[16] We report on four of the five CFIR domains: the inner setting, the outer setting, the implementation process, and the innovation itself. Review of individual level facilitators is captured in a related product: Participant Facilitators and Barriers to Diabetes Prevention and Treatment Programs and Self-Management Strategies.

Main Findings

A total of nine papers on the topic of virtual delivery of diabetes prevention services were included for data extraction and synthesized. Of the nine virtual delivery studies included, all were primary studies. Within the studies, we identified five evaluations,[28-32] three implementation studies,[32-34] one mixed methods RCT pilot study,[35] one study identified as an ‘assessment of reach and adoption’,[31] and one longitudinal non-randomized study.[36]

Four studies used in-person and online delivery in an effort to compare effectiveness between methods of intervention delivery.[30,32,33,36] The goal of these studies was to determine if in-person delivery was more (or less) effective in terms of impacts, access and reach than digitally delivered prevention programs.[32,34,35,38]

Five of the included interventions were delivered over mobile phone / text[28,29,31,33,34], five were web-based[28,30,32,33,36] and one also included a video delivery (DVD) component.[28] Of these interventions, one relied on text messaging alone,[31] another combined texting and mass media[29] another used downloadable mobile apps,[35] and teleconferencing was also used.[33] Golovaty et al. (2021) used a mix of delivery devices and techniques (web / online and in-person). The remainder of the studies were delivered online using web based platforms.

Six of the nine studies assessed engagement or participation[28,29,31,33,34,36]; other articles assessed reach (n=4)[29,32,35,36]; retention (n=2)[28,35]; acceptability (n=2)[28,35] ; adherence (n=3)[28,33,35]; feasibility (n=3)[28,34,35]; access (n=1)[30]; uptake (n=1)[35]; and, usage (n=2)[30,31]. One study relied solely on self-monitoring of behaviour change.[34] The evidence reflects overall positive outcomes related to reach (number of participants), including populations that may be considered disproportionately impacted by T2D (i.e., African Americans).[29] Although all of the digital programs aim to improve reach and accessibility in some way, only two targeted those in rural locations.[33,36]

The virtual prevention programs were based in a limited number of jurisdictions, including seven in the USA[29,31-33,35-37], one in the UK[34], and one in Australia.[28] Three were part of or modelled after the widely implemented National Diabetes Prevention Program (NDPP) in the USA.[33,35,36] T2D prevention studies delivered virtually targeted a number of groups. One intervention was targeted to men only[28] and another intervention was designed to target youth.[32] Target populations also included adults identified as 'at-risk' of developing T2D[28-30,34], with pre-diabetes[35] and African American and Mexican American populations.[29,30] One study targeted individuals that previously declined to participate in NDPP.[35] Results show positive trends in reaching target populations and in the use of mobile phones to record personal health information and set goals for reducing the risk of T2D.[29]

The virtual diabetes prevention programs focus on a variety of health and lifestyle targets from weight loss[28,29,33,35,36] to diet modification[28,35], physical activity[28-32,35] as well as other targets such as awareness[29], health literacy/knowledge[30], and intent for behaviour change.[30] Four programs identified were educational in nature [28,30,31,35] while others targeted behaviour change and/or clinical outcomes. The Txting4Health (mobile text) intervention used a population approach, which included a comprehensive social marketing campaign to enroll populations disproportionately at risk for T2D (i.e., African Americans) using a combination of mass media and face-to-face recruitment in faith-based and retail environments.[29]

Five of the virtual diabetes prevention programs included an evaluation of the implementation outcomes.[28-32] One process evaluation was conducted using surveys to measure engagement and satisfaction to assess the feasibility and acceptability of the T2D prevention intervention among the men who were targeted in recruitment.[28] Two post implementation evaluations specifically assessed reach[31,32] and adoption[31] to inform implementation learnings, of which, one was informed by RE-AIM framework (reach, effectiveness, adoption, implementation, and maintenance).[31] Understanding implementation efforts and evaluations has the potential to inform real world adaption and scale-up of initiatives that demonstrate success. For example, based on the evaluation by Vadheim et al. (2017), the number of sites offering group based tele-DPP was expanded across Montana in the US.[33] They found that group-based DPP lifestyle intervention delivery through telehealth can achieve similar participation rates, physical activity goals, and weight loss outcomes as on-site participants. The study findings suggest that that DPP lifestyle intervention through telehealth may allow a larger number of persons to

participate, may increase geographic access to this service, and may reduce the per participant cost and thus improve the cost effectiveness of the intervention.[33]

Theories, models and frameworks informing implementation

We aimed to identify relevant implementation theories, models, and frameworks leveraged to inform the design and execution of the included studies. No theories, models or frameworks related to implementation science were applied in the included papers. Three digital diabetes prevention studies were informed by or designed with another theoretical evidence base.[24] Social cognitive behaviour theory was used by Aguiar et al. (2017) to inform adoption, initiation and maintenance of health behaviours. A pilot study by Whelan et al. (2017) considered control theory in self-monitoring technologies and supports. Griauzde et al. (2019) refer to self-determination theory in their study of patients that had refused participation in NDPPs previously. Other models and frameworks leveraged included the Theory of Planned Behaviour[30], Transtheoretical Model[30] and Social Marketing Framework.[32] Given that no included prevention interventions or evaluations applied implementation specific theories, models or frameworks, there was limited coverage of the domains of the CFIR.

Implementation Characteristics

The findings that follow are organized according to four of the core domains of CFIR: the inner setting, the outer setting, the implementation process, and the innovation itself.

INNER AND OUTER SETTING

The **inner setting domain** is the setting in which the innovation is implemented and consists of 11 constructs (and 10 sub-constructs) which include: structural characteristics, relational connections, communications, culture, tension for change, compatibility, relative priority, incentive systems, mission alignment, available resources, access to knowledge and information. These constructs can be further broken down into multiple levels depending on the group (size and type) being studied.[15,38] In this review of evidence, the inner setting refers to the virtual engagement with the interventions.

Few of the constructs were reported in the literature and generally, these were described at a high level. Available resources (i.e., funding, space, materials and equipment) and access to knowledge and information were constructs reported in the summarized studies.[15] Inner setting factors that acted as barriers included access to digital devices, and access to internet connection to access an app, stream or download content.[30] For example, Buis et al. (2013) highlighted that the financial barriers associated with texting-based interventions that require texting capacity (i.e., cell phone plans without text limits) and functional cell phone service coverage could act as a deterrents to participation.[31] A similar challenge was identified with web-based interventions that require devices and bandwidth and strong internet connection to access video downloads and streaming platforms.[30,33] Offering programs at no cost or with financial support to cover costs can offset some of the financial barriers associated with virtual delivery.[33,35] Lack of personal contact with program instructors and peers was also identified as a barrier.[33] There was some evidence of differences in effectiveness of an online lifestyle change program compared to in-person format.[36] Recommendations to support behaviour change and intervention effectiveness include incorporating an in-person interaction or additional program elements or methods of contact (e.g., through e-mail or phone contact).[35,36]

The **outer setting** refers to the context (or multiple contexts) in which a program is being implemented. The updated CFIR outer setting incorporates constructs to capture the potential influence of for example, sociocultural values and beliefs, and, political or technological conditions (local conditions). The seven characteristics (and two sub-constructs) of the outer setting include: critical incidents, local attitudes, local conditions, partnerships and connections, polices and laws, financing, external pressure

(social and market).[15,16] Although only reported at a high level, the constructs identified that were relevant to the virtual delivery were: critical incidents (i.e., COVID-19), and local conditions (i.e., time and cost).

There was some evidence indicating online program reach was higher in rural compared to urban settings and success was demonstrated among particular subgroups (younger, those with less severe obesity and male).[33,36] Rurality also posed challenges related to lack of infrastructure for telehealth hubs (room space, devices, bandwidth, etc.) to deliver lifestyle interventions.[33] Additionally, the shortage of certified diabetes educators and health professionals in proximity to hub centers or facilities in rural areas creates additional barriers to staffing virtual programs.[33]

For initiatives that aimed to capture hard to reach target populations (e.g., people not connected to primary care providers, rural and younger individuals), social marketing campaigns as well as designated staff were relied on to initiate registration and inform individuals about programming.[28,29,37] At the system level, the NDPP initiatives and policies to promote diabetes prevention act as facilitators by creating public awareness and providing models to inform programs and attract participants.[35]

IMPLEMENTATION PROCESS

The **implementation process** includes the activities and strategies that can be considered and addressed systematically to support successful program virtual diabetes prevention program implementation. CFIR constructs related to the implementation process include: teaming, assessing needs, assessing context, planning, tailoring strategies, adapting, engaging, doing, reflecting and evaluating. There was no evidence from the included papers that implementation theory, models, or frameworks were used, and so it was unsurprising that four of the nine included papers addressed one construct (engaging), and details were minimal.[29,32,33,36]

Engagement with program staff (partnerships and connections) throughout intervention delivery was noted to be a strength of some of the interventions trialed.[33] Only one paper described some proactive engagement with its participants in program planning.[29] The txt4health program staff engaged a diverse group of community partners in a consumer advisory group early in their planning, which was leveraged to support product design, messaging, creative concept development, and the development and implementation of their social marketing campaign to reach priority audiences across a wide range of settings (home, work, religious settings, social settings, community).[29] Advisory group members represented or served local partners and businesses, racialized groups, as well as “vulnerable communities residing in the designated geographic area.[29] The goal of this intervention was to reach participants where they live, work and socialize, although the details of how they were engaged is not reported other than web site users and social media views.[29] Two included papers only peripherally mentioned engagement without details about who was engaged and how they were engaged.[33,36] The fourth study engaged study participants in the screening process and the intervention elements provided were tailored to their physical needs and capacity but the intervention itself was not tailored based on this information (only exposure).[30] No other program described their approach to engagement in terms of who, how, and what was done, how often, in order to engage their respective audiences; only one other program described interaction with participants and instructors via video/audio platform without more detail about whether that engagement had a purpose or whether results of the engagement were used and in what way.[33]

Three other CFIR constructs (assessing context, tailoring, and adapting) were mentioned by a single paper, but were not described in a way that would allow use of the information in future planning.[33] We acknowledge that further details could be part of unpublished documents and we did not contact authors to ask questions regarding the implementation process.

THE INNOVATION

The **innovation** represents the program being implemented, including the core program as well as adaptable components. For the purpose of this synthesis, the innovation refers to a virtual diabetes prevention program. CFIR distinguishes between the program being implemented, and the process of implementation of the program. Features of programs that can be considered to support successful implementation include: the innovation source, evidence base, relative advantage of the program over others, adaptability, trialability, complexity, design, and cost.

The innovation source was detailed most frequently, extending to information about program providers/evaluators and the evidence base for their respective programs.[28-30,32,33,35,36] While details around other innovation considerations were sparse, the included papers provided evidence that is consistent in showing positive impact, underpinning the evidence base for virtual diabetes prevention programs.

Three papers provided some detail related to relative advantage, indicating the program was easy to implement, not costly, required minimal staff time, or that nothing else was in place that was similar.[31,32,34] Other papers noted that the intervention was accessible via a number of routes (technology and in the community), and was also free of charge, so preferable to private/cost options available otherwise. However, there was no focused discussion of the relative advantage of the programs being implemented.

One paper explicitly stated that the program was adapted, although there was minimal detail around how it was adapted.[32] Four other papers mentioned adaptation, describing adaption to an mHealth platform was feasible,[35] that the program was highly adaptable,[36] and cautioned that the program's content may require consultation on local/culturally-relevant tailoring.[31] The included papers did not present concrete ways in which programs could be adaptable.

Of the nine included papers, only one mentioned trialing the program.[32] While the details provided in other papers give the impression that their respective interventions could be trialed on a pilot basis, the papers did not address trialability as a feature of the interventions being reported. Program complexity, design, and costs were not reported to be assessed across the included papers.

Equity Considerations in Implementation

The risk of type 2 diabetes is influenced by a range of social determinants of health including income, education level, employment and working conditions, food security, the built environment, access to the internet, and others.[39] Considerations for equity and the impacts of the social determinants of health were only reported in the virtual diabetes implementation literature in a minimal way if included at all, resulting in a limited ability to compare across studies. Equity-related findings focused on individual level barriers and facilitators to uptake and engagement (i.e., digital access, literacy, willingness, and motivation). One study had a particular emphasis on recruitment of African Americans within their population approach due to the disproportionate effect of T2D on this population.[29]

Of the virtual prevention programs assessed, three of the nine include equity considerations.[28-30] Two of all the included studies focused on low income adults.[29,30] Race and ethnicity were only captured and reported in two of the included studies.[29,30] None of the available literature that we found drew on equity informed guidance theories or frameworks in their design or reporting, and overall, differential impacts of virtual diabetes interventions on population groups or communities were not described in detail across the literature we examined.

Differences in access, understanding,[40] and use of digital technologies can result in unintended barriers

to advancing virtual services equitably. This is commonly known as 'the digital divide'.[40] One study we found reported that the use of technologies between White, Black, low income and Spanish speaking populations varied, highlighting barriers to uptake and engagement virtually.[28] It is important to recognize and address the structural and social determinants that create socioeconomic barriers to individual decision making and action.[39]

Limitations

Both the state of the literature included in the synthesis, and the synthesis itself, are subject to limitations. Reporting of implementation characteristics, process, factors and outcomes was sparse, varied and inconsistent across the literature. Implementation elements that were assessed within the published literature did not report on the factors that impacted implementation in meaningful detail; for example, there was little to no demonstrated collaboration and community-driven planning and implementation, or those details were not reported in the published literature. The included studies were contradictory in that they reported implementation outcomes without detail of accompanying implementation theories, models and frameworks, and without taking up elements of those theories, models and frameworks in a meaningful way.

A number of limitations of our methods should also be noted. We synthesized peer-reviewed, published diabetes prevention studies with implementation outcomes and did not include grey literature. As such, there is potential to have missed implementation of local and public health level diabetes prevention initiatives reported in other (non-peer reviewed) sources. None of the included studies were explicitly informed by implementation frameworks (i.e., CFIR), making it challenging to identify and characterize inner and outer setting characteristics. Reporting of inner setting is additionally complex to report due to variation in where the participant is interacting with the program or intervention.

Discussion and Conclusions

Most of the included studies reported that virtual delivery of T2D programs and services demonstrated increased access and reach in addition to , their consistent effectiveness on clinical outcomes (i.e., weight loss,[28,33,36] sleep,[35] physical activity,[30] and diet[30]).

Offering virtual options in parallel to existing diabetes prevention programming can positively augment and impact access to diabetes prevention and behaviour change at a population level. While indicators at the patient/individual level such as patient satisfaction are key for implementation considerations, this synthesis focused on broader factors that would influence implementation at the population level. Results across the included literature are somewhat mixed with consistent demonstration of effectiveness of virtually delivered interventions, however, some demonstrate a trade-off (reach over effectiveness, or vice versa). Digital health provides the opportunity for cost effective solutions and secure use of health information as an alternative to in-person programming. Virtual and digital T2D prevention programs are still in early stages and there are many areas where the science and practice of implementation could be optimized and advanced. The COVID-19 pandemic has necessitated faster adoption and uptake of virtual programming across health areas, including chronic disease and diabetes. This has also highlighted barriers and challenges that come with rapid technological change and innovation. It is clear that it is important to engage with communities to overcome barriers of digital access and literacy (i.e., the digital divide).[41]

Similar to engagement, health equity is an under-recognized factor that could further strengthen our understanding of implementation projects.[42] Brownson et al. (2021) identify three challenges in achieving this: 1) limitations of evidence base; 2) underdeveloped measures and methods and 3)

inadequate attention to context, all of which have been somewhat reflected in this review of evidence.[42] The recommendations suggested to address these challenges include: linking to social determinants of health outcomes; building equity into policy; using equity-relevant metrics; integrating equity into implementation models; designing and tailoring implementation strategies; engaging organizations in internal and external equity efforts; and focusing on equity in implementation science and dissemination efforts.[42] Development and implementation of evidence informed virtual programs (innovations) may provide a feasible and effective solution to some of the barriers faced at the individual (inner setting) and system (outer setting) level. Beyond this, evidence-informed implementation of virtual services could be leveraged to inform adaption, scale up and sustainability of existing successful programs. The txt4Health program is one example of how this can be done in collaboration with different levels of leadership, expertise and engagement.[29]

The limited number of theoretically- and evidence-informed virtual diabetes implementation studies found in this search signals potential barriers to advancing the field of prevention care delivery. Implementation evidence and diabetes evidence are both well established (separately), there is however lack of application and intersection of these and in virtual programming. There is a concrete foundation for more intentional use of implementation science in program development and practice to understand the key factors to impact implementation. Chaudoir et al. (2013), for example, identify factors (similar to CFIR) affecting implementation of health innovations within their review of structural, organizational, provider, patient, and innovation level measures.[43] There are multi-level variables related to the intervention itself, the local implementation context, and the behavioral strategies used to implement the intervention. The significant challenges experienced in measuring and reporting implementation factors in this review are reflected in the literature.[43] However, the field has not yet given systematic and consistent attention to how best to implement virtual diabetes prevention programs to optimize both their impact and implementation outcomes. The current knowledge to practice gap can partially be explained by the state of the evaluation literature for these types of programs. Research is often reported descriptively and conducted retrospectively rather than responsive to and adapted based contextual factors which exist at multiple levels of implementation (individuals, teams, organizational, health system).[44] Since contextual elements do not work independently and are found to intersect in complex and nuanced ways which influence success and impacts / outcomes of implementation, more attention is needed in exploring contextual factors of virtual diabetes prevention programming since effectiveness is already fairly well established.[44] Fagherazzi et al. (2019) reiterate that the goal of adapting to digital platforms is not to replace traditional or clinical prevention programs, but to complement existing programs adapted to all fields of diabetes (prevention, management, technology and research).[45] Evidence within this brief highlights that virtual care options meet a need in reaching populations that might otherwise be missed or decline participation in large scale, in-person diabetes prevention programs. Implementation science offers another perspective on how to approach such adaptations, as well as what contributes to successful implementation.

The impacts of the social and structural determinants of health related to income, education level and the social and physical environment underpin the prevalence of diabetes in communities facing marginalization including racialized groups who are disproportionately affected by T2D.[4,46] The present and longstanding impacts of systemic racism and colonialism have contributed to increased rates of diabetes among racialized groups, with distinct impacts on Indigenous Peoples.[39] Our search did not identify any studies or digital programs or services that highlighted impacts of systemic racism on diabetes. This highlights an important area for prioritizing co-development of culturally safe, virtual T2D prevention programming. Additionally, to address the unique needs of Indigenous communities, meaningful and ongoing engagement is required, and should be rooted in Indigenous Peoples right to self-determination.[47]

To support the transition to digital and telehealth service delivery, World Health Organization (WHO) has created an International Telecommunication Union and released standards for accessibility of telehealth services to inform equitable health service delivery.[48] Lessons learned in the design and deployment of services for underserved groups suggest the following key principles for researchers: 1) develop a strategic road map to address communication inequalities; 2) engage multiple stakeholders from the beginning and on an ongoing basis; 3) design with usability in mind (enhancing readability and navigability); 4) build privacy safeguards into eHealth interventions and communicate prioritization of privacy; 5) strive for a balance between open science and protection of underserved groups.[49] It is important for these lessons to be carried forward not only in concept but in practice of designing and implementing programs to address the social determinants and meet patient needs.

We recognize the value of uncovering and highlighting gaps in evidence as much as sharing novel findings. The evidence available and synthesized here, despite not being of rigorous implementation quality, is a good starting off point for continued research, design and implementation efforts. Despite the essentially null findings of this review, we argue that it is necessary to report in this level of detail to reiterate the importance of evidence based research and to inform implementation process design and planning.

References

1. Ong L. Global, regional, and national burden of diabetes from 1990 to 2021, with projections of prevalence to 2050: a systematic analysis for the global burden of disease study 2021. Lancet. 2023;402(10397):203-34. Available from: https://doi.org/10.1016/S0140-6736(23)01301-6
2. Khan MAB, Hashim MJ, King JK, Govender RD, Mustafa H, Al Kaabi J. Epidemiology of type 2 diabetes - global burden of disease and forecasted trends. J Epidemiol Glob Health. 2020;10(1):107-11. Available from: https://doi.org/10.2991/jegh.k.191028.001
3. Rathmann W, Kuss O, Kostev K. Incidence of newly diagnosed diabetes after Covid-19. Diabetologia. 2022;65(6):949-54. Available from: https://doi.org/10.1007/s00125-022-05670-0
4. Diabetes Canada. Diabetes in Ontario: 2022 backgrounder [Internet]. Toronto, ON: Diabetes Canada; 2022 [cited 2023 Jun 6]. Available from: https://www.diabetes.ca/DiabetesCanadaWebsite/media/Advocacy-and-Policy/Backgrounder/2022_Backgrounder_Ontario_English_1.pdf
5. World Health Organization (WHO). Diabetes [Internet]. Geneva: WHO; 2023 [cited 2023 Jun 6]. Available from: https://www.who.int/news-room/fact-sheets/detail/diabetes#:~:text=To%20help%20prevent%20type%202,avoid%20sugar%20and%20saturated%20fat
6. Anja B, Laura R. The cost of diabetes in Canada over 10 years: applying attributable health care costs to a diabetes incidence prediction model. Health Promot Chronic Dis Prev Can. 2017;37(2):49-53. Available from: https://doi.org/10.24095/hpcdp.37.2.03
7. Diabetes Canada. 2023 pre-budget submission; submitted to the standing committee on finance and economic affairs consultation on the 2023 Ontario budget [Internet]. Toronto, ON: King's Printer for Ontario; 2023 [cited 2023 Jul 24]. Available from: Available from: https://www.diabetes.ca/DiabetesCanadaWebsite/media/Advocacy-and-Policy/Submissions%20to%20Government/Provincial/2023-Diabetes-Canada-Prebudget-Submission-Ontario.pdf
8. Ritchie ND, Baucom KJW, Sauder KA. Current perspectives on the impact of the national diabetes prevention program: building on successes and overcoming challenges. Diabetes Metab Syndr Obes. 2020;13:2949-57. Available from: https://doi.org/10.2147/DMSO.S218334
9. Ackermann RT, O'Brien MJ. Evidence and challenges for translation and population impact of the diabetes prevention program. Curr Diab Rep. 2020;20(3):9. Available from: https://doi.org/10.1007/s11892-020-1293-4
10. Moir T. Why Is Implementation science important for intervention design and evaluation within educational settings? Front Ed. 2018;3. Available from: https://doi.org/10.3389/feduc.2018.00061
11. Bauer MS, Damschroder L, Hagedorn H, Smith J, Kilbourne AM. An introduction to implementation science for the non-specialist. BMC Psychol. 2015;3(1):32. Available from: https://doi.org/10.1186/s40359-015-0089-9
12. Kislov R, Pope C, Martin GP, Wilson PM. Harnessing the power of theorising in implementation science. Imp Sci. 2019;14(1):103. Available from: https://doi.org/10.1186/s40359-015-0089-9
13. May C. Towards a general theory of implementation. Imp Sci. 2013;8(1):18. Available from: https://doi.org/10.1186/1748-5908-8-18
14. Nilsen P. Making sense of implementation theories, models and frameworks. Imp Sci. 2015;10(1):53. Available from: https://doi.org/10.1186/s13012-015-0242-0
15. Damschroder LJ, Reardon CM, Widerquist MAO, Lowery J. The updated consolidated framework for implementation research based on user feedback. Imp Sci. 2022;17(1):75. Available from: https://doi.org/10.1186/s13012-022-01245-0

16. Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander JA, Lowery JC. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. Imp Sci. 2009;4(1):50. Available from: https://doi.org/10.1186/1748-5908-4-50
17. Golovaty I, Ritchie ND, Tuomilehto J, Mohan V, Ali MK, Gregg EW, et al. Two decades of diabetes prevention efforts: A call to innovate and revitalize our approach to lifestyle change. Diab Res Clin Prac. 2022. Available from: https://doi.org/10.1016/j.diabres.2022.110195
18. Shaver J. The state of telehealth before and after the COVID-19 pandemic. Prim Care. 2022;49(4):517-30. Available from: https://doi.org/10.1016/j.pop.2022.04.002
19. Canadian Medical Association. Virtual care in Canada: discussion paper [Internet]. Toronto, ON: CMA Health Summit; 2019 [cited 2023 Jun 6]. Available from: https://www.cma.ca/sites/default/files/pdf/News/Virtual_Care_discussionpaper_v2EN.pdf
20. UK. Department of Health and Social Care. Policy paper: a plan for digital health and social care [Internet]. London, UK: Crown copyright; 2022 [cited 2023 Jun 23]. Available from: https://www.gov.uk/government/publications/a-plan-for-digital-health-and-social-care/a-plan-for-digital-health-and-social-care
21. France. Ministry of Health and Prevention. My health 2022: a collective commitment [Internet]. Paris: Government of France; 2022 [cited 2023 Jun 23]. Available from: https://sante-gouv-fr.translate.goog/systeme-de-sante/masante2022/?_x_tr_sl=fr&_x_tr_tl=en&_x_tr_hl=en&_x_tr_pto=sc
22. World Health Organization (WHO). mHealth: use of appropriate digital technologies for public health [Internet]. Geneva: WHO; 2018 [cited 2023 Jun 23]. Available from: https://apps.who.int/gb/ebwha/pdf_files/WHA71/A71_20-en.pdf
23. Welch V, Dewidar O, Tanjong Ghogomu E, Abdisalam S, Al Ameer A, Barbeau VI, et al. How effects on health equity are assessed in systematic reviews of interventions. Cochrane Database Syst Rev. 2022;1(1). Available from: https://doi.org/10.1002/14651858.MR000028.pub2
24. O'Neill J, Tabish H, Welch V, Petticrew M, Pottie K, Clarke M, et al. Applying an equity lens to interventions: using PROGRESS ensures consideration of socially stratifying factors to illuminate inequities in health. J Clin Epidemiol. 2014;67(1):56-64. Available from: https://doi.org/10.1016/j.jclinepi.2013.08.005
25. Cargo J, Pantoja T, Booth A, Harden A, Hannes J, Flemming K, et al. Cochrane qualitative and implementation methods group guidance paper 4: methods for assessing evidence on intervention impementation. J Clin Epidemiol. 2018;97:59-69. Available from: https://doi.org/10.1016/j.jclinepi.2017.11.028
26. Noyes J, Booth A, Flemming K, Garside R, Harden A, Lewin S, et al. Cochrane qualitative and implementation methods group guidance series-paper 3: methods for assessing methodological limitations, data extraction and synthesis, and confidence in synthesized qualitative findings. J Clin Epidemiol. 2018;97:49-58. Available from: https://doi.org/10.1016/j.jclinepi.2017.06.020h
27. Flemming K, Booth A, Hannes K, Cargo M, Noyes J. Cochrane qualitative and implementation methods group guidance paper 5: reporting guidelines for qualitative, implementation and process evaluation evidence syntheses. J Clin Epidemiol. 2017;97:79-85. Available from: https://doi.org/10.1016/j.jclinepi.2017.10.022
28. Aguiar EJ, Morgan PJ, Collins CE, Plotnikoff RC, Young MD, Callister R. Process evaluation of the type 2 diabetes mellitus PULSE program randomized controlled trial: recruitment, engagement, and overall satisfaction. Am J Mens Health. 2017;11(4):1055-68. Available from: https://doi.org/10.1177/1557988317701783
29. Khurshid A, Brown L, Mukherjee S, Abebe N, Kulick D. Texting for health: an evaluation of a population approach to type 2 diabetes risk reduction with a personalized message. Diab Spec. 2015;28(4):268-75. Available from: https://doi.org/10.2337/diaspect.28.4.268

30. Reininger B, Mecca LP, Stine KM, Schultz K, Ling L, Halpern D. A type 2 diabetes prevention website for African Americans, Caucasians, and Mexican Americans: formative evaluation. JMIR Res Protocols. 2013;2(2):e24. Available from: https://doi.org/10.2196/resprot.2573
31. Buis LR, Hirzel L, Turske SA, Des Jardins TR, Yarandi H, Bondurant P. Use of a text message program to raise type 2 diabetes risk awareness and promote health behavior change (part I): assessment of participant reach and adoption. J Med Int Res. 2013;15(12):e281. Available from: https://doi.org/10.2196/jmir.2928
32. Ullmann G, Kedia SK, Homayouni R, Akkus C, Schmidt M, Klesges LM, et al. Memphis FitKids: implementing a mobile-friendly web-based application to enhance parents' participation in improving child health. BMC Public Health. 2018;18(1):1068. Available from: https://doi.org/10.1186/s12889-018-5968-6
33. Vadheim LM, Patch K, Brokaw SM, Carpenedo D, Butcher MK, Helgerson SD, et al. Telehealth delivery of the diabetes prevention program to rural communities. Translational Behav Med. 2017;7(2):286-91. Available from: https://doi.org/10.1007/s13142-017-0496-y
34. Whelan ME, Kingsnorth AP, Orme MW, Sherar LB, Esliger DW. Sensing interstitial glucose to nudge active lifestyles (SIGNAL): feasibility of combining novel self-monitoring technologies for persuasive behaviour change. BMJ Open. 2017;7(10). Available from: http://dx.doi.org/10.1136/bmjopen-2017-018282
35. Griauzde D, Kullgren JT, Liestenfeltz B, Ansari T, Johnson EH, Fedewa A, et al. A mobile phone-based program to promote healthy behaviors among adults with prediabetes who declined participation in free diabetes prevention programs: mixed-methods pilot randomized controlled trial. JMIR MHealth and UHealth. 2019;7(1):e11267. Availabe from: https://doi.org/10.2196/11267
36. Golovaty I, Wadhwa S, Fisher L, Lobach I, Crowe B, Levi R, et al. Reach, engagement and effectiveness of in-person and online lifestyle change programs to prevent diabetes. BMC Public Health. 2021;21(1):1314. Available from: https://doi.org/10.1186/s12889-021-11378-4
37. Reininger BM, Lopez J, Zolezzi M, Lee M, Mitchell-Bennett LA, Xu T, et al. Participant engagement in a community health worker-delivered intervention and type 2 diabetes clinical outcomes: a quasi-experimental study in Mexican Americans. BMJ Open. 2022;12(11). Available from: https://doi.org/10.1136/bmjopen-2022-063521
38. Fernandez ME, Walker TJ, Weiner BJ, Calo WA, Liang S, Risendal B, et al. Developing measures to assess constructs from the inner etting domain of the consolidated framework for implementation research. Imp Sci. 2018;13(1):52. Available from: https://doi.org/10.1186/s13012-018-0736-7
39. Public Health Agency of Canada. Framework for diabetes in Canada [Internet]. Ottawa, ON: Government of Canada; 2022 [cited 2023 Jun 23]. Available from: https://www.canada.ca/en/public-health/services/publications/diseases-conditions/framework-diabetes-canada.html
40. S Saeed SA, Masters RM. Disparities in health care and the digital divide. Curr Psych Rep. 2021;23(9):61. Available from: https://doi.org/10.1007/s11920-021-01274-4
41. Shah MK, Gibbs AC, Ali MK, Narayan KMV, Islam N. Overcoming the digital divide in the post-COVID-19 "reset": enhancing group virtual visits with community health workers. J Med Internet Res. 2021;23(7):e27682. Available from: https://doi.org/10.2196/27682
42. Brownson RC, Kumanyika SK, Kreuter MW, Haire-Joshu D. Implementation science should give higher priority to health equity. Imp Sci. 2021;16(1):28. Available from: https://doi.org/10.1186/s13012-021-01097-0
43. Chaudoir SR, Dugan AG, Barr CHI. Measuring factors affecting implementation of health innovations: a systematic review of structural, organizational, provider, patient, and innovation level measures. Imp Sci. 2013;8(1):22. Available from: https://doi.org/10.1186/1748-5908-8-22

44. Harvey G, Rycroft-Malone J, Seers K, Wilson P, Cassidy C, Embrett M, et al. Connecting the science and practice of implementation – applying the lens of context to inform study design in implementation research. Front Hlth Serv. 2023; 3. Available from: https://doi.org/10.3389/frhs.2023.1162762
45. Fagherazzi G, Ravaud P. Digital diabetes: perspectives for diabetes prevention, management and research. Diabetes Metab. 2019;45(4):322-9. Available from: https://doi.org/10.1016/j.diabet.2018.08.012
46. Diabetes Canada Clinical Practice Guidelines Expert Committee. Diabetes Canada 2018 clinical practice guidelines for the prevention and management of diabetes in Canada. 2018;42(Suppl 1):S1-S325. Available from: https://guidelines.diabetes.ca/cpg
47. Government of Canada, Department of Justice Canada. Principles respecting the government of Canada's relationship with Indigenous peoples [Internet]. Ottawa, ON: Government of Canada; 2021 [cited 2023 Jun 23]. Available from: https://www.justice.gc.ca/eng/csj-sjc/principles-principes.html
48. World Health Organization (WHO), Regional Office for Eastern Mediterranean. eHealth [Internet]. Geneva: WHO; 2023 [cited 2023 Jun 23]. Available from: https://www.emro.who.int/health-topics/ehealth/
49. Lee EW, McCloud RF, Viswanath K. Designing effective eHealth interventions for underserved groups: five lessons from a decade of eHealth intervention design and deployment. J Med Internet Res. 2022;24(1):e25419. Available from: https://doi.org/10.2196/25419

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