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Interventions to address global inequity in diabetes: international progress

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Contributors

SA conceptualised the Series theme and this Series paper, invited the authors, and wrote the introduction, the general sections of the changing the ecosystem, building capacity, and improving the clinical practice environment sections, the conclusions, and the table. AFW conceptualised this Series paper, and wrote portions of the introduction, the unifying theoretical frameworks section, the conceptual framework section, the table, the building capacity section, portions of the improving the clinical practice environment section, the Project ECHO Diabetes section, and the conclusions. ANW and JCM wrote the sub-Saharan Africa section. CY and NT wrote the India section. LEE, JAC, and RJW wrote the US Milwaukee needs assessment section. JAL wrote the US IMPaCT section. LM-B and SG wrote the Australia section. OE and OO wrote the T1D Exchange section.
All authors edited the overall manuscript.

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Abstract

Diabetes is a serious chronic disease with high associated burden and disproportionate costs to communities based on socioeconomic, gender, racial, and ethnic status. Addressing the complex challenges of global inequity in diabetes will require intentional efforts to focus on broader social contexts and systems that supersede individual-level interventions. We codify and highlight best practice approaches to achieve equity in diabetes care and outcomes on a global scale. We outline action plans to target diabetes equity on the basis of the recommendations established by The Lancet *Commission on Diabetes*, organising interventions by their effect on changing the ecosystem, building capacity, or improving the clinical practice environment. We present international examples of how to address diabetes inequity in the real world to show that approaches addressing the individual within a larger social context, in addition to addressing structural inequity, hold the greatest promise for creating sustainable and equitable change that curbs the global diabetes crisis.

Introduction

From 2021 to 2050, the global burden of diabetes will increase from 529 million people to 1·3 billion people.[1] Diabetes is a serious chronic disease with substantial premature morbidity and mortality, affecting people across the lifespan, with incidence increasing in young people (up to age 25 years) and, as of 2021, a prevalence of gestational diabetes as high as 13·0–25·9% globally.[2,3,4] As evidenced in the first paper in this Series,[5] diabetes disproportionately impacts communities from some socioeconomic, racial, and geographical groups, due to the proliferative effects of structural inequity (ie, structural racism and geographical inequity) on social determinants of health.[6–11] Approximately three-quarters of people with diabetes worldwide live in low-income or middle-income countries (LMICs), with a large discrepancy in healthy life-years lost to diabetes compared with high-income countries (HICs).[2] Likewise, minoritised groups within HICs and LMICs experience higher diabetes prevalence, lower access to essential medicines and new treatments, poorer glycaemic outcomes, lower quality of life, and higher premature mortality than majority groups.[2]

Governmental organisations and health-care systems have increasingly acknowledged the need to integrate social, behavioural, and community care to curb the global burden of

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diabetes.[9,12] The Lancet *Commission on Diabetes* provided guidance and implementation plans for how best to achieve such goals in practice, starting with data collection to drive change at the individual, health-care, system, and community levels to inform new policies.[13] The WHO Global Diabetes Compact is a multisectoral international initiative created to provide consensus on established targets and metrics that could guide global efforts to reduce the number of people living with diabetes and to ensure those living with diabetes have equitable access to comprehensive diabetes care and supplies.[14,15] Similarly, WHO's Sustainable Development Goal target 3.4—to reduce premature mortality from non-communicable diseases by a third by 2030—called for global action to coalesce multisectoral and multinational programmes to prevent and treat diabetes, and promote mental wellbeing.[16] Nevertheless, despite increased awareness of the global diabetes crisis and ongoing multinational efforts to curb rising diabetes rates, large translational gaps remain. A central focus and understanding of inequity in diabetes is needed to truly achieve equitable outcomes, which will involve more local knowledge, thought leadership, and collaboration than has historically occurred. Given the underrepresentation in high-impact journals of publications applying real-world approaches that study small cohorts, use mixed-methods designs, and test hypotheses in non-randomised trials, lessons in implementation and dissemination of applied interventions to address equity in the real world are lacking.

In this Series paper, we build from the first paper in this Series,[5] which outlines how structural racism and geographical inequity lead to differential and negative impacts of social determinants of health on diabetes outcomes. We enhance our original framework to codify and highlight best practice approaches to achieve equity in diabetes care and outcomes. We outline action plans to specifically target equity by including minoritised communities in the development and implementation of interventions and by incorporating multilayered strategies required to address structural inequity globally. We showcase international examples of how to address diabetes inequity in the real world. On the basis of the recommendations established by The Lancet *Commission on Diabetes*,[13] we organise our suggested interventions by their effect on changing the ecosystem, building capacity, or improving the clinical practice environment. To further systematise our approach, we have standardised intervention descriptions by describing the problem or opportunity identified, outlining the intervention undertaken, and discussing lessons learned and implications for equity.

Unifying concepts of health and disease across disciplines

The fields of public health, sociology, anthropology, health services, biomedicine, and psychology have created multilayered frameworks to conceptualise optimal health and health care. These paradigms recognise that individuals (or diseases) do not exist outside of social context, lived experiences, communities, and society, but rather that individuals operate within a larger fabric that is influenced by political, social, historical, and geographical contexts.[17,18] In public health, the social–ecological model (SEM) is widely used to consider the interplay of factors influencing health at the individual, interpersonal, community, and societal and policy levels.[19,20] Additionally, in public health, the theory of triadic influence emphasises that health-related behaviours are caused by various streams of influence, including intrapersonal, social–structural, and cultural factors.[21] In

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the social sciences, the theory of fundamental causes provides a conceptual framework for understanding the connection between socioeconomic status and health inequity, positing that affluent communities and populations experience health advantages through connections to resources in a larger social structure.[22] In health services, the Andersen health-care utilisation model applies a multilayered approach to understand the use of health-care services, and includes predisposing factors (eg, health beliefs), enabling factors (eg, access to health insurance), and needs (eg, perceived and actual need for services).[23] In the biomedical field, a classic definition of health originates from the WHO constitution, which defines health as a "state of complete physical, mental, and social wellbeing, and not merely the absence of disease or infirmity".[24] Lastly, in the field of psychology, conceptualisations of the effect of structural racism and inequity describe the large scale and deeply rooted effect of structural racism and inequity on social determinants of health that differentially and negatively impact health outcomes.[10,11]

Collectively, when applied to inequity in diabetes, these disciplinary theories provide awareness about health influences that supersede the individual and should be considered when developing and implementing interventions to address the global burdens of disease and inequity to optimise reach and sustainability. The SEM, in particular, has been broadly used to characterise multilayered contextual factors that influence health outcomes and generally provides a robust framework for representation of these types of paradigms. Nevertheless, pivoting to focus on social context and systemic structures, rather than individual-level factors, is particularly difficult when addressing diabetes because of the stigma and blame surrounding the disease and the misconceptions about diabetes being caused by poor health behaviour choices.[25,26]

Conceptual framework

In the conceptual model we proposed in the first paper in this Series,[5] individuals with diabetes across the lifespan were embedded within a multifaceted social context, which included social determinants of health having an effect on diabetes: public awareness and policy, economic development, access to high-quality care, innovations in diabetes management, and sociocultural norms. Structural inequity (structural racism and geographical inequity) serves as the backdrop to the framework to represent its deeply rooted and pervasive influence on all social determinants of health. In this Series paper, we have modified the framework to include a pragmatic, action-based approach to address inequity in diabetes, by incorporating the multilayered SEM framework and the recommendations of The Lancet *Commission of Diabetes*: change the ecosystem, build capacity, and improve the clinical practice environment (figure 1).[13] Of key importance and relevance is the idea that interventions addressing factors in the outer domains will also affect outcomes in the inner domains in SEM frameworks.[20] For example, a policy change related to coverage of continuous glucose monitors that represents a change in the ecosystem will also improve the clinical practice environment and ameliorate outcomes for people living with diabetes. We drew parallels between each level of the SEM and the recommendations set forth by The Lancet *Commission on Diabetes*:[13] (1) societal and policy level to changing the ecosystem; (2) community level to capacity building; and (3) interpersonal level to improving the clinical practice environment (figure 2). Although

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interventions have been associated with the SEM levels they best exemplify and in which their main effect occurs, we recognise that interventions could affect other SEM levels and influence each other.

Regional interventions: principles in action

Several regional interventions provide examples of how recommendations and equity principles are translated to current real-world circumstances, and how they address structural inequity and its consequences in diabetes (table).

Changing the ecosystem

Changing the ecosystem is defined by structural changes in policy, social systems, or the environment to optimise care and outcomes. In the SEM, modification of the factors in the outer domain (ie, at societal and policy levels) would qualify as changing the ecosystem, and profoundly influence the factors in the inner domains (ie, at community, interpersonal, and individual levels; figure 2).[20] National and international initiatives spearheaded by several organisations and governmental agencies, such as WHO and the National Institute on Minority Health and Health Disparities, have developed comprehensive and multilayered plans, which describe the effects of biological factors, the built environment, and health-care systems on diabetes outcomes, recommending actions to address health equity at all levels.[27,28] The WHO Global Diabetes Compact was led by a global group of multidisciplinary stakeholders to promote cross-sector engagement and funding to deliver and disseminate diabetes-specific interventions that would help to change the ecosystem.[15]

Insulin access has been a focus of the WHO Global Diabetes Compact's plan and is an important part of the ecosystem for people living with diabetes. In the USA, the cost of insulin remains very high, and legislation has been recently passed to cap the cost of insulin vials at $35 per month,[29] which will have far-reaching benefits for people who might have to ration insulin and otherwise cannot afford high-quality regular diabetes care. Similarly, global efforts to provide access to essential medicines, including insulin and insulin supplies, are part of the WHO Global Diabetes Compact with a focus on sub-Saharan Africa for some of its first pilot programmes.[30] In addition to addressing access to insulin, another important facet of changing the ecosystem involves reducing bias and ensuring historically marginalised groups have a voice in realigning priorities of governments and health-care systems. To promote health equity in diabetes, stakeholders can drive comprehensive policy change at local, national, and global levels to integrate isolated public and health-care sector efforts.

Government, industry, and health-care cross-collaboration in sub-Saharan Africa—As outlined in the first paper in this Series,[5] diabetes prevalence, morbidity and mortality, and costs are projected to exponentially increase in the next two decades in sub-Saharan Africa.[31] Between-country and within-country differences exist in this large geographical region, between resource-rich and resource-poor areas, thus creating a fragmented patchwork of inequities, which cannot be addressed with universal approaches. Two cross-cutting, pervasive issues affecting diabetes care in sub-Saharan Africa are availability of essential medicines, and food security and quality.

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Several collaborative initiatives between government and industry show how public awareness can be raised and public policy structured to change the ecosystem and reduce diabetes-related inequity. Starting in Kenya in 2021, the Diabetes CarePak was launched as an innovative, person-centred solution to increasing access to safely administered insulin and appropriate standard care supplies for self-management of diabetes.[32] The project is led by PATH, an international non-profit organisation, and has expanded to five sub-Saharan African countries (Kenya, Mali, Mozambique, Tanzania, and Uganda), with added partners and funding from The Leona M and Harry B Helmsley Charitable Trust, Novo Nordisk, Sanofi, and the International Federation of Pharmaceutical Manufacturers and Associations. The Diabetes CarePak consists of a glucose metre, test strips, lancets, alcohol swabs, needles and syringes (when applicable), a sharps container, a tool to track glucose concentrations over time, and educational materials for people living with diabetes. The Diabetes CarePak was developed using human-centred design methodology to put people living with diabetes at the core of the co-creation process and develop a solution for diabetes self-care that was accessible, usable, feasible, and of added value.[33–35] Initial or starter Diabetes CarePaks were designed to last 1 month, followed by monthly refill kits. During an initial 2-month pilot period in Kenya, people using the Diabetes CarePak not only reported improved self-care behaviours, such as more frequent blood glucose self-monitoring and dietary modification, but also experienced an average glycated haemoglobin (HbA_{1c}) decrease of 2·8%,[36] which compares favourably with the HbA_{1c} reduction observed with pharmacological agents.[37]

The Changing Diabetes in Children programme is a public–private partnership established in 2009 by Novo Nordisk, Roche, the World Diabetes Foundation, the International Society for Pediatric and Adolescent Diabetes, and Life for a Child to provide comprehensive care for children and young people (aged up to 25 years) living with type 1 diabetes in LMICs.[38] Insulin and diabetes supplies such as syringes, glucose metres, glucose test strips, and lancets are provided free of charge, coupled with patient and parent education and advocacy, healthcare professional training, and infrastructure improvement. 16 of 26 partner countries involved in this initiative are in sub-Saharan Africa; in 2019, the programme reached approximately 65% of the estimated population with type 1 diabetes in the involved countries.[38] In Cameroon, median HbA_{1C} reduction in children and adolescents enrolled in the programme was 1·9%,[39] whereas in Tanzania, survival of children and young people with type 1 diabetes improved from 59% to 69% after introducing the Changing Diabetes in Children programme and Life for a Child support programme.[40]

Since 2021, with the support of Resolve to Save Lives, Cameroon has been implementing front-of-package labelling in response to WHO recommendations for front-of-package labels to communicate nutritional information and promote healthy food choices.[41,42] This strategy could assist in addressing asymmetries in knowledge about healthy dietary practices that contribute to diabetes prevalence and outcome inequities. The front-of-package labelling was introduced with input from 14 focus groups, comprising adults from different socioeconomic, educational, and cultural backgrounds, in addition to expert panels. Four warning labels were created (excess in salt, excess in saturated fats, excess in sugars, and excess in calories), written in both French and English, and accompanied by the words Warning above and Minsante (ie, the Ministry of Public Health) below, indicating the

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endorsement by the Ministry of Public Health.[43] Initial evaluation showed that this locally developed front-of-package labelling strategy was superior to a system without labels, and also outperformed other warning label systems such as the Health Star Rating System (in Australia and New Zealand), Nutri-Score (in France), and the Multiple Traffic Lights label (in Ireland and the UK) in reducing the likelihood of an individual purchasing energy-dense foods.[44] Further work is necessary to evaluate whether this programme will have positive downstream effects on outcomes in diabetes and other non-communicable diseases; however, this change to the ecosystem is expected to result in positive outcomes.

Overall, government, non-governmental, and industry partnerships have provided meaningful, effective, and large-scale strategies to improve population health in LMICs, and are starting to change the ecosystem. However, although valuable and well intentioned, the most equitable and beneficial way to run public–private partnerships is not well researched.[45] These partnerships need to observe transparency and accountability to prevent conflicts of interests and ensure that the public health interest is disseminated equally. Evidence-based and sustainable efforts should be made to ensure that vulnerable populations are benefiting from partnership initiatives, ensuring equity. Global efforts to promote health equity in diabetes force recognition that social and economic inequality varies widely across and within global regions, and therefore, location and interventions should be tailored accordingly.

The DIABETES across the LIFECOURSE: Northern Australia Partnership—In central and northern Australia, wide inequity exists in diabetes prevalence and outcomes for Aboriginal and Torres Strait Islander peoples.[46] In the Northern Territory (NT), 27% of the population who identify as Aboriginal people experience the greatest socioeconomic disadvantage and the highest rates of diabetes, end-stage kidney disease, and mortality nationally.[46,47] Aboriginal and Torres Strait Islander peoples have experienced substantial discrimination and injustices since colonisation, including research engagement, which has not benefitted communities and might have been done on, rather than with, communities.[48] Changes to the ecosystem for inclusion of Aboriginal and Torres Strait Islander peoples' voices would impact downstream determinants, including social determinants of health, and achieve improved equity in diabetes health.

In 2011, the Northern Australia Partnership commenced to work in partnership with Aboriginal and Torres Strait Islander peoples and community-controlled organisations to use a life course perspective to prevent and improve management of obesity and diabetes, strengthen community engagement, and bolster an Aboriginal and Torres Strait Islander community-based workforce.[48] Close partnerships were created between communities, researchers, policy makers, and health service providers to improve systems of care and services for people with diabetes across vast regions of remote northern and central Australia.[49,50] 18 members form the partnership, in which Aboriginal and Torres Strait Islander families and communities are at the centre, and voices of those with lived experience of diabetes are promoted.[48] The partnership's joint governance structure includes an Aboriginal and Torres Strait Islander advisory group, a clinical reference group, a steering committee, and an investigators group to promote partnership and to create a platform for communities to share their experiences.[48] Partners have worked together in

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delivering more than 20 projects related to diabetes; current projects are outlined in figure 3.[49–51]

Since 2012, the Northern Australia Partnership has convened an annual education symposium for health professionals, researchers, and policy makers, in which the Aboriginal and Torres Strait Islander advisory group has a lead role in guiding, designing, and delivering. As a result of 10 years of work, the development of strong relationships, and the building of a partnership of 30 national investigators, 65 current reference group members, eight government health services, and 23 Aboriginal community-controlled health services across the region, the first diabetes summit was held in Alice Springs, NT, in November, 2022. The summit involved 200 people in physical attendance and 170 people in virtual attendance, including high-level policy makers, chief executive officers, and senior executives from many Aboriginal Community Controlled Health Organizations and relevant government departments of health (eg, NT Health and NT Department of the Chief Minister and Cabinet). In group workshops, attendees discussed sensitive topics, such as racism and intergenerational trauma, and contributed to community-led proposals for several NT Health strategies. As a result, a NT diabetes roadmap is being developed, and additional organisations are partnering with the Northern Australia Partnership to advocate further on diabetes and social determinants of health.

One of the most important lessons of this work has been the value of investing in relationships and valuing true equitable partnership. This initiative has taken time to change the ecosystem, overcoming generations of mistreatment and justified, deep-seated mistrust. By recognising and implementing the important principle of Indigenous-led research, governance structures and partnerships enable Aboriginal and Torres Strait Islander peoples to have genuine decision-making responsibility in relation to all research.[52] As a result, in 2011, the Northern Australia Partnership established the first Australian register of diabetes in pregnancy, which, in 2022, included information on more than 3000 women, half of whom are Aboriginal.[50] In the registry's first 2 years, identification of Aboriginal women with gestational diabetes increased by 80%.[50] Additionally, the register raised awareness for the need to upskill primary care and hospital clinicians, increase screening for diabetes in pregnancy, and optimise management.[49,50]

Addressing the impact of structural racism on diabetes in Milwaukee, WI, USA—Structural racism is long standing; however, recent social momentum in the USA stemming from disparities in deaths attributed to the COVID-19 pandemic and demonstrations after the death of George Floyd has prompted efforts to understand the mechanisms leading to inequity in health outcomes and develop strategies to reverse its effects.[53–56] Milwaukee is a majority-minority city, the most racially diverse region in the state of Wisconsin, and consistently ranks as one of the most segregated metropolitan areas in the USA. To understand how to change this inequitable ecosystem, long-term, cross-sectoral, and multidisciplinary work is needed to address structural racism, and to replace short-term, isolated approaches that disconnect policy and people.[53–56]

In 2017, our research group did a needs assessment in Wisconsin, including 2 years of stakeholder interviews and focus groups (n=350), to understand the lived experience

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of Black American communities with diabetes, and to identify areas for change.[56] In conjunction with community partners, we identified three priority populations: older Black American adults, food-insecure individuals, and people with financial instability, noting chronic stress as the primary pathway between social risk factors and health.[56] To target the priorities set by the deep needs assessment with local community stakeholders, close partnerships were formed with local organisations, including hunger relief agencies and food banks (eg, the Hunger Task Force and Feeding America Eastern Wisconsin), local churches, community organisations, and health systems seeking to understand how to incorporate social risks into health care. Important discoveries from this indepth longitudinal work showed that, for older Black American adults in Milwaukee, financial hardship was the major underlying factor influencing food choices and insecurity; stigma surrounding food insecurity was a factor limiting individuals in accessing available resources; governmental programmes, such as the Hunger Task Force's stockbox programme to deliver healthy foods to seniors with a low income free of charge, were inconvenient and limited the use of services; and programmes that allowed food choice and education on diabetes were instead more convenient and thus preferred, yet such options were not readily available.[57,58]

Through close partnerships with communities and opportunities to listen to them, the initial idea of direct pathways between food insecurity, chronic stress, and diabetes outcomes was expanded to account for more complex pathways involving financial insecurity and stigma resulting from long-standing effects of structural racism.[56] As a result, this work has broadened from addressing isolated food insecurity to identifying how to address structural factors limiting economic stability within local Black American communities, and opportunities for changing the ecosystem.[56] Working with community stakeholders will be crucial to address deeply rooted racism, which has remained within city policies and conditions that perpetuate financial hardship, shared trauma and stress, and affect diabetes outcomes.[59] These experiences highlight the importance of creating a network of partners across disciplines and geographical areas to achieve equity in diabetes outcomes, and to ensure that the voices of communities in need drive change in systems.[59]

Building capacity

Building capacity corresponds most to the community level of the SEM (figure 2), and includes concepts, such as stakeholder engagement and community-based participatory research, that are well integrated into public health practice.[60–63] In public health, an important element of social change is to empower communities to better meet local, health-related challenges, otherwise known as building community capacity. Community capacity is defined as "the characteristics of communities that affect their ability to identify, mobilize, and address social and public health problems".[61] Sustained change within a community relies on community capacity.[61,63]

Building community capacity in diabetes requires empowering a large workforce to deliver diabetes care in an effort to reach medically underserved communities and mitigate social determinants of health. Community health workers and peer mentors could increase capacity building and the effects of their involvement are well established, with a wealth of evidence showing improved diabetes outcomes.[64–72] Community health worker programmes expand

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the workforce, and better align the needs of underserved communities with resources of health-care systems. Community health worker programmes offer tangible, affordable, and sustainable solutions, especially in addressing educational needs, care coordination, high-risk follow-up, provider bias, and social hardship. Another approach to expanding the diabetes workforce involves empowering primary care providers to deliver diabetes care, given barriers that underserved communities face in using routine endocrinology services.[73] Medically underserved people often rely on primary care providers in local communities as trusted sources of medical care; thus, training primary care providers to deliver diabetes care is an important aspect of building community capacity.[74–76]

The IMPaCT community health worker programme—Research on the participation of community health workers and peer mentors in diabetes care shows the value of involving trusted community members in bridging underserved communities to care and improving diabetes-related support networks. Community health worker and peer programmes have a strong presence globally, which has helped to inform the concept for integration into the US health care system.[67]

In the past 10 years, in Philadelphia (PA, USA), the Individualized Management for Patient-Centered Targets (IMPaCT) community health worker programme has been developed and tested.[77–79] In the IMPaCT programme, trained community health workers deliver a three-stage IMPaCT intervention: goal-setting, tailored support, and connection with long-term support.[77] Although the programme was not specifically designed for people with diabetes, two of three efficacy trials found HbA_{1c} improvement of 0·4% and 0·2% in people in the intervention group compared with those receiving usual care, on par with other internationally recognised social care programmes.[77,78] Importantly, people working with community health workers had increases in engagement and activation (as measured by the patient activation measure[80]), lower risk of hospital admissions, shorter length of hospital stay, and lower likelihood of readmission when hospitalised. Effects persisted even after the intervention ended.[79] A return on investment analysis showed that every dollar invested in the IMPaCT programme returned $2·47 to an average US Medicaid (public health insurance) payer within the fiscal year.[81]

The IMPaCT success resulted from deep integration into local health systems, building health-care capacity, and hiring community health workers from the community served by the programme (people who do not typically have opportunities to work in the direct delivery of care).[77–79] Community health worker interventions are not cheap, but they are cost-effective. The cost per patient is roughly $1721 annually;[81] however, as noted, the return on investment can be positive. To spread the IMPaCT community health worker interventions, several aspects needed to be clearly expressed to payors, including the social and clinical benefits, the potential for positive return on investment, and that the payor or health system should be the beneficiary of this return on investment.[77–79] Continuous quality assessment of the programme permits system leadership appreciation of the value added even in difficult financial times.[82] Additionally, community health worker programmes have frequently helped non-profit hospitals address community benefit requirements, providing additional justification for the investment.[82] During the COVID-19 pandemic, the IMPaCT mobile phone-delivered intervention and other remote formats showed the potential for the

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programme to adjust to various clinical settings and situations in diabetes, and provide health-care capacity in times of need.[78,79] Implications of this work include both policy and payment reform to further support community health worker programmes, as well as enhancing and standardising programme quality metrics.[78,79] One step in the right direction is IMPaCT's inclusion as a national standard in the Building a Sustainable Workforce for Healthy Communities Act to develop or expand state community health worker programmes. This bill was incorporated into the Consolidated Appropriations Act of 2023 and signed by the US President on Dec 29, 2022.

The Project ECHO Diabetes—Underserved communities of people living with diabetes face many challenges in obtaining routine, preventive, endocrine care.[73,83–85] Distance also creates substantial barriers to access to endocrinology care.[84] The overall rising scarcity of endocrinologists and growing wait times for subspecialty care in diabetes exacerbate the challenges, even for people in close geographical proximity to care.[73,83–85] Primary care providers deliver most diabetes care, particularly in regions where shortages of endocrinologists and urban clustering occur.[84,86] The Project Extension for Community Healthcare Outcomes (ECHO) is a tele-mentoring model used to reach medically underserved communities. Since its launch in 2003, the model has been applied in more than 9000 cities and 193 countries globally.[87] Project ECHO provides subspecialty care through tele-mentoring, and applies a hub-and-spoke model whereby the hub represents a multidisciplinary team of subspecialty experts connecting to a large network of rural and remote primary care providers (spokes).[88,89] Project ECHO has already shown broad dissemination potential, but was not originally targeted specifically towards people with diabetes using multiple daily injections of insulin.[90,91]

To address this gap, the ECHO Diabetes programme was introduced in the states of Florida and California in 2018, and is one of 34 diabetes-specific Project ECHO programmes in the USA. The ECHO Diabetes programme used geospatial methods and the Neighborhood Deprivation Index to identify providers who care for medically underserved communities, and was integrated with 41 federally qualified health centres in 107 different underserved geographical catchment areas to build primary diabetes care capacity.[92,93] In addition to the traditional tele-education model, the ECHO Diabetes programme uses diabetes support coaches—that is, local community people who are both community health workers and peer mentors living with diabetes (figure 4).[72] Results from 3 years of this programme have shown significant improvement in primary care providers' knowledge and confidence in type 1 and type 2 diabetes care, including confidence to serve as the type 1 diabetes provider for their community (43·8% pre-intervention *vs* 68·8% post-intervention; p=0·005), manage insulin therapy (62·8% *vs* 84·3%; p=0–002), and identify symptoms of diabetes distress (62·8% *vs* 84·3%; p=0·002).[94] After the intervention, primary care providers also reported significant improvements in their confidence in all aspects of diabetes technology, including prescribing technology (41·2% pre-intervention *vs* 68·6% post-intervention, p=0·001), managing insulin pumps (41·2% *vs* 68·6%, p=0·001) and hybrid closed loop therapy (10·2% *vs* 26·5%, p=0·033), and interpreting sensor data (41·2% *vs* 68·6%, p=0–001).[94] Patient-level outcomes analyses are currently underway using a stepped-wedge trial design.

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One of the important lessons from the ECHO Diabetes implementation has been the pivotal importance of establishing and maintaining relationships with federally qualified health centres. The diabetes support coaches have served as the liaison between the hub teams and federally qualified health centres, and they had an irreplaceable role in recruiting medically underserved people with diabetes into research and clinical efforts.[72] The ECHO Diabetes programme has built capacity for medically underserved communities of people with diabetes by using a multilayered approach to reduce diabetes inequity.

Improving the clinical practice environment

Health outcomes in people living with diabetes depend on where, how, and if individuals receive clinical care. In the conceptual model (figure 1), clinical care is the nearest domain to people living with diabetes. In many ways, this domain represents features of the SEM that are referred to as interpersonal and encompasses interactions with health-care providers and systems (figure 2). Interpersonal interactions and experiences in the clinical setting are grounded in norms and beliefs about people living with diabetes and shaped by protocols that inform care delivery. Developing large-scale data registries to do research and drive quality improvement in patient care can substantially change practice environments by identifying and stratifying risk, and optimising evidence-based care for implementation. The use of large-scale data registries has been a central focus for both The Lancet *Commission on Diabetes*[13] and the WHO Global Diabetes Compact.[14] Data tracking to inform high-quality diabetes care within learning health systems can change clinical practice environments, promote innovations in diabetes treatment and management, and encourage person-centred care.

Addressing undernutrition and gestational diabetes in India—Diabetes in pregnancy is an epidemic within an epidemic, affecting 16% of pregnant women worldwide.[3] The highest standardised prevalence of gestational diabetes is in the Middle East and north Africa, followed by south Asia, the west Pacific, and sub-Saharan Africa.[3] Babies born to mothers with gestational diabetes can develop fetal hyperinsulinaemia and experience postnatal hypoglycaemia.[95] In early childhood, these children risk poorer visual motor development and greater executive dysfunction than their peers;[95] as adults they are more likely to develop obesity and diabetes.[96,97] Additionally, a U-shaped association exists between birthweight and diabetes risk, because both high and low birthweights increase future diabetes risk.[98,99] After adjusting for confounders such as socioeconomic status,[98] pre-pregnancy BMI,[99] and maternal diabetes,[99] the association of diabetes risk with low birthweight becomes stronger than that of diabetes risk with high birthweight.[99] This association of low birthweight with subsequent diabetes highlights a transgenerational risk in areas where maternal undernutrition remains an issue. Prevention, diagnosis, and treatment in early pregnancy might be too late to prevent obesity, adiposity, and glucose intolerance in the next generation.[100,101]

To prevent gestational diabetes, changes in the clinical practice environment are needed, from antenatal clinics to communities. Such efforts are afoot in India in an interventional study trial (Pune Rural Intervention in Young Adolescents [PRIYA]) within a birth cohort study (Pune Maternal Nutrition Study [PMNS]), which explored a nutritional intervention

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based on findings observed in mothers of the index generation (F0 generation) to improve the health of children in the next and future generations.

In 1993, the preconceptional PMNS was set up in partnership with six villages near Pune, India, to investigate factors affecting fetal growth (maternal nutrition and metabolism) and associations with glucose intolerance in later life.[102] The participants have been serially followed up for more than 25 years (figure 5). The children born as the first generation of offspring in the study (F1 generation) had a low birthweight, low lean mass, and high body fat, compared with children in the UK, a trend which persisted through childhood.[104,105] Low maternal vitamin B12 and high folate concentrations in pregnancy were associated with higher adiposity and insulin resistance in these children.[106] This predominantly vegetarian population had a high prevalence of vitamin B12 deficiency.[106] Owing to the possible role of vitamin B12 as a methyl donor in influencing epigenetic programming, an interventional study (PRIYA) was started in the PMNS cohort in 2012 (figure 5).[107] The aim of PRIYA was to test the effect of vitamin B12 supplementation with and without other micronutrients in adolescent F1 participants to promote fetal growth, epigenetic markers, and cardiometabolic outcomes in the next (F2) generation.[107] The follow-up of the trial halted in February, 2020, due to the COVID-19 pandemic. Initial results showed a 250 g increase in the birthweight of the F2 children, when compared with the birthweight of their mothers (F1 generation). Cord blood transcriptome tests showed alteration in cell cycle dynamics in babies born to mothers who received multiple micronutrients containing vitamin B12.[108] Children of mothers who received vitamin B12 showed increased neurocognitive performance between age 2–4 years.[109] Cardiometabolic outcomes are planned to be studied in subsequent follow-ups.

To achieve long-standing partnerships with these communities and facilitate long-term engagement, investigators had to create trust with women in the village, who were traditionally not included in research and did not operate independently from their families or life obligations. By aligning study aims with what the women deemed important, namely that their children live healthy lives without diabetes, data on a cohort of 702 children and mothers during a period of 24 years could be obtained. Since 1994, the PMNS study area has undergone marked socioeconomic transition and urbanisation, including the introduction of irrigation and start-up of several small industries, allowing researchers to study diabetes risk in rural settings that are undergoing rapid urbanisation.[110] Continued efforts to change the clinical practice environment by bringing care into the community will help future generations to mitigate the risk of generational diabetes, which would also help tackle gender and socioeconomic inequity.

The T1DX-QI—In the USA, diabetes burdens are not shared equally across populations. In people with type 1 diabetes, low socioeconomic status is a risk factor for high HbA_{1c} concentrations, and increased risk of morbidity and mortality.[6–8] Hispanic and non-Hispanic Black individuals are more likely to have the highest rates of diabetic ketoacidosis and death from complications related to type 1 diabetes among all racial and ethnic groups in the USA.[6,8] Disparities also exist for the use and prescription of technologies such as continuous glucose monitors and insulin pumps for non-Hispanic Black people living with type 1 diabetes.[111–114] Substantial gaps in the delivery of type 1 diabetes care exist, which

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have ripple effects on outcomes and inequity. Changes in the clinical practice environment to deliver more equitable care are needed.

The T1D Exchange is a non-profit organisation based in Boston (MA, USA) and established in 2009, with a mission to drive improvement in outcomes for individuals with type 1 and type 2 diabetes across the USA, using real-world evidence and collaborative change. As a core programme, the T1D Exchange Quality Improvement Collaborative (T1DX-QI) uses quality improvement methodology and benchmarking to drive change for people with diabetes, translating research findings into action through its network of 55 centres for type 1 diabetes and five centres for type 2 diabetes, which overall care for 100 000 people in the USA.[115,116]

The T1DX-QI made addressing inequity a strategic goal in 2019.[115] The collaborative established a national equity innovation lab, the Health Equity Advancement Lab, which includes national health equity leaders from multiple sectors including education, business, workplace wellness, and health care to generate cross-collaborative ideas.[115,116] As a result, the T1DX-QI has evaluated and is addressing provider biases by using assessments to plan provider bias training, transform clinical practice environments, promote shared decision making, and implement new clinical decision support systems.[116] With its learning network design, the T1DX-QI fosters collaboration and conversation, which provides postgraduate medical education to improve and promote person-centred cutting-edge diabetes care. The T1DX-QI also embraces use of real-world data to co-develop and drive equity change packages through its extensive and racially diverse electronic medical record database of more than 60 000 individuals of all ages with diabetes. The T1DX-QI uses new diabetes equity frameworks to inform quality improvement at the clinic level, which has led to substantial reduction in disparities for diabetes quality measures, including increased access to social support, psychological care, uptake of diabetes technologies, and glycaemic outcomes.[115,116]

The T1DX-QI has been able to not only transform the clinical practice environment of its participating centres, but also develop national benchmarking metrics in type 1 and type 2 diabetes to achieve equity and standards of care for minoritised groups with type 1 and type 2 diabetes in the USA. The collaborative does so by maintaining a library of successful and replicable equity interventions, and by promoting continued self-analysis and change through access to a quality improvement portal of clinical benchmarking data. To change national practice environments on a larger scale, the T1DX-QI has partnered with major US advocacy organisations to work collectively for policy changes that can reduce inequities. For example, the T1DX-QI worked with two state US Medicaid agencies to use the findings from their real-world data to advocate for coverage at the state level, which has achieved equity on a broader scale, beyond T1DX-QI centres.[115] T1DX-QI data showed that people with diabetes on public insurance were less likely to be on continuous glucose monitors and had suboptimal glycaemic concentrations.[117] As a follow-up, we found that people with diabetes on public insurance receiving care at centres with expanded access to continuous glucose monitors had better glycaemic outcomes than those at centres without expanded access to continuous glucose monitors.[118] Although much work still needs to be done to reduce inequity in diabetes, the T1DX-QI leadership and members have successfully

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incorporated the voices of under-represented people, and will continue to work to improve the clinical practice environment to promote a people-first approach to achieve equity in diabetes.

Conclusions

The global diabetes crisis is set to overtake many non-communicable diseases in the coming years, and is further fuelled by inequity in diabetes, creating an urgent need to enact change now. The Lancet *Commission on Diabetes* and the WHO Global Diabetes Compact call for multilayered approaches to address complex challenges in diabetes and to reduce the burden of diabetes for minoritised populations. In this Series paper, we have highlighted examples of interventions that are answering this call by changing the ecosystem, building community capacity, and improving the clinical practice environment. Connections between these approaches and long-standing frameworks within public health and the social sciences are highlighted to increase the visibility of their utility in reducing inequity in health outcomes for people living with diabetes. Collectively, these examples of interventions show that approaches addressing the individual within a larger social context, as well as addressing structural inequity head on, hold the greatest promise for creating sustainable and equitable change in diabetes globally.

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Search strategy and selection criteria

We searched PubMed and Embase for articles published in English from Jan 1, 2003, to March 31, 2023, using the terms “race”, “racism”, “structural racism”, “equity”, “inequity”, “racial inequity”, “structural inequity”, “minoritized”, “geographic inequity”, “ethnicity”, “low income country/countries”, “middle income country/countries”, “low and middle income country/countries”, “high income country/countries”, “global”, “global burden”, “social”, “social factors”, “social determinants of health”, “socioecological model”, and “conceptual framework/model” in combination with “diabetes”. We reviewed articles resulting from these searches and their references, and selected those relevant to the topic of this Series paper. We also reviewed The Lancet *Commission on Diabetes* to frame the interventions in this paper.

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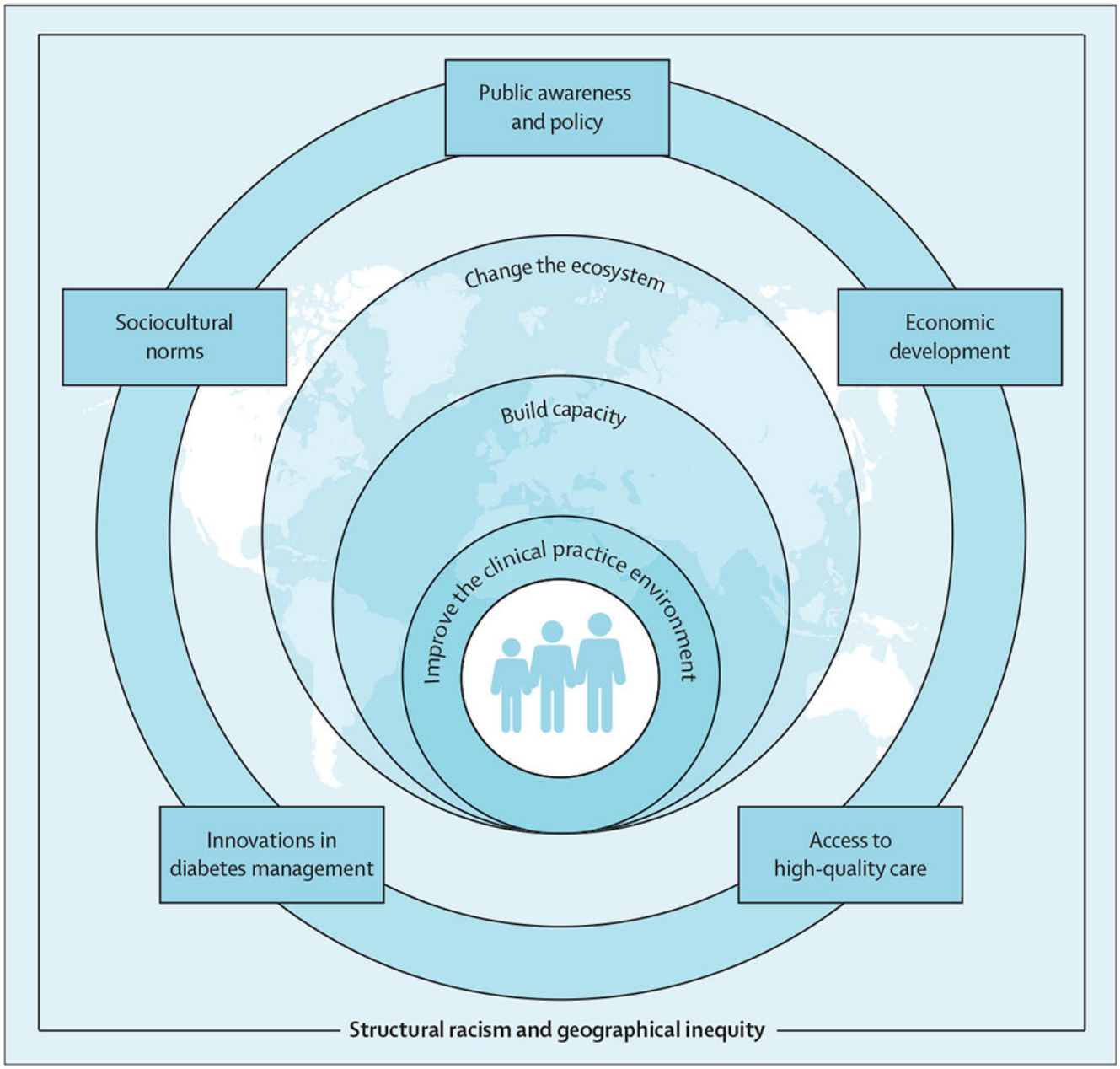


Figure 1:
A pragmatic action-based framework to address global inequity in diabetes

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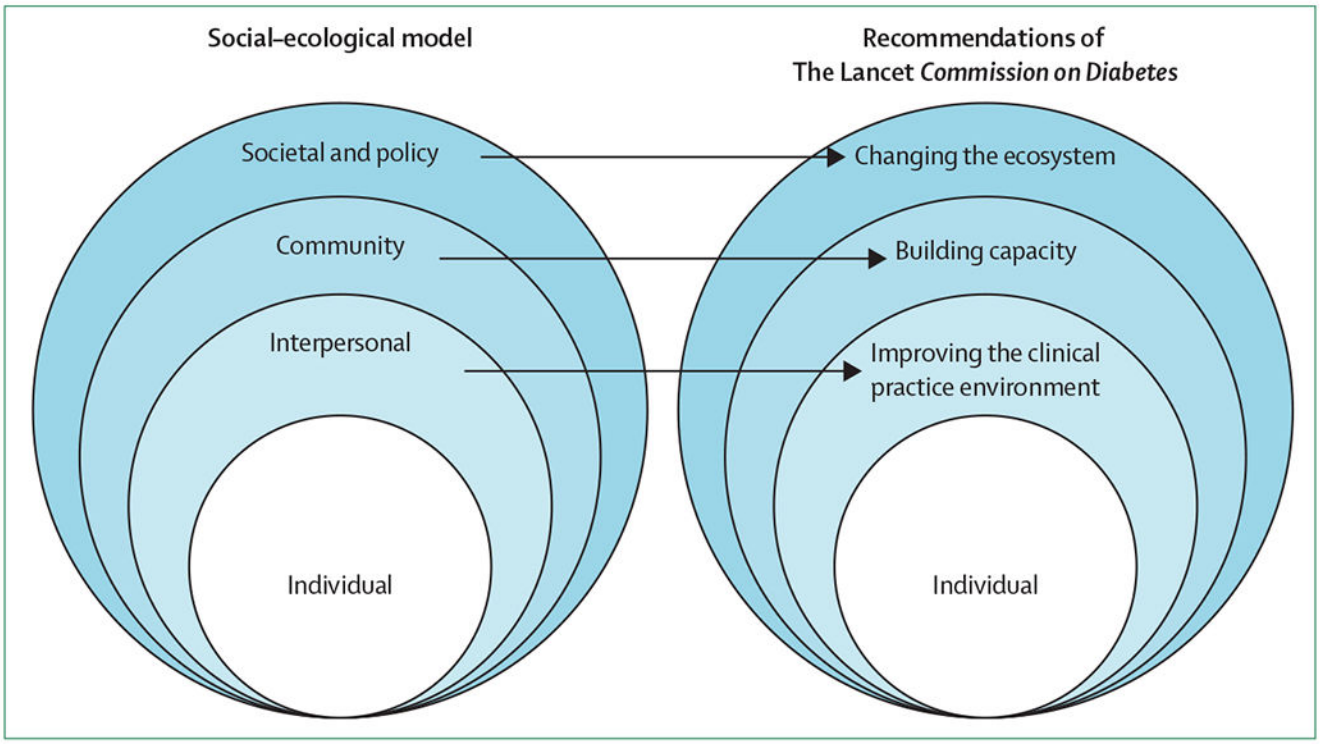


Figure 2:
Corresponding levels of the social–ecological model to the recommendations of The Lancet Commission on *Diabetes*[13]

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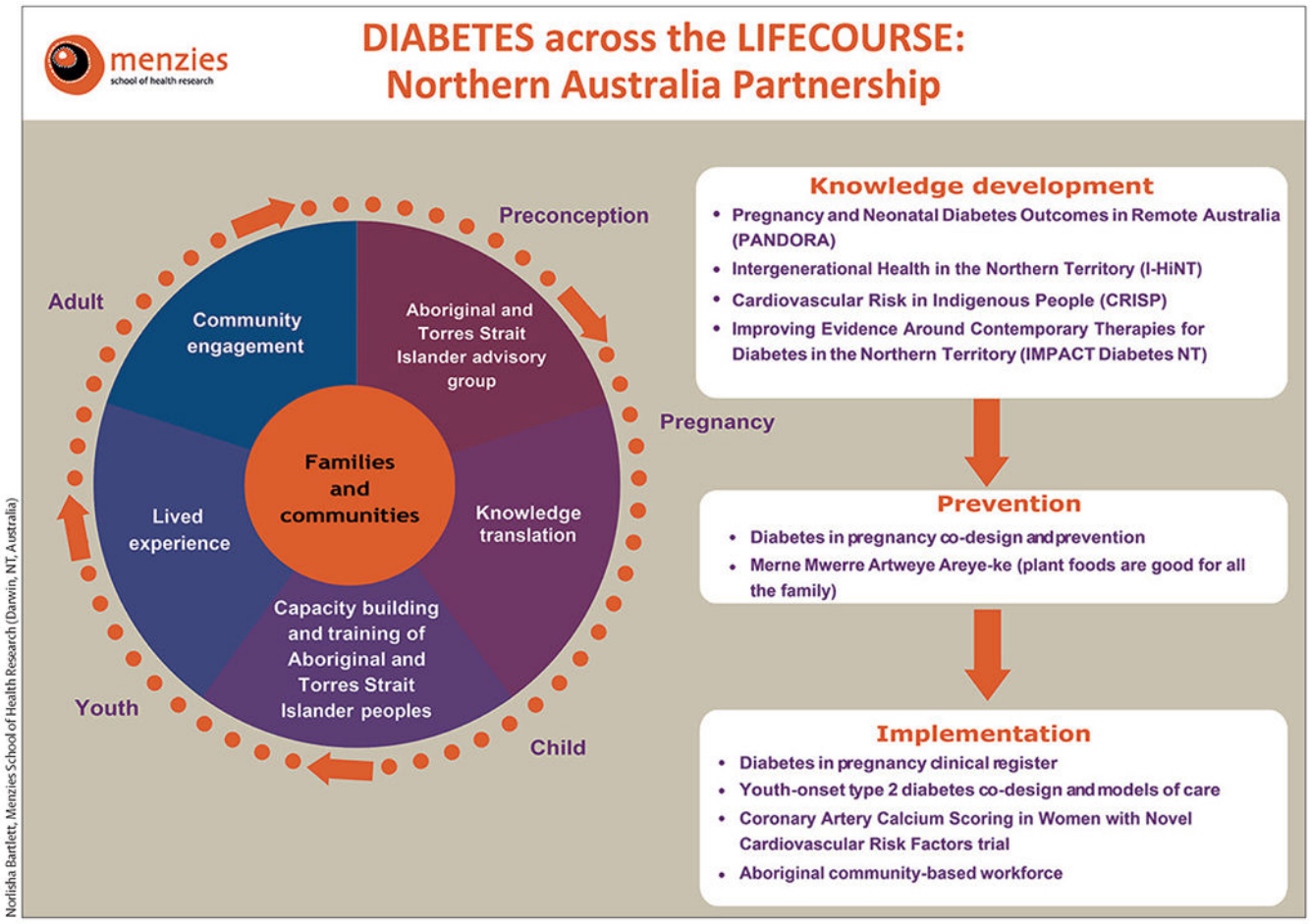


Figure 3:
DIABETES across the LIFECOURSE: Northern Australia Partnership

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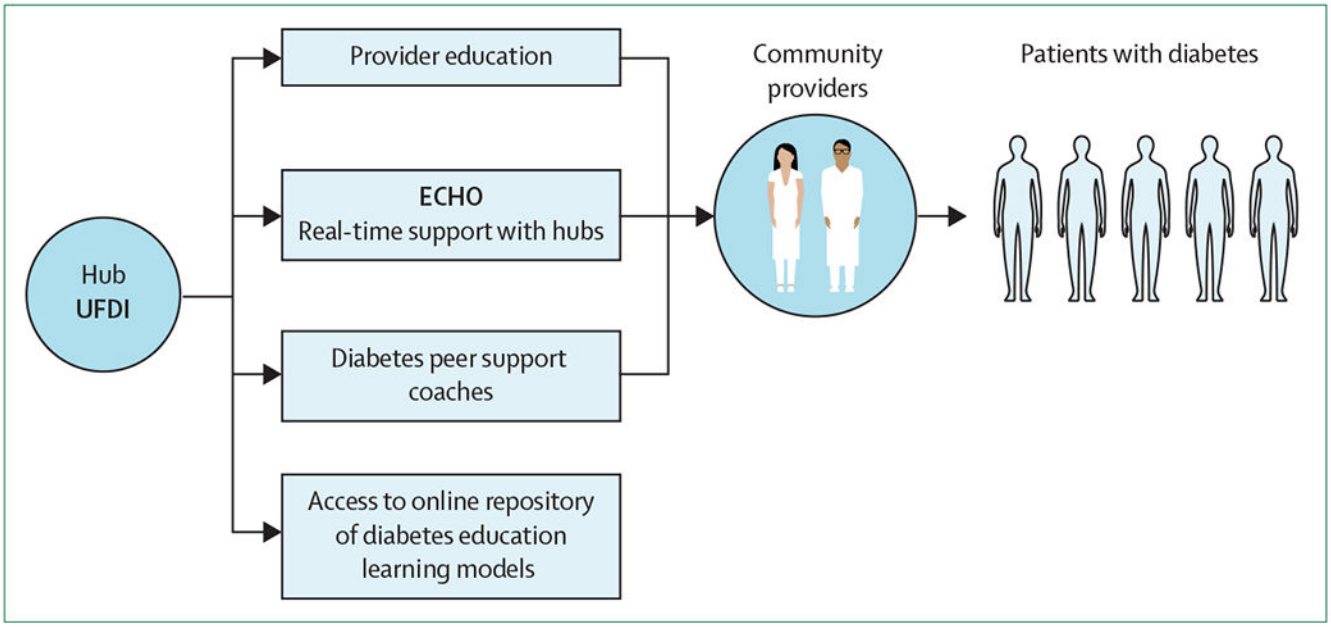


Figure 4: The Project ECHO Diabetes model

Adapted from Walker et al.[93] ECHO=Extension for Community Healthcare Outcomes. UFDI=University of Florida Diabetes Institute.

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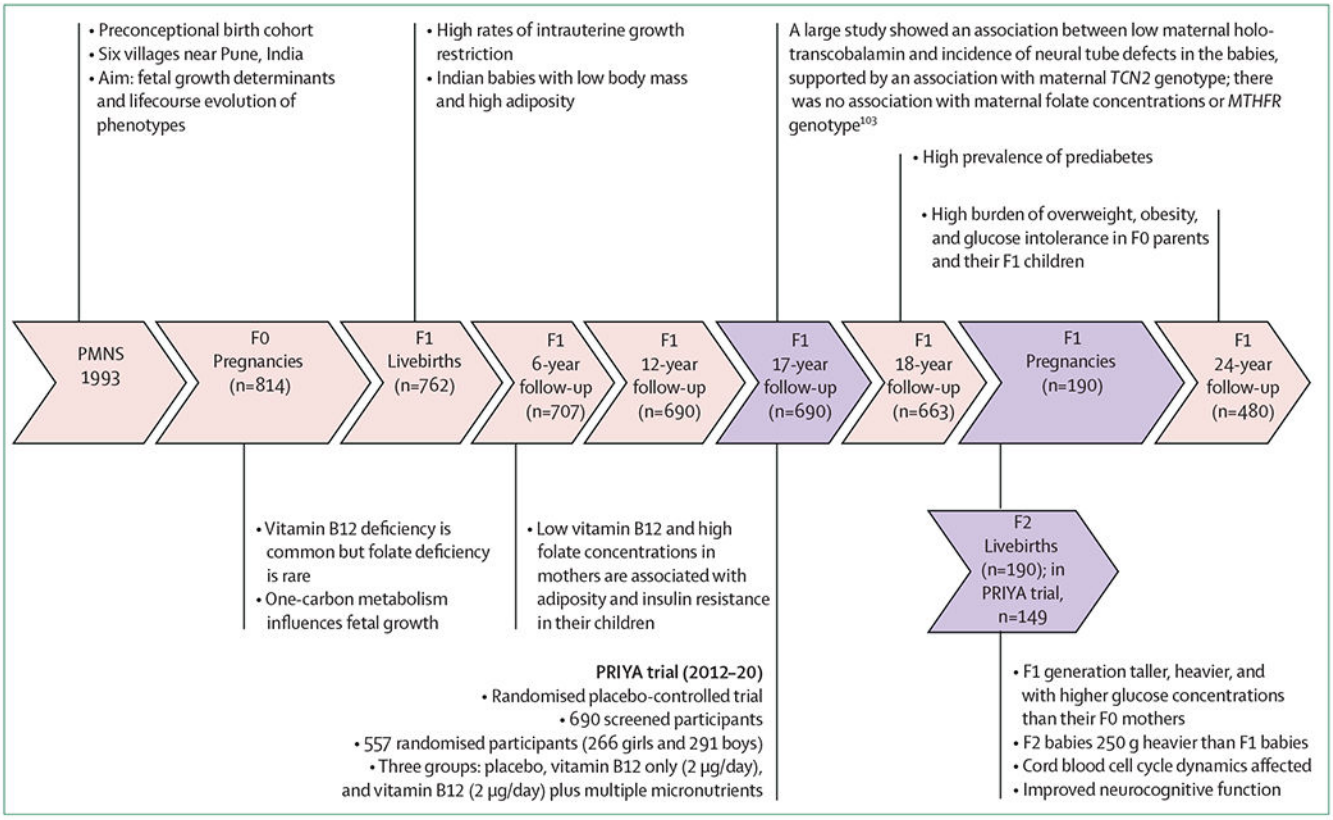


Figure 5: PMNS and PRIYA

Generations are indicated as F0, F1, and F2. PMNS=Pune Maternal Nutrition Study. PRIYA=Pune Rural Intervention in Young Adolescents.

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Table:

International examples of diabetes programmes that address and advance health equity

	Multilayered approach	Stakeholder involvement	Measures of success	Long-term anticipated impact on diabetes outcomes
Changing the ecosystem				
Sub-Saharan Africa: Diabetes CarePak to provide vital diabetes supplies; Changing Diabetes in Children to provide education, supplies, and outreach services to people with type 1 diabetes; and front-of-product food warning labels to communicate nutritional information and promote healthy food choices	(1) Individual level: underserved people with diabetes gained access to vital supplies and resources; (2) community level: increased capacity for providing diabetes supplies and education; (3) societal and policy level: cross-sector funding and partnerships to address lack of access to basic diabetes supplies	People with diabetes co-created the CarePak; underrepresented communities participated in focus groups for the creation of food labels	Improved HbA_{1c} concentrations; increased blood glucose monitoring; increased insulin access; reduction in consumption of carbohydrate, salt, and fat-dense foods	Improved access to safe insulin administration tools and life-saving supplies; improved diabetes self-management; reduction in diabetes morbidity and mortality in low-income and middle-income countries; improved mental health and quality of life
Australia: DIABETES across the LIFECOURSE: Northern Australia Partnership to improve the health and wellbeing of Aboriginal and Torres Strait Islander peoples in northern and central Australia by working together to grow and share knowledge about diabetes, strengthen systems of care and services for people with diabetes, and develop prevention strategies	(1) Individual level: inclusion of Aboriginal and Torres Strait Islander communities in discussions and leadership; (2) community level: symposium provides diabetes education to community leaders, building capacity of the Aboriginal and Torres Strait Islander health-care workforce; (3) societal and policy level: diabetes policy and practice change at local and regional levels related to diabetes in pregnancy and youth-onset type 2 diabetes; diabetes roadmap created to inform diabetes-related policy change	Aboriginal and Torres Strait Islander communities co-created and drove the Northern Australia Partnership	Representation of underserved communities with diabetes; multisector partnership; longevity of partnership; new initiatives as products of work; development of registry to track and better manage inequity in diabetes in pregnancy outcomes among Aboriginal and Torres Strait Islander peoples	Voice of under-represented communities with diabetes can drive policy change; development of a diabetes roadmap based on research findings to allow for better prediction and treatment in diabetes; reduction in diabetes morbidity and mortality in Aboriginal and Torres Strait Islander peoples; reduction in intergenerational diabetes
USA: Milwaukee community needs assessment to identify and address social risk in underserved Black Americans communities	(1) Individual level: addressing food and financial insecurity; (2) community level: leveraging community partnerships to address food insecurity and increasing community capacity to effect social change; (3) societal and policy level: change in policies that perpetuate structural racism	Black American communities with diabetes participated in focus groups to identify priority areas for change	Representation of underserved communities with diabetes; alignment of priority areas between multiple sectors; increase in social capital for communities at risk	Identification of pathways that lead to disparities in diabetes; development of upstream interventions to prevent diabetes and reduce diabetes-related complications; partnerships and information to drive city policy change
Building capacity				
USA: IMPaCT community health worker programme integrated into clinical care delivery to address social determinants of health for medically underserved communities	(1) Individual level: people with diabetes receive support from community health workers; (2) community level: clinical care settings have greater capacity for addressing social determinants of health; (3) societal and policy level: formation of a national policy expanding community health worker coverage	Community health workers are hired from local communities and serve as trusted peers with shared life experiences	Reduction in hospital admissions and readmissions; increased patient satisfaction; increased patient activation	Scaling of community health worker programmes to be integrated components of diabetes care delivery within health systems; reduction in diabetes morbidity and mortality by addressing social determinants of health; reduction in stigma and shame surrounding living with diabetes
USA: ECHO Diabetes tele-education to empower primary care providers in medically underserved communities, and use of diabetes	(1) Individual level: people with diabetes at federally qualified health centres gain access to diabetes support coaches; (2) community level: empowerment of primary care providers	Underserved communities of people living with type 1 diabetes participated in focus groups for needs assessment;	Improved HbA_{1c} concentrations; reduction in diabetes distress; increase in diabetes knowledge and	Expanded access to diabetes care through tele-education and empowerment of primary care providers in medically underserved geographical

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	Multilayered approach	Stakeholder involvement	Measures of success	Long-term anticipated impact on diabetes outcomes
support coaches for community capacity building	through diabetes tele-education builds capacity; (3) societal and policy level: increased access to diabetes care in medically underserved areas	diabetes support coaches (peer mentors living with diabetes) were recruited from underserved communities	confidence for primary care providers; increased use of continuous glucose monitors in federally qualified health centres	catchment areas; reduction in diabetes morbidity and mortality; building of career pathways for people with diabetes as diabetes support coaches
Improving the clinical care environment				
India: Pune Rural Intervention in Young Adolescents programme partnership to address gestational diabetes and undernutrition in pregnancy	(1) Individual level: stakeholder-driven needs assessment; (2) community level: improved clinical protocols for preconception care to reduce gestational risk of undernutrition and future risk of diabetes; (3) societal and policy level: potential for changes in clinical practice guidelines	Underserved women from six villages near Pune, India, participated in research to better understand and predict diabetes risk	Improvement in maternal diet and nutrition; lower number of infants with low birthweight	Reduction in intergenerational diabetes
USA: T1D Exchange registry, a national data repository and registry of people with type 1 and type 2 diabetes and platform for collaborative care initiatives at local, regional, and national levels	(1) Individual level: direct changes to clinical care; (2) community level: data-driven initiatives by the T1D Exchange Quality Improvement Collaborative, tailored to clinical settings; (3) societal and policy level: creation of national registry for type 1 and type 2 diabetes to better stratify risks and advocate for policy-level change	People with type 1 and type 2 diabetes living in the USA are the basis for the registry	Improved HbA_{1c} concentrations; increased use of diabetes technologies; increased psychosocial screening and access to diabetes care	Increase in quality of diabetes care; use of real-world data to advance diabetes outcomes and equity; reduction of disparities in morbidity and mortality rates for people living with type 1 and type 2 diabetes

HbA_{1c} =glycated haemoglobin.