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Recommendations from Diabetes UK's 2022 diabetes and physical activity workshop

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Abbreviations:

DRSGs Diabetes Research Steering Groups
HIIT High intensity interval training
MRC Medical Research Council
NHS National Health Service
LVPA Leisure-time vigorous physical activity
MICT Moderate-intensity continuous training
MLTC Multiple long-term conditions
MVPA Moderate to vigorous physical activity
PROMS Patient reported outcome measures
RT Resistance Training

Novelty Statement:

- Physical activity is known to enhance health and blood glucose management in people with diabetes, however there are gaps in knowledge relating to the mechanisms underpinning this, how this might differ between individuals and change throughout the life course, and the best approaches to engage different populations with physical activity.
- Diabetes UK held a research workshop that brought together clinicians, academics, funder representatives and people living with or affected by diabetes to identify key research recommendations in the area of diabetes and physical activity.
- Four priority areas were identified and clear recommendations for research in each area were developed:
    - Better understanding of the physiology of exercise in all groups of people
    - Designing physical activity interventions for maximum impact
    - Promoting sustained physical activity across the life course
    - Designing physical activity studies for people with type 2 diabetes and multiple long-term conditions (MLTCs)

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Keywords:

Diabetes; physical activity; patient and public involvement; research; priorities; interventions; physiology

Abstract

Aims
To describe the process and outputs of a workshop convened to identify key priorities for future research in the area of diabetes and physical activity and provide recommendations to researchers and research funders on how best to address them.

Methods
A one-day research workshop was conducted, bringing together researchers, people living with diabetes, healthcare professionals, and members of staff from Diabetes UK to identify and prioritise recommendations for future research into physical activity and diabetes.

Results
Workshop attendees prioritised four key themes for further research: (i) Better understanding of the physiology of exercise in all groups of people: in particular, what patient metabolic characteristics influence or predict the physiological response to physical activity, and the potential role of physical activity in beta cell preservation; (ii) Designing physical activity interventions for maximum impact; (iii) Promoting sustained physical activity across the life course ; (iv) Designing physical activity studies for groups with multiple long-term conditions.

Conclusions
This paper outlines recommendations to address the current gaps in knowledge related to diabetes and physical activity and calls on the research community to develop applications in these areas and funders to consider how to stimulate research in these areas.

Introduction

Physical activity plays an important role in the management of both type 1 and type 2 diabetes, contributing to improved glycaemic control, lower risk of cardiometabolic complications, and improved mental health and quality of life [1-3]. Lifestyle interventions including physical activity combined with dietary modification are also effective in preventing or delaying progression to type 2 diabetes in individuals at increased risk of the condition [4]. However there remain uncertainties around the physiological responses to different types of physical activity across diverse groups of people with, or at risk of, diabetes and how this might qualitatively and quantitively affect recommended activity dose. We also need to know more about how to develop, evaluate and implement effective interventions to promote sustained increases in physical activity in these groups. These gaps in knowledge were identified by the Diabetes UK Diabetes Research Steering Groups (DRSGs) which were established, in 2017, to bring together researchers, healthcare professionals, and people affected by diabetes to examine the research landscape, amplify the voices of people affected by diabetes, and identify research priorities and practical actions to progress research in areas of unmet need. As part of their landscape analysis, the DRSGs review existing priority setting exercises undertaken with people with, or at risk of, diabetes and have identified the need for increased research investment that focuses on understanding the role of physical activity in diabetes management and how to increase engagement and motivation with physical activity by different groups. This was particularly highlighted in the type 2 diabetes Priority Setting Partnership carried out in collaboration with the James Lind Alliance [5] which identified the following priorities:

- What is the best way to encourage people with type 2 diabetes, whoever they are and wherever they live, to self-manage their condition, and how should it be delivered?
- Should diet and exercise be used as an alternative to drugs for the management of type 2 diabetes, or alongside them?

In response to these recommendations, an expert advisory group was formed, and a workshop conducted to identify the key research priorities around diabetes and physical activity, create a roadmap for the diabetes research and funding communities, provide a space for networking, and foster future research collaborations.

The aim of the process was to develop a position statement which identifies research priorities related to diabetes and physical activity and provides recommendations to researchers and research funders on how best to conduct research in these areas.

Methodology

In March 2022, Diabetes UK brought together clinical, academic, and lived expertise for a one-day workshop to identify key gaps in the evidence around diabetes and physical activity. In total, there were 48 attendees, including 10 people living with or affected by diabetes, 24 researchers, six healthcare professionals, three research funders, and five Diabetes UK staff who facilitated the workshop. Attendees are listed in Appendix I.

Prior to the workshop, an expert advisory group met to determine the scope and format of the workshop. This group advised that the workshop should focus on two areas with built-in consideration of three cross-cutting themes as described below.

Focus 1: Changes across the life-course of diabetes (childhood, teen, young adult, pregnancy, menopause, older age)

Focus 2: Multiple long-term conditions and the role of physical activity

Cross-cutting themes:

- Understanding physiology
- How to increase engagement and maintain motivation
- Gender and ethnicity

The day opened with presentations from experts in the field. Following these presentations, attendees were split into small groups, each with representation from different areas of expertise, and were asked to discuss the following questions: (1) Having heard the speakers and bringing in your own views, what do we already know about this area? (2) What strengths do we have that we can build on? (3) Where are the gaps? and (4) What opportunities do you see?

Each group was asked to prioritise one or two priority topics for further discussion. These topics were collated by the Diabetes UK team and attendees were asked to rank the resulting themes in order of priority.

The top themes were selected for further discussion. Attendees were asked to go back into small groups, each focused on a different theme, and discuss the following questions: (1) What could help address these gaps? What is the research question? (2) What approaches should be taken? (3) What are the barriers? How could they be overcome? (4) When could this be achieved and are there any dependencies; and (5) What skills/capabilities are needed?

Finally, the groups fed back to the whole group of attendees and asked the following questions: (1) What could make this idea even better? (2) What else do you think needs to be considered? (3) What are the dependencies/links to other themes?

This report summarises the outputs from those discussions and outlines key recommendations under each of the themes.

Research priorities and recommendations:

Theme 1: Better understanding of the physiology of exercise in all groups of people: in particular what metabolic characteristics within an individual influence or predict the physiological response to physical activity, and the potential role of physical activity in beta cell preservation

Context

Type 1 diabetes

People with type 1 diabetes can experience dramatic fluctuations in blood glucose during and even several hours after activity, often resulting in hypo- or hyperglycaemia [6]. These fluctuations seem to be influenced by the type of activity undertaken (e.g. aerobic, resistance or high-intensity interval training (HIIT)), intensity and duration [6-9]. Importantly, these fluctuations make exercise (i.e. undertaking physical activity which is planned, structured, and repetitive and has as a final or an intermediate objective the improvement or maintenance of physical fitness) a challenging aspect of diabetes management with two of the top-ranking barriers to exercise being 'diabetes specific': fear of hypoglycaemia/ hyperglycaemia and loss of control/ glycaemic variability [10]. As such, understanding the acute effect of exercise on glycaemia is a crucial step to reducing barriers to exercise in people with type 1 diabetes.

Although the most active people with type 1 diabetes have reduced HbA1c and fewer diabetes-related complications [11], a meta-analysis of training studies did not provide evidence that chronic exercise benefits HbA1c [12]. This difference may be because there is a lack of large, long-term (at least 6 months), well-designed trials investigating the glycaemic benefits of exercise in people with type 1 diabetes or because the advice we give about managing glucose around exercise is poor. However, exercise training has been shown to improve cardiorespiratory fitness, insulin sensitivity, lipids, endothelial function, strength and well-being and reduce insulin requirements [13].

Type 2 diabetes

A single bout of exercise, either aerobic, resistance or HIIT, has been shown to increase insulin sensitivity for at least 72h [14]. In addition, meta-analyses have shown that regular exercise training (aerobic, resistance or HIIT) reduces HbA1c in people with type 2 diabetes [15-18], with the reduction comparable to that observed with the addition of 'non-insulin glucose lowering drugs' [19]. Regular exercise training has also been shown to improve insulin sensitivity, lipids, blood pressure, other metabolic parameters, and cardiorespiratory fitness, even without weight loss [20].

Evidence suggests that exercise type, duration [15] and intensity [16] may influence the magnitude of change in clinical outcomes but uncertainty regarding optimal interventions and the minimal dose of exercise still exists which should be considered in future studies. In addition, much of the evidence has been developed in people with good glycaemic management (HbA1c <75 mmol/mol (<9%)), aged approximately 60, without major comorbidities and treated through lifestyle modification or metformin alone. As such, work is needed in a larger spectrum of people with type 2 diabetes, taking into consideration how exercise may need to be modified across the life-course.

Research recommendations

Type 1 diabetes

- There is a need to establish how modality (Moderate-intensity continuous training (MICT), Resistance training (RT) or HIIT), time of day (morning vs evening) and nutritional strategies (insulin dosage, carbohydrate intake) influence the blood glucose response to exercise. Within such studies, consideration of underlying physiological factors such as sex, age and physical fitness need to be considered.
- A consensus should be developed on the most important outcomes for investigating blood glucose responses to exercise and how these outcomes should be reported. This would enable meta-analysis to be conducted.
- Mechanistic and definitive interventions are needed to determine whether exercise can impact the trajectory of beta-cell decline in people newly diagnosed with type 1 diabetes and people at high risk of type 1 diabetes. In these trials, exercise should be studied on its own or in combination with other therapies.

Type 2 diabetes

- There is a need for more research on whole-body physiological responses, both acute and long term, to exercise in different groups of people, for example, the influence of age, ethnicity, sex, and body weight. Such studies should consider interventions across the physical activity spectrum (breaking sitting to HIIT) to provide greater information towards optimised personal prescriptions.
- There is a need to understand how exercise physiology interacts with commonly prescribed and newer generations of glucose-lowering therapies, as there is potential for both synergistic and antagonistic interactions.

Both type 1 and type 2 diabetes

- Measurement of dose should be considered in the standard reporting of exercise and physical activity interventions. Such reports should consider the frequency, intensity, timing (duration) and type of exercise/physical activity performed. Where possible this should be conducted using appropriate objective measures.

Theme 2: Designing physical activity interventions for maximum impact

Designing and evaluating multi-level approaches for physical activity promotion

Context

Despite multi-level approaches to behaviour change being used as frameworks for promoting health behaviours for many years [21-23], most physical activity intervention research to date has focused on individual-level intervention approaches (delivering interventions to individuals, either one-to-one, or in small groups (of around 10-20 people)). However, there is increasing recognition of multi-level influences on behaviour change. While intra-individual cognitive processes may underpin motivation for engaging in physical activity to prevent and manage diabetes, the social/family, physical, financial and cultural environment around individuals, as well as other contextual factors (e.g., occupation, shift work, school environment, taxation, regulations, health and social care systems, geographical location) may also be substantial influences [24]. In previous research on interventions to promote physical activity for diabetes prevention and management, these influences have largely been overlooked or understudied.

Various frameworks of multi-level influence already exist, such as Bronfenbrenner's ecological systems model [25]. Recent Medical Research Council (MRC) guidelines on intervention development and evaluation [24] highlight the need to identify multi-level influences on health behaviour and to consider intervention strategies that might target them. However, a key challenge is to unpick the complex inter-relationships between complicated systems of factors that influence change and identify targets for intervention. The MRC guidance also includes ideas on how to conduct evaluations of multi-level interventions which inevitably require different approaches to those assessing individual level changes. These ideas may have relevance to diabetes prevention, where there currently is a lack of evidence to identify the optimal balance between targeted individual level interventions for people at high-risk of type 2 diabetes and more systemic interventions targeted at wider populations.

Place and space (i.e. the physical nature of our environment and its social and cultural context) is an important consideration in the design of interventions but is not always considered in this context. Environment that is conducive to physical activity has been shown to reduce health inequalities [26]. There is a lack of cross-discipline and cross-sector working in the design of environments to make the living environment more resilient and conducive to health benefits (e.g., pedestrianised areas and workplace design).

Research recommendations

- More research is needed to identify/understand the influences of environment and multi-level influences on physical activity in people with diabetes, or at risk of type 2 diabetes (as well as in the general population). This may include data mining, retrospective analysis of previous interventions, or natural experimental approaches to identify a) the extent to which environmental or system-level factors influence physical activity b) specific effects on people with, or at risk of diabetes and c) factors that are associated with long-term maintenance of physical activity.
- More research is needed to design and evaluate interventions that work at multiple levels of behavioural influence. This may include intervention at the family, community /environmental, workplace, regional or population level, either separately or in combination with individual level interventions.
- There are significant methodological challenges around evaluating systems-level and multi-level approaches, so innovative (including non-trial) methodologies should be welcomed [24, 27]. These

may include, but are not limited to natural experiments, stepped wedge or cluster trials, realist evaluation, action research, systems mapping (including mapping of physical activity opportunities in a locality) and network analysis. This may include evaluation/research nested in larger-scale real-world systems, such as national diabetes prevention programmes.

- Intervention evaluations should consider the potential health economic impact on the whole population of people at risk of, or living with, diabetes. This will allow comparison of different types /levels of intervention.
- Place and space should be considered in the design of all interventions through cross-sectoral engagement with key stakeholders and policy makers to ensure place and space is conducive to physical activity.
- The value of developing communities of interest to facilitate cross-sectoral engagement of researchers, beneficiaries, policy makers and funders, including support for engagement in research and delivery of outcomes across all disciplines and communities, requires consideration and evaluation.
- Where new interventions are developed, rigorous methods that include co-design (including topic experts as well as experts by experience and other relevant stakeholders) are needed and should include collection of new bespoke data where needed and synthesis of multiple sources of evidence and sufficient time to deliver this. A wider range of experts may be needed for multi-level intervention approaches.

Co-designing physical activity interventions

Context

Research that is conducted *with* people that it might affect rather than simply *on* them should be valued more highly. Meaningful participation by key stakeholders in all stages of the research process has the potential to shape the type of research that is conducted, increase impact, reduce research wastage, improve intervention design and address inequities if those often excluded from the process can have a voice [28]. There are many approaches to involving key stakeholders in the research process including co-design, co-production, participatory methodologies and patient and public involvement. Common themes across these methods are the inclusion of multiple perspectives, the need to build and maintain trusting relationships with others and the incorporation of these multiple perspectives in the shaping of any research project. The differences are evident in the origins of each approach, the points at which each method helps to shape the research project and the degree to which these multiple perspectives can contribute to the project direction.

Research recommendations

- Research should, at an early stage, include a mapping process to identify key stakeholders (i.e., those who have an interest in the intervention and/or its outcomes) for a co-design partnership. Efforts should be made to ensure that seldom heard groups who might benefit from the intervention are included.

- Co-design should involve a collaborative partnership between all stakeholders where the contributions of all are valued. Key decisions such as agenda setting, intervention design, and evaluation planning should be shared, open and accountable. A spirit of inclusiveness and mutual respect should exist, and different perspectives, experiences, and expertise should be valued.

- There is a need for greater innovation and evaluation of co-design and participatory processes in research. As such, research studies should report how they have engaged people in projects; how this engagement was planned, what the aims were, the methods used, how engagement was optimised and how the impact of this engagement was evaluated.

Theme 3: Promoting sustained physical activity across the life course

Context

Physical activity as part of daily life has an important yet sometimes underestimated role to play in helping people living with diabetes improve blood glucose management and enhance their quality of life [29]. Interventions demonstrating success in studies of physical activity do not always translate into increased uptake in real-world settings, and there is no one size fits all intervention that can be applied across all communities. Strategies need to reflect and evolve across the life course and be inclusive to all potential beneficiaries.

Even small increases in physical activity are likely to be beneficial for people who are not currently meeting government physical activity guidelines [31], including people with type 1 and type 2 diabetes. However, short-term increases in physical activity that are not sustained are unlikely to have much impact on longer-term diabetes or cardiovascular outcomes.

There is a limited range of evidence looking at long-term follow up (beyond 12 months) of interventions to promote physical activity, particularly in people living with or at risk of diabetes. There have been a few trials, such as the PROPELS trial [32] which showed that changes in walking activity (532 steps per day) at 12 months were not sustained at 48 months.

In the wider adult population, recent systematic reviews of long-term physical activity following interventions [33] indicate that effects on physical activity are sometimes sustained quite well, although the number of trials reporting effects beyond 12 months is small. One of the best performing interventions seems to be providing pedometers alongside brief support from a nurse in the PACE-UP trial (this increased steps by one-tenth at 12 months and this was sustained at three-year follow-up) [34]. However, this success has not been replicated in people with or at risk of diabetes; for example, the PROPELS intervention outlined above included similar components, but did not produce long term effects on daily step-count or other measures of physical activity. More research is needed to understand what kinds of interventions support sustained physical activity, for whom and in what circumstances. Different interventions may also be needed depending on the type of activity targeted: The complex relationship between sedentary behaviour, moderate or vigorous physical activity and health conditions is still emerging [35].

Evidence on effectiveness of real-world interventions that successfully promote long term changes in physical activity in children /adolescents, with or without diabetes is sparse [36]. Although there is some evidence of effective interventions in older adults [37, 38], only a few trials have demonstrated long term benefits (beyond 12 months) [39]. Whilst it has been suggested that transition points in life, such as retirement or changing schools present key opportunities for interventions to increase or maintain physical activity, there is very little evidence on the effectiveness of such interventions [40].

The issue of inclusivity /adaptation of physical activity interventions (or ways to maximise access) for different ethnic and cultural groups is another major issue if widespread and equitable implementation is required, and this applies to both adults and children.

There are potential learnings from existing interventions or behaviour change frameworks and community programmes for specific groups [30] that are not consistently used by others probably due to lack of reporting or lack of robust findings from limited scale investigations. Improved qualitative information, detailing how and why interventions work, would support larger trial development, delivery and outcomes. How different communities could be supported to do this – e.g., partnering with academic and delivery teams - is unclear.

Research recommendations

Sustaining physical activity

- Research is needed to evidence what works for sustaining changes in physical activity. More research is needed on interventions that target sustained physical activity (for longer than 12 months) or aim to extend the effects of already-effective short-term physical activity interventions.
- Studies should look at differences in individual characteristics, context or processes of behaviour change between groups of people that have achieved sustained behaviour change, and those that have not (studies of relapse and resilience). This may include analysis of prospective /retrospective cohorts, signing up of trial participants for longer-term follow-up, or enrolment of people into a long-term physical activity registry.
- A number of physical activity interventions have been successful at increasing physical activity over the short- to medium-term in people with, or at risk of, diabetes. Research is needed to determine whether such approaches are scalable, and whether they are effective and cost-effective over the long-term.
- Implementation research is needed to maximise the uptake and reach/inclusivity of successful (and realistically deliverable) interventions promoting sustained physical activity in people with, or at risk of diabetes. We need robust methods as well as research to identify a) what needs to be different about our intervention approaches for which ethnic /cultural /socioeconomic groups and b) How can we adapt our intervention approaches to maximise inclusivity/ engagement and adherence?
- Researching maintenance comes with methodological (and funding) challenges due to the long-term follow-up periods required. Innovative approaches are needed to deliver “efficient” evaluations of long-term physical activity interventions. This may include multi-arm, or ’platform’ trials, use of digital or routine data collection, or data linkage (e.g., to general practice research databases, Hospital Episode Statistics, or Google trace).
- More research is needed to map out the health economics and potential value of different approaches to promoting long-term changes in physical activity for people with or at risk of diabetes: How much is it worth spending to achieve a mean 20-minute increase in weekly moderate-to-vigorous physical activity, or in muscle strengthening activity, or in light physical activity that is sustained for 5, 10, or 15 years? What intensity and duration of interventions will provide the best (long-term) value for money? The comparative health economics of more

intensive, or ongoing intervention vs briefer intervention approaches needs to be evaluated or modelled. The benefits to different stakeholders (Researchers, Healthcare professionals, NHS, patients, wider society) also need to be identified.

Promoting physical activity across the life course

- Evidence is needed for what constitutes a clinically meaningful (sustained) increase in physical activity for people with diabetes, and whether this differs across the life course.
- Evidence is needed on what intervention techniques /formats work for promoting physical activity across the lifespan (for people with type 1, type 2, pre-diabetes).
- Research should focus on how we can best promote physical activity (including diverse modes of physical activity, such as breaking prolonged sedentary behaviour, MVPA (moderate to vigorous physical activity), LVPA (leisure-time vigorous activity), HIIT (high intensity interval training)) for children and adults at scale.
- More research is needed into what factors might impact on physical activity change during key life transitions (e.g., the transition to young adulthood, having children or retirement) and what interventions would help to sustain physical activity across key life transitions in early years, adulthood and older age.
- Research is needed to understand and address the post-COVID decline in physical activity and how this relates to different age groups.
- Across the lifespan, we need robust methods as well as research to identify a) what needs to be different about our intervention approaches for which ethnic / cultural /socioeconomic groups and b) How can we adapt our intervention approaches to maximise inclusivity/ engagement and adherence?
- There is a need to evaluate novel approaches to individual-level interventions, for example stepped care and digital approaches.
- Longer term evidence is needed on the impact of digital interventions.
- Strategies are required to use what has already been learnt from other settings and disciplines to establish practicable approaches which are deliverable in health and care settings to benefit the recipients and reach and engage relevant communities.
- Ways to enhance and integrate co-production, outreach and implementation science approaches to improving physical activity in daily life for people living with diabetes should be identified, and the benefits assessed.

Theme 4: Designing physical activity studies for people with type 2 diabetes and multiple long-term conditions (MLTCs)

Context

Type 2 diabetes reflects a physiological model of accelerated biological ageing affecting whole body health and function [41]. One of the manifestations of this is the high prevalence of comorbidity or multimorbidity. Over two-thirds of those with type 2 diabetes have at least one comorbidity, the most common being hypertension, depression and coronary heart disease [42]. Whilst the importance of comorbidity and multimorbidity are well publicised, one of the most pernicious sequelae is an increased risk of poor physical function, disability and frailty that can occur in younger as well as older people living with diabetes. By middle-age, those with type 2 diabetes are up to five times more likely to be frail than individuals without type 2 diabetes [43], with frailty and the preceding 'pre-frail' state increasing both the individual (hospitalisation, institutionalisation and/or death) and public health (health care expenditure) burden of diabetes [44-46]. Indeed, frailty and physical disability are now recognised as a third major category of complications in people with type 2 diabetes after micro- and macro- vascular complications [47]. Those with type 2 diabetes are known to have impaired muscle function and structure [48], which contribute to impaired physical function, disability and frailty. Physical activity has an important role to play in this respect. Aside from the positive impact on blood glucose regulation and cardiovascular risk profile, physical activity can act as an anabolic stimulant to improve physical function and muscle health, while also improving mental health and reducing levels of depression. Accordingly, exercise-based rehabilitation is a well-established therapy for other chronic conditions associated with disability and frailty. However further research is needed to understand how the rehabilitation model of delivery can be adopted and utilised within the management of type 2 diabetes, taking into consideration the functional limitations imposed by common comorbidities. Importantly, levels of multimorbidity and frailty/disability are more prevalent in deprived and minority ethnic communities [49, 50]. Thus, a concerted effort is needed to ensure that seldom-heard populations are included within both the co-design of and participation in clinical trials.

Research recommendations

Mechanistic to phase II clinical trials

- Interventions should work to understand and address the underpinning phenotypes of frailty and MLTCs in type 2 diabetes, such as muscle dysfunction.
- There is a need to investigate the effect of recent innovations in weight loss and glucose management interventions for type 2 diabetes in those with concurrent MLTCs and frailty, including remission diets or newer generations of weight loss therapies, and whether physical activity can be used to optimise metabolic responses, preserve lean mass and improve physical function.

Phase III, behavioural trials and health services research

- There is need to investigate whether established cardiac and pulmonary rehabilitation pathways could be adapted to, and integrated within, diabetes management pathways for those with MLTCs and poor physical function or frailty.

- Using and adapting referral pathways for physical activity interventions within the community are required for those with diabetes and MLTCs, with the necessary training and upskilling of the wider sport and physical activity workforce around best practice for screening and prescribing physical activity in these populations.
- It is recognised that a "one size fits all" approach to physical activity promotion and support is unrealistic, particularly in those with MLTCs. Specialities need to work together with people with diabetes using a condition agnostic approach to co-design a "menu of options" focusing on improving accessibility and adoptability. This would allow multiple interventions to be evaluated, with the aim of tailoring the right intervention to the right individual, gaining an improved understanding of how such approaches can be optimised for delivery in those from deprived or multi-ethnic communities.

Measurement and outcomes

- An agreed set of core outcomes (including PROMS) are needed for exercise and physical activity research in those with type 2 diabetes and associated MLTCs, that capture underpinning phenotypes common to MLTCs, such as impaired physical function and breathlessness.

Conclusion

This position statement outlines over 30 specific research recommendations developed across four key themes. It calls on the diabetes research community and funders to act upon these recommendations.

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Appendix I: Workshop participants

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