Title page

Title

Physical activity and exercise in adults with type 1 diabetes: understanding their needs using a person-centered approach.

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Running title

Physical activity and exercise in adults with T1D.

Key words

Physical activity; diabetes; person-centered approach; behavioral change; determinants.

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Abstract

Aims: Physical activity is a key component in the management of diabetes, but most people do not engage in recommended levels of physical activity. A recent consensus statement on exercise management in Type 1 Diabetes (T1D) fails to mention behavioral change and the specific determinants impacting on exercise management. The aim of this study is to investigate the needs of adults with T1D around physical activity and the challenges they face. Method: Using a person-centered approach, focus groups and individual semi-structured interviews recorded the perspectives of 67 adults aged 18+ with diabetes. Results: Four global themes were identified: 1) it's a balancing act; 2) winging it; 3) engagement and 4) encouraging uptake. These findings suggest that adults with T1D find it difficult to manage their diabetes and physical activity and decision-making is based on trial and error with minimal input from healthcare professionals. Participants want more information to enable them to manage their diabetes and physical activity effectively. Conclusions: Adults with T1D face unique challenges in relation to physical activity. Participants reported key determinants for being active. Research is needed to understand how physical activity promotion is best developed for those with T1D and the preparedness of healthcare professionals for delivering guidance to adults with T1D.

206 words

Physical activity and exercise in adults with type 1 diabetes: understanding their needs using a person-centered approach.

Introduction

Physical inactivity is on the increase and represents a leading risk factor for global mortality. In 2011 the World Health Authority (WHO) produced a set of physical activity guidelines in response to the problem of declining physical activity levels and the corresponding increase in prevalence of non-communicable diseases, including diabetes [1]. Physical activity in the context of these guidelines and this paper includes transportation, occupational and household physical activity, as well as sports and planned exercise. The recommendations advocate that adults aged 18-64 are active on a daily basis and over the course of a week engage in either 150 minutes of moderate intensity activity, 75 minutes of vigorous intensity activity or a combination of the two. In addition, adults are advised to undertake physical activity to promote muscle strength on at least two days per week. More recently, the importance of reducing sedentary time has been added to the recommendations [2,3].

The evidence clearly demonstrates that physical activity contributes to overall health and mental wellbeing [4]. For people with diabetes it has additional benefits since it is a key component of the initial and ongoing lifestyle management of the condition [5,6]. In those with Type 2 diabetes (T2D) evidence confirms that physical activity can improve glycaemic control [7] and for individuals with Type 1 (T1D), improvements in cardiovascular health and insulin requirements have been established [8,9]. Furthermore, these health benefits may help reduce the risk of long-term diabetes-related complications and improve quality of life. For these reasons individuals with diabetes are recommended to participate in physical activity as much as the general population [10,11]. Even so, despite all the

evidence in support of physical activity as a management tool for diabetes, studies show that most people with either T1D or T2D, just like their healthy counterparts, are still insufficiently active [12]. Similarly, the importance of reducing sedentary behavior alongside increasing physical activity levels as a whole package for the management of diabetes is not emphasized enough [13,14].

The literature highlights the modifiable factors responsible for the lack of engagement in physical activity and health improvement interventions amongst healthy populations [15], but less so for those with diabetes, in particular those with T1D. Health improvement interventions which tackle lifestyle risk factors are important from a public health perspective [16]. In developing effective interventions, the literature calls for person-centered approaches in understanding the determinants that enable and inhibit participation in lifestyle interventions, including physical activity [17]. Person- and patient-centered approaches are often used interchangeably. However, person-centered approaches focus on the whole person and represent a growing trend in healthcare for the need to understand the person living with the condition in the context of their overall lives and recognize their expertise in decisions affecting their care [18]. Instead of being passive recipients of care, those living with a chronic condition such as T1D, increasingly are encouraged to be active participants in their care [19]. Although similar, the use of ‘patient’ in patient-centered approaches suggests a focus on people, only in terms of accessing a health service for care or treatment, rather than the wider context in which they live their lives. In addition, it has been suggested that ‘patient’ is synonymous with a power imbalance, between the person with the condition and the healthcare provider [20].

Given the emphasis on person-centered approaches and the fact that determinants are not only multi-layered, but also can be inextricably connected, public health guidance recommends adopting a socio-ecological perspective to understand the

factors that facilitate and inhibit participation in protective behaviors such as physical activity [17]. In this approach, determinants are viewed from the behavioral, social and environmental perspectives and aspire to provide detailed insights and furnish understanding of how best to intervene [17].

Few studies have examined the reasons why people with T1D are less active and only one study that we have found uses qualitative methods to investigate inactivity in those with T1D [21]. In recognition of the fact that those with T1D and the issues they have relating to physical activity are under-reported in the literature, the aim of this paper is to use a person-centered approach as part of a qualitative framework. This is important in order to provide a more in-depth appreciation of the wider lifestyle challenges facing adults living with and managing T1D than previously reported and to improve our understanding of the ways in which physical activity amongst this group can be increased. Moreover, the findings have the potential to shape the planning and delivery of effective interventions for this group.

Method

Given the call for person-centered approaches discussed [17], this current research was based on a phenomenological approach that focused on people's lived experiences [22]. This was considered to be the most appropriate theoretical framework for our work with adults who had diabetes, since it facilitated an exploration of their perceptions and understandings in relation to their condition and physical activity.

Data collection

A purposive sampling approach was adopted to recruit adults with diabetes to share their experiences of living with diabetes and physical activity. Inclusion criteria were established that incorporated males and females of any ethnicity, aged 18 and above, with diabetes. All participants attended a hospital in England,

which we have named H-A. Participants were recruited via a covering letter explaining the research and this was sent from the diabetologist and the lead author who had no prior interaction with the sample of potential participants. Those participants that responded to the covering letter were sent an information sheet and a consent form. When the signed consent form was returned participants were contacted to attend a focus group discussion or a one-to-one interview in their locality.

Focus groups and interviews were chosen as the methods for data collection to allow participants relatively free scope to explore and elaborate on their own views and experiences in respect of diabetes and physical activity [23]. Participants tell us they want to spend as little time as possible attending hospital and, therefore, focus groups were held on neutral territory at a venue in the local community. In addition, they were arranged at a time to suit the participants and no healthcare professionals (HCPs) or other individuals were present. Interviews were conducted face-to-face in participants' homes or by telephone.

Focus groups

A focus group and interview schedule was developed to guide the questions (see Table i). This was piloted beforehand to check the language used, the participants' understanding and the suitability of the questions in relation to the research aims. All the focus groups followed best practice guidelines, which meant the lead author facilitated the discussion and a second researcher made notes to capture paralanguage, contextual meanings, etc. [24]. Each focus group lasted approximately 1 hour 30 minutes and included between 8 and 10 people and the interviews lasted between 30 minutes to 1 hour. Focus groups and interviews were conducted until data saturation was achieved. Focus groups and interviews were recorded with the participants' consent and all took part voluntarily; no participation incentives were offered. Ethical approval was obtained from the relevant NHS and

University ethics committees, as well as the Research and Development department at H-A. The research study followed COREQ (consolidated criteria for reporting qualitative research) guidelines [25].

Sample characteristics

From a caseload of approximately 670 adults with T1D, 100 individuals responded to the initial letter explaining the research and 67 participants took part in the research. A total of 6 focus groups were conducted with an average of 8 participants per group; 17 interviews took place. All focus groups and interviews included males and females across all age groups, with 64% of males and 36% of females participating overall. The age range of females was 26 years to 84 years and that of males was 33 years to 91 years. The time since participants were diagnosed ranged from 2 years to 57 years and the age at which participants were diagnosed ranged from birth to 87 years. See Table ii for the participants' characteristics.

Data analysis

The focus groups and interviews were recorded, transcribed and analyzed according to thematic analysis [26]. This process was inductive and involved generating categories and coding data so that common themes and links could be identified. Two, and occasionally three, researchers were involved, thereby reducing interpretation bias. In addition, research participants verified the themes as a means of establishing the reliability of the research findings.

This paper focuses on the themes relating to individuals with T1D and are presented here concurrent with a qualitative approach.

Results

The findings from an analysis of the focus groups and interviews revealed four main or global themes (26). These were: 1) It's a balancing act; 2) Winging it; 3)

Engagement; 4) Encouraging uptake. Each global theme is presented along with an explanation of the organizing and basic themes that led to the development of the global theme. See Table iii for a breakdown of the global, organizing and basic themes.

Theme 1: It's a balancing act

A recurring theme amongst participants with T1D was the difficulty of managing the condition and physical activity. Regardless of the level at which individuals engaged in physical activity, the overwhelming response was that it was always a balancing act. The type of activity and the challenging nature of the condition meant that participants had to constantly weigh up the pros and cons of doing physical activity.

Type of physical activity

Planned or unplanned

Participants referred to planned and unplanned activity and the importance of a routine. In general the consensus was that participants found it easier to control their diabetes if physical activity was part of an established routine. Participants encountered problems when physical activity was unplanned because they had not prepared for it:

> "Looking after the kids is when I go the lowest, because I almost forgot about it then. I can pre-plan when I'm going for a run or playing football, but chasing around after a 7 year old…that's when I struggle the most." [Male; age 38]

Intensity and duration

The type of activity that participants engaged in, how hard they worked and for how long, were key themes to emerge from the data. Participants tended to stay safe by choosing activities that they felt confident enough to be able to manage with their diabetes. Explosive and high intensity activity took them out of their comfort zone:

> "On the different exercise I know exactly how I am going to be, pretty much on swimming, cycling and running. If you ask me to go play football it's a bit of an unknown quantity, I don't know because it's stopping and starting and I don't quite know how I would be." [Male; age 40]

Challenge of T1D

Too many variables

"Unpredictable", "frustrating", "demoralizing" and "complicated" were terms used in relation to the management of T1D when physical activity was added to what participants referred to as, "the control mix". The number of variables that had to be considered in managing the condition meant that participants could never be sure that the decisions they made were the right ones:

> "I think the common thing is, however you're managing your diabetes, exercise just brings with it a huge amount of variables and unpredictability. But to me that's the barrier to exercise is that feeling of, how is this going to affect my blood sugars?" [Female; age 42]

> "I can get demoralized with trying to balance my insulin and the exercise…I don't feel like I've cracked it with my exercise at all." [Female; age 52]

Active living and exercise

When physical activity was separated into active living and exercise, participants referred to the difficulties they encountered with active living, for example, housework or gardening. Unlike for activities that participants considered to be exercise, participants did not make any insulin adjustments for active living:

> "Hoovering…it always takes me by surprise…I'll test it and it will be low, it might have dropped 3 or 4 from what it was at

> breakfast, but I won't have given myself extra at breakfast, it's just dropped for cleaning, it's bizarre." [Female; age 47]

Theme 2: Winging it

The phrase 'wing it' was frequently used when participants described how they managed their diabetes and physical activity. Participants explained that they often improvised and discovered what worked for them through trial and error, with minimal input from HCPs.

HCPs

Training

Most participants believed that HCPs did not necessarily know how to manage diabetes and physical activity, which meant it was difficult for them to obtain accurate information and meaningful advice:

> "I was shocked when I first got diabetes, how hard it was to find that information (about physical activity) what to do and how to practically manage your diabetes. I found it very hard to get that specific advice." [Male; age 45]

Education

Most participants received very little, if any, education about physical activity as part of their diabetes management. The exception to this was if a HCP had a special interest in physical activity and they readily passed on their knowledge and expertise to participants. Participants acknowledged that if HCPs had not received training relating to physical activity it was difficult for them to offer appropriate and consistent education:

> "It has basically been trial and error to get them (blood sugars) balanced to what they are now because when you speak to one diabetes nurse you will get different advice from when you speak to a doctor or when you check on line." [Female; age 26]

Management strategies

Understanding

Many participants reported that they did not fully understand the relationship between diabetes and physical activity. Therefore, they did not necessarily know how to get the most out of physical activity and still manage their diabetes effectively:

> "To me it's the understanding thing and trying the different things as to what works for you…the theory is the same, but everybody is different…you've to understand." [Male; age 40]

Independence

Most participants had not explored beyond the largely generic diabetes information provided by H-A. It was the exception rather than the norm for participants to have done their own research to enable them to engage in physical activity more successfully:

> "My experience with a lot of Type 1 diabetics, they wing it with exercise and I don't personally believe that you need to wing it. I think that there is a methodical process you can go through in terms of managing your insulin regime with a bit of coaching." [Male; age 45]

Theme 3: Engagement

Many of the facilitators and barriers for engaging in physical activity were unique to the T1D population.

Facilitators to activity

Health promotion

The main reason why participants were active was to improve their overall health, both physical and mental, not just their diabetes. When diabetes was presented as a motivating factor for being active, it was to reduce the health risks associated with

the condition:

> "My motivation to exercise is better control and to try and reduce complications…I don't think I would exercise, I might not be as motivated to exercise if I wasn't diabetic." [Male; age 41]

Enjoyment

Many participants were active simply because they enjoyed it. A measure of how committed they were to their chosen activity was that their diabetes had to fit in with their active lifestyle rather than diabetes dictating how they lived their lives:

> "Through my life I don't think diabetes has ever got in the way of exercise. I have done lots of different things, climbing, canoeing, running and all sorts of stuff." [Female; age 51]

Barriers to activity

Hypoglycaemia

The fear of hypoglycaemia (hypos) was the most common barrier preventing participants from being physically active. Some participants were not deterred because they had the confidence to make adjustments to avoid hypos; for others, the fear of hypos had an inhibiting effect, discouraging them from engaging in activity or reducing activity to a lower level compared with what they did before diagnosis:

> "I take the odd walk, but even the odd gentle walk for an hour or so, my sugar is down so I'm very anxious about going. I won't go on my own just in case something happens." [Female; age 61]

Motivation

Many participants struggled to find the enthusiasm to be active because they had to predict, plan and manage their blood sugar levels. They stated how easy it was

to feel demoralized and demotivated:

> "You know because you just feel like a freak sometimes, you think, 'what more have I got to do? If I hadn't have gone to the gym at all I'd have been fine' and you are trying to motivate yourself." [Female; age 45]

Embarrassment

Participants explained how they avoided gyms and formal activity classes because they found it embarrassing having to disclose their diabetes and then to be treated differently because of their condition, especially if they had a visible diabetes-related complication.

Theme 4: Encouraging uptake

We asked participants what would encourage them to either take up an activity or increase the level at which they engaged in an activity. The overwhelming response was to be better informed about their diabetes and specifically, to learn how physical activity affected their diabetes. Participants highlighted several methods which would increase the likelihood that they would be more active.

HCPs

Culture

Primarily, participants said a change in the general culture towards diabetes and physical activity amongst HCPs would encourage more people with T1D to be active. The perception was that physical activity was not seen as a priority by HCPs, instead, it tended to be perceived as a problem. Participants stated that HCPs needed to be more positive and adopt a 'can do' approach:

> "You've got to have a consultant that is willing to say, 'What is it that you want to do, what do we need to do to allow you to do that?'" [Male; age 60].

Advice

Participants appreciated that it was difficult for HCPs to give individual advice relating to physical activity. Nevertheless, they thought the advice they received was too basic and generic:

> "It's still a one-size-fits-all thing you know. That's the advice that they've (HCPs) got and one might know a little bit more than another, but they don't know how it's going to affect you compared to how it's going to affect me." [Male; age 47]

Participants wanted tailored information with guidelines and instructions on how to specifically manage activity with T1D:

> "You need some kind of advice tailored to what you want to do…then somebody to help you review it, you know, 'so how is it going, what's not working?'" [Male; age 65].

Peer support

Talking

Participants appreciated the opportunity provided by the focus groups to talk and share experiences about physical activity. They were in favor of attending courses and group gatherings where they could discuss different aspects of physical activity and learn from one another:

> "I am finding this discussion group…I am finding this incredibly helpful. To have something like this from time to time would be fantastic." [Female; age 26].

Instruction

Workshops/courses

Most participants expressed a definite reluctance to attend any activity class labelled as diabetes-related. However, they welcomed the idea of workshops focused on diabetes management and physical activity and suggested a series of

workshops over a period of time aligned to different themes, including the science behind diabetes and physical activity:

> "You kind of have this little bit of understanding of this disease you've got, but now somebody is explaining, 'well that happens because of this, when you do this that happens' and I think you are more confident when someone has explained the science to it." [Male; age 41].

Physical activity weekend

A diabetes and physical activity weekend was suggested as a potential way forward where participants could try different activities in a controlled and safe environment. Those who had previously attended such an event were very enthusiastic:

> "I feel really lucky that I found out about that exercise thing (weekend event) and went and everyone who went there has said that everybody who is diabetic should get to go on something like this…you are like, 'well that's why that happens'." [Male; age 41].

Discussion

In this study we conducted a qualitative exploration of the challenges facing adults with T1D and physical activity participation. Using a person-centered approach, called for in the literature [17], findings show that participants reported the key determinants to the adoption of preventative health behaviors (self-efficacy, social support, decisional balance and enjoyment), which support core behaviors such as being physically active. In terms of providing social support, advice and education, participants reported the role of HCPs. Overall, the findings raise important

practical applications for how interventions are designed and delivered for adults with T1D diabetes.

The salient literature incorporates many studies that focus on increasing our understanding of physical activity in adults with T2D [6,7,27], including ethnic populations [28]. However, it is noticeable that only a limited number of studies exist that have concentrated on identifying the determinants of physical activity amongst those with T1D [21,29]. Furthermore, the findings from these focus on barriers that are common to the general population to explain why members of the T1D population do not engage in physical activity [21,30,31]. Whilst we acknowledge that these barriers are important, our findings go further and indicate that in order to fully understand the relationship between those with T1D and physical activity, it is necessary to adopt a person-centered approach and consider other more complex and multifaceted determinants from a socio-ecological perspective and how these impact on health improvement interventions aimed at this group. Whilst recognizing that some of these determinants are generic across other populations with chronic conditions, for example, those with T2D or cancer, how these play out in practice for the T1D population is unique, given the requirement to manage T1D and physical activity through the use of insulin. Very few chronic conditions require this type of acute consideration.

A dominant theme to emerge from our study was that participants found it a constant challenge balancing the different attributes of physical activity alongside their diabetes. Reflecting decisional balance processes [32], our findings indicated that participants weigh up the pros and cons of adopting physical activity behaviors, taking into account the frequency, type and duration of physical activity. This was in contrast to other studies that emphasized time, access to facilities and fitting physical activity around work [33]. Whilst hypoglycaemia was highlighted as a potential impediment to physical activity amongst our research participants, which

ties in with the findings from other studies [21,29], this was not necessarily identified as a deterrent in our study. Participants reported that they enjoyed being active and engaged in activity to mitigate the health risks associated with their condition, which ties in with a person-centered approach that considers enjoyment and decisional balance as important factors in the uptake of physical activity. This was despite the fact that participants sometimes lacked the motivation to be active due to the additional burden that physical activity placed on maintaining effective diabetes control and feeling embarrassed by their diabetes. Participants did not stop being active, but were able to overcome these inhibiting factors.

A further theme to emerge from our study indicated that individuals with T1D did not understand the relationship between their condition and physical activity. In agreement with previous studies, we found that knowledge of insulin and its effects on blood glucose over time was variable [31]. For those who did have some knowledge, rather than discouraging them from engaging in physical activity we discovered that they were more inclined to experiment and take risks. This meant decision-making was based on trying a number of different strategies until they found an approach that worked for them. In effect, some participants had learnt how to perform successful health enhancing behaviors such as being physically active, despite their condition. Not only does this provide an opportunity for individuals to become proficient in performing preventative behaviors [33], but also, regularly practicing such behaviors facilitates the refinement of factors that can support core behaviors. Laying down regular behavioral routines has the potential to facilitate self-efficacy and supportive social networks that can maintain being physically active [32]. Regularly practicing health enhancing behaviors also provides participants with an opportunity to establish what works and why, and celebrate and enjoy positive behavioral successes [35,36].

Furthermore, some participants deployed certain strategies when being physically active, including comprehending the benefits of being physically active (e.g. *what being active felt like*), substituting alternative practices (*e.g. when and how to amend frequency, timing, mode, duration of physical activity*), reminding oneself (e.*g. when and what to eat before and during physical activity*), increasing knowledge (e.*g. where to get advice on physical activity*) and securing social support (e.*g. which networks could provide information and appraisal to support being active*) [32].

Regarding social support and reflecting social and environmental determinants [17], and in common with other studies [5,37], an emergent theme from our study was the role of HCPs in providing informational and appraising social support in the form of education around diabetes and physical activity. Previous studies have concentrated on HCP training and predominantly people with T2D [5,6,38]. The main focus of HCP training has been behavior change theory and the necessity to avoid overloading T1D adults with too much information [38]. In contrast, firstly, our study identified a need for improved HCP knowledge of physical activity in relation to T1D, alongside appropriate and individualized application of this knowledge as part of a program that emphasizes the importance of physical activity in diabetes management [39]. Secondly, rather than a reluctance to take on board information, our findings strongly suggest that participants crave knowledge around physical activity and T1D. However, they are at a loss as to where to obtain information that is relevant and appropriate for them. Thirdly, we have highlighted the importance of developing strategies that support the core preventive behaviors and the essential role of HCPs in this process. To this end, our findings underline the importance of understanding the preparedness of HCPs for delivering guidance and support to participants. Further research is needed to understand how strategies used to support physical activity promotion are best developed for adults with T1D. With so

many demands placed on HCPs [40] it is feasible that not all HCPs will be able to provide guidance and support in a way that meets the physical activity needs of individuals with T1D. That said, for those who have preparedness to help, dialogue with HCPs is essential in understanding how best they can support individuals with T1D to be physically active.

Given that calls for person-centered intervention planning and design recommend adopting a socio-ecological perspective [17], future investigations should include HCPs and explore the multi-level determinants they face when developing programs for people with T1D. In this respect, mapping of the determinants HCPs encounter in their practice will provide detailed intelligence that can be used to shape future education and training programs in order that they can best meet the needs of people with T1D.

As far as encouraging uptake of physical activity amongst the T1D population, evidence is limited and to our knowledge only one study refers specifically to strategies for the promotion of physical activity amongst the T1D population [21]. The study in question presented participants with pre-identified options for encouraging physical activity. In contrast, our findings are based on an inductive approach where the participants themselves identified factors that would more likely incentivize them to be active. Participants highlighted the role of HCPs in the promotion of physical activity and the importance of differentiated advice to motivate individuals. This links to previous evidence around the power of medical advice to influence behavior [21]. However, rather than simply offering advice, our study demonstrates that a ‘can do’ culture amongst HCPs, with individuals who adopt a positive attitude towards physical activity for those with T1D is equally important. Furthermore, participants provided additional insights into the factors that would encourage activity which have not been raised until now; these included peer support, tailored workshops and a physical activity weekend.

Limitations and strengths

In terms of the limitations of this study, the findings presented here reflect the views and opinions of the study participants. For this reason the findings are not necessarily representative of the wider T1D population. Nevertheless, although generalizability may be limited, the salient themes highlighted in this study are likely to be pertinent to other T1D populations elsewhere. The strengths of this paper include an in-depth appreciation of the unique challenges facing adults with T1D, which greatly improves our understanding of the ways in which physical activity amongst this group can be increased. In particular, reflecting the need for person-centered approaches to intervention design [17], this study provided an understanding of the determinants impacting on those with T1D. In meeting the needs of this group, our paper provides valuable insights for future program development and design. More broadly it demonstrates that the T1D population deserves increased attention in respect of physical activity, including raising the profile of physical activity and T1D within health services and in future policies. The publication of this paper is particularly timely given that the recently published consensus statement on exercise management in T1D [10] fails to mention behavioral change and the specific determinants impacting on exercise management for this population [41].

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References

1. WHO. *Global recommendations on physical activity for health*. Geneva, Switzerland: WHO, 2011.

2. All Party Commission on Physical Activity. *Tackling physical inactivity – a coordinated approach*. London, UK: All-Party Commission on Physical Activity, 2014.

3. Public Health England. *Everybody active, every day: an evidence-based approach to physical activity*. London, UK: Public Health England, 2014.

4. Reiner M, Niermann C, Jekauc D, Wolf A. Long-term health benefits of physical activity: a systematic review of longitudinal studies. *BMC Public Health* 2013; **13**; 813.

5. Kirk AF, Barnett J, Mutrie N. Physical activity consultation for people with Type 2 diabetes. Evidence and guidelines. *Diabetic Med* 2007; **24**; 809-816.

6. Korkiakangas E, Alahuhta M, Laitinen J. Barriers to regular exercise among adults at high risk or diagnosed with type 2 diabetes: a systematic review. *Health Promotion Int* 2009; **24**(4); 416-427.

7. Colberg SR, Sigal RJ, Fernhall B, *et al*. Exercise and type 2 diabetes: the American College of Sports Medicine and the American Diabetes Association: joint position statement. *Diabetes Care* 2010; **33**; e147-e167.

8. Chimen M, Kennedy A, Nirantharakumar K, *et al*. What are the health benefits of physical activity in type 1 diabetes mellitus? A literature review. *Diabetologia* 2012; **55**; 542-551.

9. Cuenca-Garcia M, Jago R, Shield J, *et al*. How does physical activity and fitness influence glycaemic control in young people with Type 1 diabetes? *Diabetic Med* 2012; **29;** e369-376.

10. Riddell MC, Gallen IW, Smart CE, *et al*. Exercise management in type 1 diabetes: a consensus statement. *Lancet* 2016; doi: 10.1016/S2213-8587(17)30014-1.

11. Bull FC. and the Expert Working Groups. *Physical Activity Guidelines in the U.K.: Review and Recommendations*. School of Sport, Exercise and Health Sciences, Loughborough University, 2010.

12. Hayes C and Kriska A. Role of physical activity in diabetes management and prevention. *J Am Diet Assoc* 2008; **108**; S19-S23.

13. Healy GN, Winkler EAH, Owen N, *et al*. Replacing sitting time with standing or stepping: associations with cardio-metabolic risk biomarkers. *Eur Heart J* 2015: doi:10.1093: 1-7.

14. Wilmot EG, Edwardson CL, Achana FA, *et al*. Sedentary time in adults and the association with diabetes, cardiovascular disease and death: systematic review and meta-analysis. *Diabetologia* 2012; **55**; 2895-2905.

15. Biddle SJH, Mutrie N. *Psychology of Physical Activity: Determinants, well-being and interventions*. London: Routledge, 2005.

16. Zwolinsky S, McKenna J, Pringle A, *et al*. Physical Activity and Sedentary Behavior Clustering: Segmentation to Optimize Active Lifestyles. *J Phys Act Health* 2016; **13**(9); 921-8.

17. Eldredge-Bartholomew LK, Markham CM, Kok G, *et al*. *Planning health promotion programs: an intervention mapping approach*. New Jersey, USA: John Wiley & Sons, 2016.

18. World Health Organization (WHO) WHO global strategy on people-centred and integrated health services. Interim report. 2015. Available at: http://www.who.int/servicedeliverysafety/areas/people-centred-care/global-strategy/en/ (accessed August 2018).

19. NHS England. Five year forward view. 2014. Available at: http://www.england.nhs.uk/wp-content/uploads/2014/10/5yfv-web.pdf (accessed May 2018).

20. Barnett, N. Person-centred over patient-centred care: not just semantics. *Clin Pharm* 2018; 10(4); DOI: 10.1211/CP.20204578.

21. Lascar N, Kennedy A, Hancock B, *et al*. Attitudes and barriers to exercise in adults with type 1 diabetes (T1DM) and how best to address them: a qualitative study. *Plos One* 2014; **9**(9); 1-8.

22. Creswell J. *Qualitative inquiry and research design: Choosing among five approaches*. Thousand Oaks CA: Sage, 2012.

23. Mansell I, Bennett G, Northway R, *et al*. The learning curve: the advantages and disadvantages in the use of focus groups as a method of data collection. *Nurse Res* 2004; **11;** 79–88.

24. Kruger RA, Casey MA. *Focus groups: a practical guide for applied research*. London, UK: Sage, 2008.

25. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. *Int J Qual Health Care* 2007; **19**(6); 349-357.

26. Attride-Stirling J. Thematic networks: an analytical tool for qualitative research. *Qual Res* 2001; **1**; 385-405.

27. Casey D, De Civita M, Dasgupta K. Understanding physical activity facilitators and barriers during and following a supervised exercise programme in Type 2 diabetes: a qualitative study. *Diabetic Med* 2010; **27**; 79-84.

28. Mier N, Medina AA, Ory MG. Mexican Americans with type 2 diabetes: perspectives on definitions, motivators, and programs of physical activity. *Prev Chronic Dis* 2007; **4**(2); 1-8.

29. Brazeau AS, Gingras V, Leroux C, *et al*. Barriers to physical activity among patients with type 1 diabetes. *Diabetes Care* 2008; **31**(11); 2108-2109.

30. Sherwood NE, Jeffery RW. The behavioral determinants of exercise: implications for physical activity interventions. *Ann Rev Nutri* 2000; **20**; 21-44.

31. Yardley J, Mollard R, MacIntosh A, *et al*. Vigorous Intensity Exercise for Glycemic Control in Patients with Type 1 Diabetes. *Can J Diabetes* 2013; **37**; 427-432.

32. Marcus BH, Forsyth LH. Motivating people to be physically active. Champaign, Illinois: Human Kinetics, 2009.

33. Pringle A, Zwolinsky S, McKenna J, *et al*. Health improvement for men and hard-to-engage-men delivered in English Premier League football clubs. *Health educ Res* 2014; **29**(3); 503-520.

34. Cohen S, Mermelstein R, Kamarck T, *et al*. Measuring the functional components of social support. In: Sarason, IG (ed). *Social support: Theory, research and applications.* Netherlands: Springer, 1985, 73-94.

35. Archibald D, Douglas F, Hoddinott P, *et al*. A qualitative evidence synthesis on the management of male obesity. *BMJ Open* 2015; **5**; e008372 doi:10.1136/bmjopen-2015-008372.

36. Weaver NF, Hayes L, Unwin NC, *et al*. 'Obesity' and 'clinical obesity'. Men's understandings of obesity and its relation to the risk of diabetes: a qualitative study. *BMC Public Health* 2008; **8**; 311. doi:10.1186/1471-2458-8-311.

37. American College of Sports Medicine. Exercise and Type 2 diabetes. *Med Sci Sports Exerc* 2000; **32;** 1345-1360.

38. Matthews L, Kirk A, Mutrie N. Insight from health professionals on physical activity promotion within routine diabetes care. *Pract Diabetes Int* 2014; **31**(3); 111-116e.

39. Sigal MD, Armstrong MJ, Colby P, *et al*. Physical Activity and Diabetes. *Can J Diabetes* 2013; **37**: S40-S44.

40. Gelsema TI, Van Der Doef M, Maes S, *et al*. A longitudinal study of job stress in the nursing profession: causes and consequences. *J Nurs Manag* 2006; **14**(4); 289-299.

41. Kime NH, Pringle A. Exercise and physical activity in people with Type 1 diabetes: the importance of behaviour change. *Diabetes Res Clin Pract* 2018; DOI: https://doi.org/10.1016/j.diabres.2018.02.024.

Table i Guide for focus group discussions/interviews

DEFINE – Diabetes Exercise and Fitness Needs. A qualitative study investigating physical activity and exercise in adults with diabetes.
This guide for the focus group discussions/interviews is designed to explore physical activity in relation to diabetes from the participants' perspectives.

Identify the current situation amongst participants regarding physical activity.
Probes:

- What does physical activity mean to participants?
- How much physical activity do participants think adults are currently recommended to do each week?
- How do you they find out about physical activity opportunities?

Explore physical activity in its broadest sense i.e. physical activity that is part of daily life, e.g. household, workplace and lifestyle related tasks and physical activity that is planned/ structured/done to improve at least one aspect of physical fitness, e.g. cycling, running, swimming.
Probes:

- What type of physical activity do participants do, how often and where? Why this particular activity?
- Why do participants engage in physical activity? Facilitators.
- Why do participants *not* engage in physical activity? Barriers.
- What are participants' attitudes, beliefs, perceptions, etc. towards physical activity?

Physical activity and the management of diabetes.
Probes:

- How does physical activity affect participants' diabetes and their overall health?
- How does it make them feel?
- How do participants' combine physical activity with nutrition and eating?
- How do participants' fit physical activity into their lifestyles? What strategies do they employ/'top tips'? What strategies have they tried that don't work?
- What type of physical activity have participants tried before, if any? What's worked and what hasn't? Why?
- What's changed, if anything, compared with before participants were diagnosed with diabetes?

Explore what is missing in terms of physical activity.
Probes:

- Where are the gaps, e.g. environmental (facilities, education, etc.) and personal (motivation, participants' knowledge and understanding, etc.)?

Explore what needs to change in terms of participants' physical activity and what needs to happen to bring about this change.
Probes:

- Education, confidence/self-efficacy, support/guidance from healthcare professionals/others, etc.

What can be done to help participants engage in physical activity/increase their uptake of physical activity/get more out of their physical activity?
Probes:

- What, where, who would they like to attend, i.e. people of similar ability/condition/gender/age, etc. and who would they like to facilitate (people they can relate to in terms of age/gender/ability, etc.)?

Table ii Participants' characteristics

Participant	Gender F Female M Male	Age	Age at diagnosis	Time since diagnosis	T1D/ T2D
1	F	65	62	3	T1
2	M	83	Missing data	Missing data	T1
3	M	66	17	49	T1
4	F	52	40	12	T1
5	F	26	9	17	T1
6	M	68	32	36	T1
7	M	91	87	3	T2
8	M	38	2	36	T1
9	F	54	29	25	T1
10	F	63	20	43	T1
11	M	48	23	25	T1
12	F	30	28	2	T1
13	M	Missing data	Missing data	Missing data	T2
14	M	38	24	14	T1
15	F	57	50	7	T1
16	F	26	11	15	T1
17	M	45	41	4	T1
18	M	56	42	14	T2
19	F	63	35	28	T1
20	F	42	25	17	T1
21	M	51	40	11	T1
22	M	50	16	34	T1
23	M	55	38	17	T1
24	M	46	13	33	T1
25	M	52	Missing data	Missing data	T2
26	M	53	51	2	T2
27	F	64	50	14	T2
28	F	56	52	4	T2
29	F	57	0	57	T1
30	M	67	25	42	T1
31	F	51	10	41	T1
32	M	52	20	32	T1
33	M	60	58	2	T1
34	M	64	30	34	T2
35	M	41	39	2	T1
36	M	36	23	13	T1
37	M	33	23	10	T1
38	M	58	13	45	T1
39	M	67	55	12	T1
40	M	60	8	52	T1
41	F	61	28	33	T1
42	F	84	Missing data	Missing data	T1
43	M	65	20	40	T1
44	F	65	20	40	T1
45	M	53	25	28	T1
46	M	65	30	35	T1
47	M	60	48	12	T1
48	F	45	8	37	T1
49	M	40	16	24	T1

50	F	47	13	34	T1
51	F	44	Missing data	Missing data	T1
52	M	42	14	28	T1
53	M	72	55	17	T2
54	M	46	43	3	T2
55	F	33	15	18	T1
56	M	Missing data	Missing data	34	T2
57	M	64	55	9	T1
58	M	46	13	33	T1
59	F	50	9	41	T1
60	F	50	10	40	T1
61	M	47	1	46	T1
62	M	53	25	28	T1
63	F	54	Missing data	Missing data	T1
64	M	56	43	13	T2
65	M	59	41	18	T2
66	M	52	Missing data	Missing data	T2
67	M	36	30	6	T1

Table iii Thematic analysis

Basic themes	Organizing themes	Global themes
Planned or unplanned	Type of physical activity	It's a balancing act
Intensity and duration		
Too many variables	Challenge of T1D	
Active living and exercise		
Training	Healthcare Professionals	Winging it
Education		
Understanding	Management strategies	
Independence		
Health promotion	Facilitators to activity	Engagement
Enjoyment		
Hypoglycaemia	Barriers to activity	
Motivation		
Embarrassment		
Culture	Healthcare Professionals	Encouraging uptake
Advice		
Talking	Peer support	
Workshops/courses	Instruction	
Physical activity weekend		